Village and Household Economies in India's Semi-arid Tropics

Thomas S. Walker and
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To Ann, Bill, Barbara, and Donna

In loving memory of Jim and Mary and for
Wendy, Stephen, and Christine

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Preface

This book has been a long time in coming. The hypotheses that guided much of the empirical research were framed in 1974. Data collection started in 1975. But the origin of the book really dates to 1972 when the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was founded in Hyderabad, India. ICRISAT was the first new center formally created in the emerging international agricultural research system. Its establishment reflected the importance in population and geographic area of rain-fed farming and the semi-arid tropics in world agriculture.

Semi-arid tropical regions are often characterized by scanty and uncertain rainfall, on which agricultural production largely depends, infertile soils, poor infrastructure, extreme poverty, rapid population growth, and high risks. That characterization of neglect also applied to social science research in the semi-arid tropics in the early 1970s. While India was well endowed with survey information and secondary data, much of it was aggregative, partial, cross-sectional, and concentrated on non-SAT regions. A consistent household time-series data base on a representative cross section of SAT villages was lacking. Such benchmark households and villages could be used by scientists at ICRISAT and cooperating Indian and overseas research institutions to enhance understanding of development in the Indian SAT and to test hypotheses relevant to the design of technology and policies for the improvement of economic well-being.

With those purposes in mind, longitudinal village studies were initiated in three important and contrasting production regions in India's semi-arid tropics in the mid-1970s. This book is largely about what we learned from those studies. In the early 1980s, the approach was extended to two other regions in India's SAT and to three regions in West Africa's SAT.

Because the SAT has not received much attention in the development literature, we felt it was important to document the microeconomic features of India's SAT which are common to other regions and the more numerous ones which are unique to it. We begin at the microscopic level of individuals and fields, aggregate to socioeconomic groups and villages, and ultimately move to regional contrasts.

Designing research and development strategies in the predominantly rain-fed SAT is not an easy task. It is our hope that the book will heighten the awareness of national policy makers and the international community of both the challenges and opportunities facing the hundreds of million people in SAT India. If it does not, this neglected region may neither realize its full potential nor participate in the gains from national economic growth.

There is literally a cast of thousands to acknowledge for contributing to the production of the book. Our greatest debt of gratitude is to the 264 respondent families in the six study villages for so willingly and cheerfully allowing us to invade their privacy over a period of more than ten years. Without their cooperation and hospitality and that of their fellow villagers, the studies could not have been conducted. To them we offer our most sincere *dhanyavad.*

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Village and Household Economies in India's Semi-arid Tropics

1 Introduction

The green revolution in wheat and rice in South Asia has largely bypassed two very extensive agricultural regions: India's dry semi-arid tropics (SAT) and East India's wetter upland rice-growing region. This book focuses on the dynamics of and prospects for agricultural economic development in the former region, where more than 250 million rural people live and depend heavily on rainfed agriculture for their sustenance.

Regions such as India's SAT, with comparatively limited potential for agricultural growth but with rapid population growth, pose difficult problems for an agricultural-based strategy of rural development. Several such regions occur in the SAT, including large parts of west, east, and southern Africa, northeast Brazil, and northeast Thailand.

The problem of a bypassed agricultural region is not of minor national significance, as illustrated by the Massif Central in France, Okinawa in Japan, and West Virginia in the United States. Although India has invested in irrigation at a historically unprecedented pace during the last three decades, 50 to 60 percent of cultivated area will still be rainfed by the year 2000. In spite of the geographic and demographic importance of dryland agriculture, irrigated agriculture has commanded the lion's share of agricultural research resources, and farmers in large canal-irrigated areas have benefited disproportionately from subsidized water, fertilizer, electricity, fuel, and credit. Moreover, research and experience in the irrigated Indo-Gangetic Plain in North India loom unduly large in conditioning much of the conventional wisdom about village and household economies and derived implications for development in India.

To partially redress that balance, we take a hard microeconomic look at what has happened recently to households in predominantly dryland agricultural villages in India's SAT. We start in this chapter by delineating India's SAT and the study regions, proceed to the focus of the book in the second section, and conclude by outlining the organization of the presentation.

India's SAT and the Study Regions

Agroclimatologically, the SAT includes those tropical regions of the world where rainfall exceeds potential evaporation four to six months of the year. Mean annual rainfall in the SAT ranges from about 400 to 1,200 mm. As defined in 1975 (at the initiation of the research on which this book is based), much of peninsular India is semi-arid tropical, and so are large parts of the states of Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, and Uttar Pradesh (figure 1.1). The noncoastal regions of Andhra Pradesh, Karnataka, Maharashtra, and Tamil Nadu on the Deccan Plateau and much of Gujarat and western and central Madhya Pradesh comprise the heartland of the rainfed agricultural belt in India's semi-arid tropics.

India's SAT is vast and encompasses about fifteen to twenty large regions, each embracing several districts. Based on cropping, soil, and climatic criteria, three contrasting dryland agricultural regions were selected for study: the Telengana region in Andhra Pradesh, the Bombay Deccan in Maharashtra, and the Vidarbha region also in Maharashtra (figure 1.1). Districts representative of those regions included Mahbubnagar in the Telengana region, Sholapur on the Bombay Deccan, and Akola in the Vidarbha region. Salient agricultural features of the selected districts are given in table 1.1.

To put agricultural growth in the study districts in perspective to what has been achieved in the irrigated wheat-growing belt of northwest India and in India's predominantly dryland semi-arid tropical states, the district annual growth rates of total cereal production from the late 1950s to the early 1980s are presented in table 1.2. Two major observations emerge from table 1.2: (1) growth in cereal production in the predominantly dryland agricultural SAT states has lagged far behind what has been obtained in the irrigated northwest and (2) cereal production performance varies considerably from district to district within the dryland SAT states, almost all of which contain regions of high, medium, and low production potential.

The study districts span much of the range of the diverse recent growth experience in cereal production within India's dryland SAT. In the rainfall-assured but little irrigated Akola region, growth (at 3.5 percent) in cereal output has easily outstripped population growth; in the more heavily irrigated but drought-prone Mahbubnagar region, growth in cereal production (1.5 percent) has just kept pace with population growth; and in rainfall-unassured Sholapur district, cereal production has stagnated (0.3 percent).

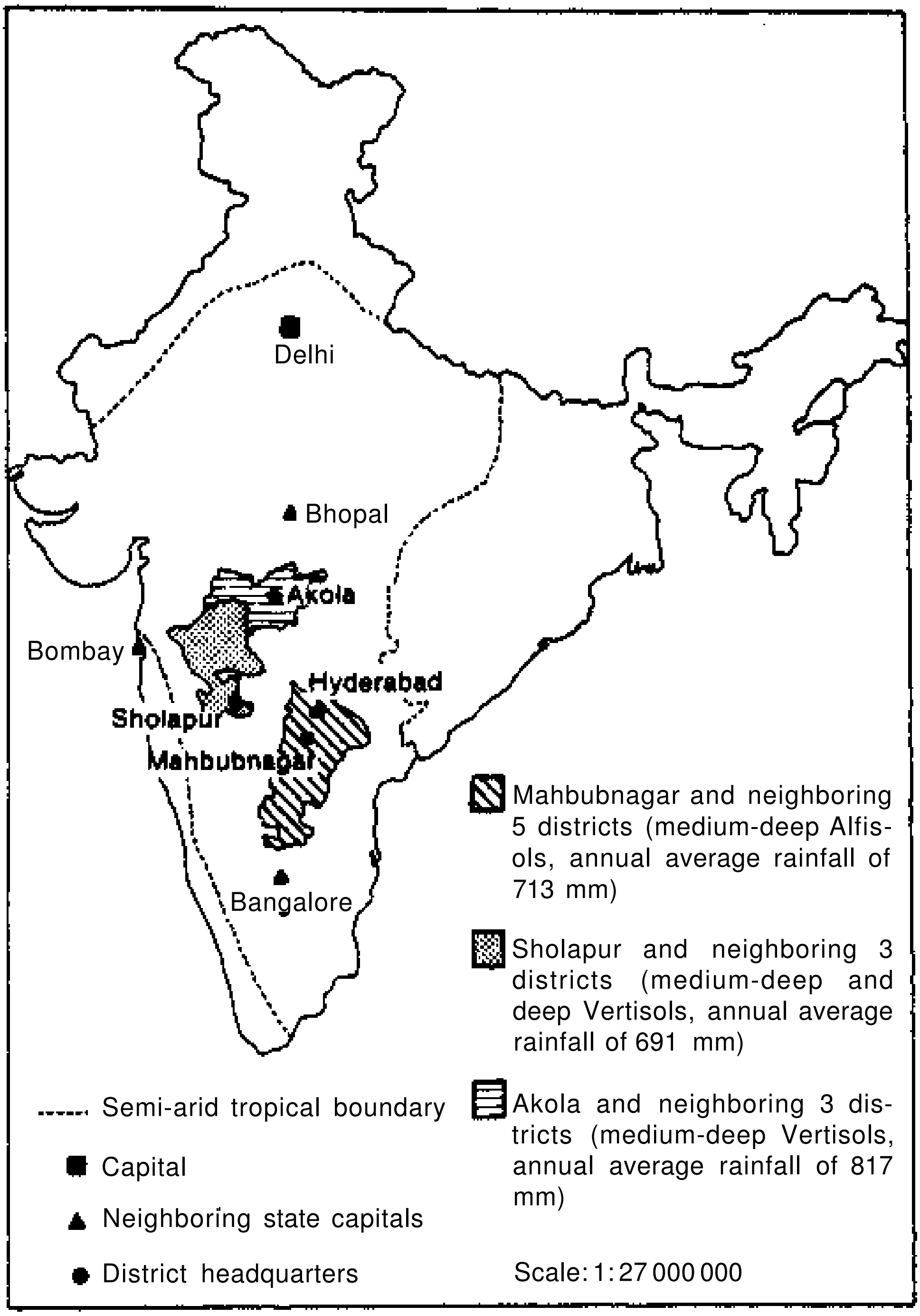


Figure 1.1 Location of India's semi-arid tropics and the three study regions in 1975
Note: The delineation of India's SAT has changed since 1975 because the mapping at that time was based on Troll's classification using temperature as one input; the revised mapping is conceptually identical but geographically somewhat different because potential evaporation has replaced temperature (S. M. Virmani, personal communication).

Focus

Enhancing the understanding of the dynamics of agricultural development in one of the poorest rural regions of Asia is the overall objective of this book. A recurring theme that cuts across the broad microeconomic canvass painted is the particularity of dryland agriculture. Some of the differences between dryland and irrigated agriculture are of degree; others are of kind. These differences, especially rainfall uncertainty at planting,

Table 1.1. Soil, rainfall, and crop characteristics of the study regions

	Region		
Characteristic	*Mahbubnagar*	*Shotapur*	*Akola*
Soils	Red soils (Alfisols); low-water retention capacity	Deep black heavy clay soils (Vertisols); high water-retention capacity	Medium deep black clay soils (Inceptisols);[a] medium water-retention capacity
Rainfall[b]	Unassured, 630 mm, 31% CV	Unassured, 630 mm, 35% CV	Assured, 890 mm, 22% CV
Major crops	Kharif, or rainy season, sorghum, castor, pearl millet, paddy (rice), pigeon pea, groundnut	Rabi, or post-rainy season, sorghum, pigeon pea, minor pulses	Cotton, sorghum, mung bean, pigeon pea, wheat

[a] Loosely called medium-deep Vertisols.

[b] The mean rainfall estimates and their coefficients of variation (CVs) in percent refer to ten annual observations collected in one study village in each region from 1975/76-1984/85.

the synchronic timing of operations, covariate production risk, and soil heterogeneity, and farmers' adaptation to them often mean that public policies or investment initiatives have bleaker prospects of achieving success in dryland than in irrigated agriculture. Even policies such as crop insurance, which would seem to be tailored to solving the problems of dryland agriculture, may be considerably more effective in achieving their objectives in irrigated tracts.

That dryland agriculture in the semi-arid tropics has a distinct flavor is commonly recognized by agricultural and social scientists. Permanent cultivation in semi-arid climates figures as a general type of permanent upland system in Ruthenberg's classic *Farming Systems in the Tropics* (1980). The distinguishing features of dryland agriculture have also been used to organize comparative studies across India's and West Africa's SAT (Hill 1982). But what these characteristics imply for the organization of production, policy performance, and technical change has only recently started to receive more empirical and theoretical attention. Some of the theoretical foundations have been laid by Binswanger and Rosenzweig (1986a), who, drawing on fairly recent advances in microeconomic theory, examine the implications of these features on production relations in a harsh, land-scarce environment similar to India's SAT.

Organization of the Book

The book is divided into four parts and is based on a unique source of information: household panel data from longitudinal village studies that we and our collaborators have been carrying out since 1975 in two villages in each of the selected three districts. The next two chapters are largely expository. How the village studies were conducted and where they fit

Table 1.2. Classification of districts by growth in total cereal production by region and state, from 1958/59-1960/61 to 1981/82-1983/84

Region and State	Compound Annual Growth Rate (%)					
	>4.5	3.1-4.5	2.4-3.0	1.6-2.3	0.0-1.5	<0
Irrigated northwest	45	12	4	1	2	0
Haryana	5	1	0	0	0	0
Punjab	10	0	0	0	0	0
Uttar Pradesh[a]	30	11	4	1	2	0
Predominantly dryland SAT	20	35	11	38	44	8
Andhra Pradesh	1	7	2	5	5	0
Gujarat	6	8	2	1	1	0
Karnataka	5	6	1	5	2	0
Madhya Pradesh	0	3	9	14	16	1
Maharashtra	0	5	3	7	9	2
Rajasthan	8	5	2	5	5	1
Tamil Nadu	0	1	0	1	6	4
Total	65	47	23	39	46	8

Source: Jansen (1988: table 2.5).
[a]Includes all districts in Uttar Pradesh, not just those in western Uttar Pradesh.

into social science and agricultural research in India are discussed in chapter 2. Profiles of the study regions and villages are presented in chapter 3. Agriculture dominates that presentation that concludes part 1 and sets the stage for the substantive chapters that follow.

Agricultural and economic development in these study villages since Independence in 1947 and particularly in the period 1975 to 1985 is treated in part 2. Time-related features of household income, consumption, and wealth are analyzed in chapter 4. The operation and recent evolution of village labor, land, and capital markets are featured in chapters 5, 6, and 7.

Part 3 makes for a more integrated microeconomic treatment of agricultural development in predominantly dryland production environments. Risk, nutrition, and technical change are the subjects of chapters 8, 9, and 10.

From chapters 3 to 10, some key empirical facts emerge which have important implications for agricultural development. Often these findings are at variance with conventional wisdom. Examples include the tightening in and the response of the village labor market to supply and demand influences and lack of support for "efficiency" and "subsistence" theories of wage determination, the absence of distress sales of land, decreasing economic polarization in the ownership of land, the beneficial role of moneylenders in financing productive investment, the lack of seasonality in caloric and protein intake, and the greater relative income gains made in the recent past by the poorer (often landless) households. Other findings, such as the production inefficiency of sharecropping, affirm popular belief. The implications of these findings are drawn out in a concluding section of each subject matter chapter, and, in a final synthesis chapter, the particular features of India's SAT are reviewed and prospects for agricultural development assessed.

The book is written mainly for specialists in the economic development of agriculture, but we hope that agricultural and social scientists other than economists, development specialists, and practitioners interested in microeconomic agricultural development in general and the semi-arid tropics in particular will find parts of the book useful. Agricultural scientists should feel at home in chapters 2, 3, and 10 and in the introductory and concluding sections to chapters 4 through 9. Reading those sections should enhance agricultural scientists' appreciation of why economists and other social scientists are often cast in the role of the bearers of bad news.

Part One Methods and Profiles

2 The Approach: Longitudinal Village Studies

The raw material for this book comes from a panel of households in benchmark villages representative of larger production regions within India's semi-arid tropics. These village studies, initiated in 1975, combine features of ethnographic inquiry, farm management studies, special purpose surveys, and on-farm research.

We begin this chapter by chronicling the genesis of the village studies. Sacrificing breadth for depth places a premium on choosing villages that are representative of their regions; therefore, we describe at length in the second section what we did to meet the yardstick of representativeness. What data were gathered and how they were collected is the subject of the third section. We conclude by discussing the thorny issues of extrapolating case study results to a wider geographic scale and the degree to which we feel researchers' presence in the villages could have influenced the findings.

India has a rich field research experience in village studies. Viewing the village as a focal point for agricultural and social science research dates back to at least 1915, when Harold Mann (1917) formally surveyed households in a village near Pune on the Bombay Deccan. This chapter would be incomplete without a discussion, provided in appendix 2.1, of where these longitudinal village studies fit into India's village and farm management research traditions. We also highlight some of the main lessons we have learned in the conduct of longitudinal village studies in appendix 2.2, which ends on a discussion of the trade-offs in and transferability of longitudinal study methods in agricultural research with a farming systems perspective.

Genesis

The need to collect uniform data across a panel of households over several years arose from three mutually reinforcing considerations centering on the nature of interdisciplinary research at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the variability of agricultural production in the SAT, and the potential for complementarities in data collection and analysis to address a range of research topics. In interdisciplinary agricultural research, the role of the social scientist is usually supportive: to provide information for decision making by biological scientists and research administrators. In particular, biological scientists wanted quick answers to diagnostic questions to ensure accurate problem identification and subsequent technology design. What was needed were representative benchmark locations which could function as loci for diagnostic research on technology design and adaptation. A more permanent field presence was indispensable to developing an institutional memory so essential to efficient agricultural research. Emphasizing a longitudinal study approach also meshed well with the comparative advantage of an International Agricultural Research Center (IARC) such as ICRISAT. Imparting continuity and stability to the agricultural research process was a major motivation for the IARCs' establishment.

An unstable production environment characteristic of the semi-arid tropics further underscored the need for a commitment to research in the same locations. Questions relating to risk, yield stability, and stabilization policies can best (and often only) be analyzed empirically with time series data at the household level.

Lastly, the research agenda of the ICRISAT Economics Program was broader than narrowly focused concerns about technology adaptation. Identifying constraints to agricultural development in the semi-arid tropics and alleviating them through technological and institutional change figured as an objective in the mandate of the institute. Given that objective, the following priority research areas were described with an accompanying set of hypotheses in 1974 (Binswanger et al.): (1) economic and environmental explanations of cultivation practices, (2) seasonal availability of resources—bottlenecks and surpluses, (3) human nutrition, (4) impact of risk on farmers' behavior, particularly on adoption of technology, (5) marketing and consumer acceptance, (6) social organization and group action, (7) income distribution and the distribution of benefits from technology, and (8) the speed of diffusion of new technology. Several of these areas shared common empirical features. That commonality could be exploited by collecting multiple observations on the same units. Moreover, by channeling the analytical capabilities of a number of researchers inside and outside ICRISAT on the same data base, complementarities could be produced which would add to more than the simple sum of individual results and insights. Thus, developing and nurturing a longitudinal data base appeared to be an effective means to multiply social science research resources.

Based on these three overriding considerations, village studies in three broad production regions of India's SAT were started in 1975. Other benchmark village sites—five in West Africa and two more in India—were opened in the 1980s.

Selecting the Villages and the Household Panel

The sample was selected in four stages (Jodha, Asokan, and Ryan 1977). First, as described in chapter 1, we identified districts that were representative of broad agroclimatic regions within India's SAT. Second, we relied heavily on secondary data to choose typical talukas (i.e., smaller administrative units) within those districts. Next, we picked representative villages within those talukas, and finally, we selected a random sample of agricultural households within the chosen villages.

The districts were chosen on rainfall, soil, and cropping criteria. After reviewing secondary data and consulting with scientists within ICRISAT, the national program (Indian Council for Agricultural Research [ICAR]), and the state agricultural universities, we focused on three districts representing three distinct agroclimatic and soils regions that comprise a considerable share of India's SAT (figure 1.1, table 1.1). Distance from ICRISAT headquarters then in Hyderabad, Andhra Pradesh, and access to a nearby agricultural university or research station for logistical support were other considerations that influenced district selection.

Secondary data on about forty variables were examined to choose modal talukas within each of the selected districts. In general, the talukas that were most frequently characterized by values falling within the modal intervals of the forty variables were chosen.

Keeping in mind the representative characteristics conditioning district and taluka selection, we visited twelve to twenty villages in each selected taluka. Villages located near larger towns or on paved roads and those having special government programs or direct access to outside resources, such as where private voluntary organizations were active, were not considered. The experience of scientists in state agricultural universities and officials in local government was invaluable in village selection.

Considering the amount of data to be collected, the memory bias inherent in longer periods between interviews, and the need for formal statistical analysis to explain variation in interhousehold behavior, we arrived at a sample size of forty households within each village. Every household was surveyed in the village early in 1975. That village census provided the basis for drawing the sample, which was selected mainly on the size of operational holding and the occupation of the household. We wanted to sample households that relied heavily on agriculture, either as cultivators or as landless laborers. To achieve that aim, full-time village artisans, shopkeepers, and traders were excluded from the sample. After eliminating nonagricultural households, about 95 percent of the village households still remained the population of interest.

A sample of thirty cultivator and ten landless labor households was drawn in each village. The cultivating households in each village were stratified according to (operated) farm size into three equally numerous groups. A random sample of ten households was drawn from each tercile. Landless labor households were defined as those operating less than half an acre (0.2 ha) and whose main source of income was earnings in the casual agricultural labor market.

A fixed sample size of cultivator and landless labor households in each village means that the sampling fractions and relative farm sizes that demarcate the cultivator terciles vary from village to village. The likelihood that a village household was in the sample ranged from about one in four in the smaller Akola villages to about one in ten in the larger Mahbubnagar villages (table 2.1). Landless labor households are somewhat underrepresented in the sample in all the villages. On average across the six villages, they comprise about one-third of the households in the household population of interest, but their share in the sample is only one-quarter. But, because their mean household size is less than that of cultivator households, a one-quarter representation is a fair reflection of their presence in the individual population of interest.

Data Collection and the Resident Investigator

The concept of a resident investigator was central to the village studies. One investigator was posted in each of the six villages in May 1975. The investigator had a university education in agricultural economics, came from a rural background, and spoke the local language.

The investigator was mainly responsible for collecting and coding data on the nine schedules documented in Binswanger and Jodha (1978). Data on household transactions, labor and draft power utilization, and crop cultivation by plot were canvassed at three-to-four-week intervals. Information on the composition of the household, which crops were sown to which plots in which seasons, credit and debt, stocks, livestock, implements and machinery, and farm buildings was updated annually.

In the spirit of Harold Mann's village studies (Neale 1957), the resident investigator functioned as a participant observer and took auxiliary measurements to enhance the reliability of the data collected. Initially, all plots owned by the sample households were measured, crop cuts were taken to check for systematic biases in farmers' reported yields, the incidence of pests and disease in crops was assessed through field scoring, and observations on daily rainfall were recorded. Over time the role of the investigator also evolved into a facilitator of on-farm research as bi-

Table 2.1. Household population, sampling fractions, and relative farm sizes, by study village

Sampling information[a]	Region/Village					
	Mahbubnagar		*Sholapur*		*Akola*	
	Aurepalle	*Dokur*	*Shirapur*	*Kalman*	*Kanzara*	*Kinkheda*
Household population (N)						
Laborers	146	76	97	156	54	55
	(30.7)[e]	(24.3)	(32.7)	(36.9)	(32.0)	(38.5)
Cultivators	322	226	183	211	109	83
	(67.7)	(72.2)	(61.6)	(49.9)	(64.5)	(58.0)
Others[b]	8	11	17	56	6	5
	(1.7)	(3.5)	(5.7)	(13.2)	(3.6)	(3.5)
Total	476	313	297	423	169	143
	(100)	(100)	(100)	(100)	(100)	(100)
Sampling fractions (%)[c]						
Laborers	7	13	10	6	29	18
Cultivators	9	13	16	14	28	36
Total	8	13	13	9	24	28
Farm size (ha)[d]						
Small	0.2-1.2	0.2-0.9	0.2-2.0	0.2-3.6	0.2-1.8	0.2-2.0
Medium	1.2-3.2	0.9-2.1	2.0-5.3	3.7-8.5	1.8-5.3	2.0-4.5
Large	>3.2	>2.1	>5.3	>8.5	>5.3	>4.5

[a]Based on the 1975 village census and Jodha, Asokan, and Ryan (1977).
[b] Includes specialist traders, artisans, and others whose members are not primarily involved in agriculture.
[c]% of village households in each group.
[d] Refers to operational size defined as the area of owned land minus the area cash-rented or sharecropped out plus the area cash-rented or sharecropped in 1974/75.
[e]% of total.

ological scientists used the villages as sites for problem identification and hypothesis testing. An inventory, organized around the stages of farming systems research, of on-farm research activities in the villages is given in table 2.2. How the village studies were used to bring a farming systems perspective to agricultural research is discussed at length in Ryan (1984a).

In addition to these main tasks, the investigators interviewed the panel households during special-purpose inquiries, many of which are listed in table 2.3. Because much of the core household information was available in the routine schedules, the special-purpose surveys were usually highly focused and brief. Although women were never employed as resident investigators, they did carry out several of the special-purpose surveys and interviewed both women and men on health, nutrition, demographic, and time allocation issues.

The resident investigator was intensively supervised by senior staff, who made monthly trips to the villages in the early years and later visited

Table 2.2. An inventory of biological investigations in the study villages since 1975, by phase of farming systems research

Research Phase	*Topic Investigated (and Village)*
Description/diagnosis	Reasons for poor fertilizer response in post-rainy season sorghum (Shirapur)
	Extent and cause of poor stand establishment in sorghum and pearl millet (Aurepalle)
	Extent of timely postharvest cultivation practices and reasons for crop planting directions (6 villages)
	Incidence of pests, diseases, and weeds in farmers' fields (6 villages)
	Reasons for poor germination of chick-pea (Kanzara and Kinkheda)
	Effects of contour bunding (Shirapur, Kalman, Kanzara, and Kinkheda)
Design	Response to rhizobium and fertilizer and their interactions in groundnut and pigeon pea (Aurepalle and Dokur)
	Herbicide yield response (6 villages)
	Cereal fertilizer response in traditional intercropping systems (Aurepalle)
	Sustainability and productivity of rabi-kharif-rabi pigeon pea (Shirapur)
	Effects of wheeled tool carriers on productivity (Aurepalle and Shirapur)
	Response of foliar disease-resistant groundnut varieties compared to susceptible varieties and fungicide (Dokur)
Testing/verification	Soil, crop, and water management options on small watersheds (Aurepalle, Shirapur, and Kanzara)
	Short-duration pigeon pea cropping systems (Aurepalle, Shirapur, and Kanzara)
	Striga-resistant sorghum varieties (Aurepalle and Shirapur)
	Heliothis-less susceptible pigeon pea varieties (Aurepalle and Shirapur)
	Released sorghum, chick-pea, and groundnut varieties (Kanzara and Kinkheda)
Extension/training	Procurement and distribution (at cost) of released varieties in response to farmer requests (Aurepalle, Shirapur, and Kanzara)
	Field days for farmers

Source; Adapted from Ryan (1984a: table 6).

quarterly. Greater social and biological science capability was added to the village studies in the late 1970s, when social anthropological and agronomic investigators were posted in two of the villages for about two years.

We used incentives to keep the investigator in the village and the

Table 2.3. Special-purpose surveys conducted in the study villages from 1975 to 1985, by topic and coverage

	Coverage		
7op/c *Examined*	*Date*	*Villages*	*Households*
Household time allocation	1975/77	6 study villages	Respondents[a]
Price information	1975/78 1980/85	6 villages	 Key informants
Nutrition and health	1976/78	6 villages	Respondents
Tenancy	1977	6 villages	Respondents
Risk attitudes	1977	6 villages	Respondents
Fertilizer use histories	1977/78	6 villages	Respondents
Labor relations	1978/80	6 villages; emphasis on Aurepalle	Key informants and respondents
Manure and firewood use	1979	Aurepalle, Shirapur, and Kanzara	Respondents
Well ownership and group action	1979/80	6 villages	Respondents
Credit and debt histories	1979/80	Aurepalle, Shirapur, and Kanzara	Respondents
Histories of land market transactions and of human fertility	1980	Aurepalle, Shirapur, and Kanzara	Respondents
Social relations	1981/82	6 villages; Aurepalle and Kanzara more intensively than others	Respondents
Stand establishment	1981/82	Aurepalle	Selected farmers
Price and yield expectations	1982/83	Dokur and 2 neighboring villages	30 well owners
Consumer preferences for sorghum genotypes	1983	Aurepalle and Kanzara	Respondents
Evolution of common property resources	1984	6 villages	Key informants
Well water utilization and hydrology	1984/85	Aurepalle	Well owners
Retrospective family histories	1984/85	6 villages	Respondents and split-off families
Benefits and costs of land fragmentation	1985	6 villages	Respondent cultivators
Farmers' soil taxonomies	1985	Aurepalle, Shirapur, and Kanzara	Respondent cultivators
Pesticide use	1985	6 villages	Respondents

[a]Refers to sample households in the panel.

sample household in the panel. Stays by the resident investigator in the village were as short as two months or as long as six years. Eight of the investigators stayed continuously in their assigned villages for more than three years. One inducement for the investigator was the prospect of promotion and return to headquarters. Four of the early investigators were promoted to a more supervisory role in the late 1970s.

To reduce respondent fatigue and promote interest in the studies, we organized an annual three-to-four-day excursion for the respondent households to places of agricultural and religious significance within a radius of 300 km from the village. All the respondent households looked forward to the trip, which cost about U.S. $300 per village per year. Many sample households were also interested in the biological research on their and their neighbors' fields. They realized that they would be the first to benefit if any technological components performed well. Although the agronomic experimental work was not subsidized, there was excess demand on the part of farmers to cooperate, and the investigators often chose farmers outside the panel to spread the potential benefits of the research activities across more households in the village.

Of the original sample of 240 households across the six villages, 24 left the panel during the period of analysis from 1975/76 to 1984/85. The majority of those 24 permanently emigrated from the village; several heads of household also died. As soon as a head of household retired from the panel, he or she was replaced by another household head chosen randomly from those in the same farm-size stratum based on the 1975 village census. Thus, at any point in time from 1975/76 to 1984/85, the sample size was maintained at 240 households.

The "routine" data, contained in the nine schedules, were collected for the complete ten-year period for one village in each region; that is, Aurepalle in Mahbubnagar, Shirapur in Sholapur, and Kanzara in Akola. These villages are arbitrarily referred to as the "continuous" villages, and the 104 households who stayed in the panel from those villages belong to the "continuous" sample. The empirical analyses of income dynamics in chapter 4, of borrowing transactions in chapter 7, of the simulated benefits from crop insurance in chapter 8, and of yield instability in chapter 10 are based on the continuous sample. Much of the rest of the book is founded on the six-village sample of 240 panel households.

In 1978, we stopped routine data collection on the companion study village in each district. These are called the "closed" villages and include Dokur in Mahbubnagar, Kalman in Sholapur, and Kinkheda in Akola. Special-purpose surveys and on-farm investigations were still carried out in those villages after 1978.

The similarity of findings emerging from the first two years' data between villages in the same study district was the main impetus for stopping routine data collection in the closed villages. The sharpest within-region contrast among the three village pairs was between Aurepalle and heavily irrigated Dokur in the Mahbubnagar region. To better understand those intervillage differences, we kept the resident investigator in Dokur during 1977/78 to collect information on the nine schedules for one more year.

Extrapolation across Space and Representativeness over Time

In 1920, Harold Mann reported sharp changes in cotton prices, wages, and rents but not interest rates in two Deccan villages which he and his associates had surveyed over several years (Catanach 1970). Mann thought that those changes were fairly typical of what was happening on the Bombay Deccan, but he was hesitant to draw wider inferences because his results were based on village case studies. The dilemma confronting Mann has to sooner or later be faced by every researcher who relies on case study material. The researcher's predicament is usually couched in closing remarks such as "it would be foolhardy or rash to extrapolate from these results based on so few household observations but. . ." The "but" usually introduces the author's assertion that there are precious few data such as those from his or her case study that can answer the question posed. Fortunately, in India that is often not the case, as past and present research topical to the dynamics of agricultural development in regions of low production potential exists for many of the issues addressed in this book. We draw on such collateral literature to spatially and temporally frame the findings in the chapters that follow.

Because of the greater integration of the Indian national economy over time, it should be easier to claim greater representativeness now than in the past. Uniform sampling of two villages in each of three regions and a large within-village sample of forty households also give us more leverage to answer questions on how far the results can be extrapolated across space and over time than the typical case study. We believe that some of the findings reflect what is happening nationally, most apply to the study regions, while a minority are unique to the villages.

Another potentially difficult issue is the degree to which an outside presence in the village will inevitably lead to changes in household behavior. The critical question is, Do those changes influence the findings to the extent that the results are spatially and temporally atypical? In particular, because of the use of the village as a locus for biological investigations one would suspect that, over time, the villages could become significantly more technologically progressive than the surrounding region. We are fairly sure, however, that that was not the case. The purpose of the studies and much of the biological research, reported in table 2.2, was analytically descriptive and diagnostic and not normative and demonstrative.

Improving the availability (at cost) of the seed of some high-yielding varieties (HYVs) was the main tangible intervention of the resident investigator. Thus, relying on the village data to estimate the spread of HYVs would lead to overestimates for the region. Improved genotypes are important in India's SAT, and they can clearly make a difference to household welfare. But, as the next chapter on village profiles makes abundantly clear, nature is niggardly in India's SAT; the prospect of abrupt, green revolution-type technical change is unlikely, particularly in the regions we studied.

Appendix 2.1 The ICRISAT Village Studies and Rural Social Science Research in India

In this appendix, we provide historical perspective on where the ICRISAT village studies fit (with regard to method) into social science research on agriculture in India's SAT (Binswanger and Ryan 1979). We do not cover inquiries based on national sampling frames such as those of the National Sample Survey Organization or the National Council of Applied Economic Research (NCAER). The longitudinal household data collected by the NCAER from 1969 to 1972 and retrospectively canvassed in 1981 are briefly described in chapter 4.

Village Studies

Some of the earlier published studies and monographs are reviewed in Adams and Woltemade (1970); several hundred (both published and unpublished) written between 1950 and 1975 are comprehensively compiled and evaluated in abstract form in Moore, Connell, and Lambert (1976). Where applicable, data from village studies were also utilized to draw comparative inferences on labor utilization (Connell and Lipton 1977) and on nutrition (Schofield 1974).

Many of the early studies followed a common format featuring single-point interviews of all the households in the village, complemented by extensive reporting on village history, institutions, and infrastructure (Moore, Connell, and Lambert 1976). One purpose of those studies was to acquaint the layman or the ruling elite with the broad features of the village and the characteristics of its residents.

More academic studies usually followed the ethnographic approach of anthropologists. Researchers would reside in villages and make personal observations on the production technology, economic relationships, customs, religion, demography, and language of a particular community. Because of the wide scope of inquiry and self-reliance in personal observation, the technological and economic data are frequently limited to case histories of particular individuals or families. Those observations are not generally amenable to statistical analysis, but this weakness is compensated for by the thoroughness of the data stemming from the reviewer's own involvement and by the capacity to interpret them in the full context of the material and nonmaterial relationships existing in the community. Ethnographies can be compared across space and over time, and the field derives most of its generalizations from such comparisons. Outstanding examples of the ethnographic approach in India's SAT include Srinivas (1976) and Epstein (1962, 1973). Agarwal (1988) is a recent example showing how information from a large number of ethnographic and village studies can be combined to address questions which often were peripheral to the objectives of any specific study.

The most systematic effort at carrying out village studies took place in the 1950s and 1960s under the auspices of the Village Level Studies Scheme of the Agro-Economic Research Centers (AERCs). The AERCs are usually associated with the economics departments of universities and were sponsored by the Directorate of Economics and Statistics of the Ministry of Agriculture. Since the 1950s, they have conducted village surveys which focused heavily on demographic, economic, and sociological features. These studies were designed to pinpoint structural influences which contributed to or hindered development.

The presence or absence of cooperatives, irrigation, specialty crops, nonagricultural activities, and locational considerations loomed large in village selection. Many of the villages either had large tribal populations or access to canal or tubewell irrigation. After about a decade, some of the villages were resurveyed. As with the ethnographic approach, insights were to be derived comparatively across space and over time.

The village studies of the AERCs were frequently criticized for the absence of a statistical framework in village selection, which limited the extrapolation of the results. But given their objectives, that criticism is somewhat unfair. A more relevant criticism was leveled at the abundance of data collected compared with the paucity analyzed and reported (Moore, Connell, and Lambert 1976). Moreover, the decision by several centers to follow the standard ethnographic practice of interviewing all households in each village placed an inordinate strain on scarce research resources and greatly increased nonsampling error with single-point interviews and associated memory bias. The absence of a uniform framework in data collection and analysis also vitiated the extent to which comparative inferences could be drawn (Schofield 1974). Only a few AERCs continue these village studies and those that do most often carry out resurveys rather than initiate new ones. Nevertheless, an important sliver of the AERC village research still represents the only source of empirical inquiry on interesting and relevant developmental issues in India's SAT (Upton 1983a, 1983b).

Farm Management Studies and the Cost of Cultivation Scheme

In the 1950s, economists in India perceived an urgent need to collect data on the structure and performance of farm enterprises. In developed countries, such data were usually procured through voluntary farm record-keeping schemes, which lacked a rigorous sampling frame. The extraordinarily successful Farm Management Studies of the Ministry of Agriculture were conducted by the AERCs. Data were systematically canvassed by investigators, who visited the sample households almost daily for two to three years.

The Farm Management Studies were clearly multipurpose; they provided a common tabulation and reporting framework on farm structure, yields, cost of cultivation, relative profitability of farm-size strata, input and credit use, and other farm management variables. The tabulated information in the farm management reports and to a lesser extent the original data were used by many researchers to answer a wide variety of economic and farm management questions. Despite the often considerable time lag between data collection and reporting, the knowledge gained from these studies has provided major insights.

Nonetheless, the Farm Management Studies were limited in scope. They did not include agricultural labor households as respondents, nor did they pay much heed to the technical and biological aspects of cultivation. They were essentially designed by economists for their own purposes. Because the original data were not computerized, access to them was not open to many researchers outside the centers where they were collected.

The Farm Management Studies were replaced in the early 1970s by the Cost of Cultivation Scheme, initiated at the request of the Agricultural Prices Commission, which wanted more reliable and rapid information on the costs and benefits of specific crops for price policy purposes. Sampling was shifted from an area to a crop frame. The task of data collection was assigned mainly to agricultural universities participating on a voluntary basis. While the scope of data gathering is largely the same as in the Farm Management Studies, the reporting is usually limited to the cost of cultivation of a specific crop. The data have not been utilized to produce the equivalent of the old farm management reports. Making these data more "user friendly" would be a major step toward enhancing understanding about India's agriculture.

Appendix 2.2 Lessons Learned in the Conduct of Longitudinal Village Studies and Implications for Agricultural Research with a Farming Systems Perspective

The description of the approach in this chapter may give the erroneous impression that we always chose the correct course of action because that was the right thing to do. We made our fair share of mistakes. The longitudinal studies were very much a learning-by-doing exercise. In particular, had the studies not been conducted with the underlying hypotheses to guide them, a large body of undigested data would have resulted.

The survey instruments evolved over time and were modified by experience. A balance must be struck between improving and rationalizing the type and extent of data gathered and maintaining the necessary continuity of the time series. On a number of occasions changes were made in formats and frequency of data collection which in retrospect disrupted continuity, even though they resulted in improved information for the more limited period for which the new methods applied. Continuity was regained by later consolidation of data into a similar form to that gathered earlier, although this took considerable time and effort. The lesson is to ensure that when changes are made they do not preclude maintenance of the time series data on the originally chosen variables.

The conduct of consistency and integrity checks is critical to the success of intensive longitudinal studies. Reinterviews with randomly selected respondents and range tests on data to identify outliers were regularly carried out. Relatively unstructured interview schedules were found to be advantageous provided the investigators were thoroughly trained beforehand and had a set of prompters to ensure key questions were posed to elicit the required information. Unstructured worksheets used at interviews allowed checking to be done after coding of data in the investigator's village office. Usually more information was written on these worksheets than was required for the coding sheets. This qualitative as well as quantitative information continues to provide raw material for new studies and to support consistency checks on the results from earlier research.

Most of the delays in using data from the village studies were due to the interval between the interviews, to the coding of interview data, and to the checking and validation of the coded data both in the village and back at ICRISAT Center, Patancheru. Investigators were requested to code data within a few days of each interview. A number were reasonably successful in achieving that goal, but most took up to one month to do so. Once a backlog accumulated, it was difficult to overcome. Supervisory visits occurred monthly in the early years but reverted to more extended intervals of up to three months in later years. (A valuable by-product of the supervisors' visits was short trip reports updating information on developments in the village.) This led to further delays in data accessibility, which were exacerbated by the added one to two months required to conduct data checks at ICRISAT Center, relay questions back to the investigators, and receive replies.

The foregoing delays were a necessary ingredient in endeavoring to ensure the data were of a high quality. The number of errors in arithmetic and coding and of commission and omission which such practices uncovered leads us to doubt whether use should be made of any socioeconomic data from rural areas where sufficient time has not been taken to ensure its integrity, validity, and reliability.

The studies could have benefited from a greater degree of priority setting in the checking and computerization of the data. In the first five years of the studies, the longest delays occurred as a result of constraints on the ICRISAT computer system. The requirements for the VLS were simply underestimated, both in terms of data entry and storage/retrieval capacities. We probably could have concentrated on the household census, inventory, plot, cultivation, crop, livestock, and labor schedules and given the transactions schedules less priority, as the latter were not utilized to the same extent as the former earlier in the studies. The coding of all schedules is best conducted at the same time, however, as there are many instances where entries are required in more than one schedule and are dependent on one another. Time savings could have come from delaying the computerization of the transactions schedules.

Other important lessons were mentioned earlier in this chapter. Of paramount importance is the explicit recognition of the need for incentives at the outset of the studies so that everyone, including members of the household panel, villagers outside the panel, and the resident investigators, feels they have something to gain from participation.

The characteristic features of the ICRISAT longitudinal studies have been (1) their time series nature, which involves a set of comprehensive panel data on a large number of households; (2) the incorporation of agrobiological observations, measurements, and experiments from the outset with both interdisciplinary and multidisciplinary features; (3) inclusion of a sample of landless as well as farmer respondents; (4) careful and purposive selection of villages to ensure they feature the modalities of the agroclimatic region which they were chosen to represent; (5) the location of resident investigators permanently in the villages, each having a university education in agricultural economics or the equivalent, coming from a rural background, and speaking the local language; (6) the collection of all crop data on plot basis; (7) a village focus as opposed to a single crop or socioeconomic group focus; and (8) timely analysis of accumulated data to answer important questions related to technology design, research resource allocation priorities, and agricultural policy. How does this longitudinal study approach compare with a more conventional farming systems research approach that relies heavily on rapid rural appraisal techniques?

Interest in rapid rural appraisal is increasing and largely stems from disenchantment with formal survey methods to provide timely information for decision making mainly on issues concerning agricultural development projects. (The origins, strengths, and weaknesses of rapid rural appraisal methods are discussed in papers in a special edition of *Agricultural Administration* [November 1981] and in Khon Kaen University [1987].) Such disenchantment with "long and dirty" formal surveys is eloquently expressed by Chambers (1987: 36):

> In its still not uncommon pathological form, the survey questionnaire has thirty or more pages (multi-disciplinary, each discipline with its questions), which if asked are never coded, or if coded never punched, or if punched never processed, or if processed and printed out, never examined, or if examined, never analyzed or written up, or if analyzed and written up, never read, or if read, never understood or remembered, or if understood or remembered, never actually used to change action.

Although Chambers does not indict the ICRISAT village studies on those counts (he cites our studies as an example of a "long and clean" investigation), we believe that the total package of elements of the longitudinal studies would be difficult to replicate in their entirety even by the largest national programs or by other IARCs. In most agricultural research institutions, social science is still a weak sister in the interdisciplinary research partnership (Byerlee and Tripp 1988). However, we remain convinced that the insights gained from such an approach are not possible with alternatives.

Perhaps the most beneficial and transferable element of the longitudinal study approach is the continuity provided in maintaining benchmark on-farm research sites and in sustaining interactions with farmers. A longer-term perspective diminishes the start-up costs of on-farm research as one has already established one's bone fides, engenders increased understanding and trust between researchers and farmers, sets the stage for the development of a corporate memory, and does not lead to the overestimation of the severity of transitory policy constraints. All too often farming systems research programs are carried out in a piecemeal project fashion, and "the introduction of an FSR program may have led to an over-emphasis on adaptive research when the real need was for a careful diagnosis of farmers' circumstances as a basis for orienting applied research" (Byerlee and Tripp 1988: 140).

The main cost of the longer-term benchmark village perspective is the risk of choosing unrepresentative villages. Pressures to demonstrate results, often accompanied by subsidized government programs, can also make the villages unrepresentative of their regions of interest and erode the opportunities for constructive and participatory diagnostic research.

Returning to the question of trade-offs posed at the outset of this section, our experience with the conduct of the longitudinal village studies and with rapid rural techniques we have utilized in an ad hoc manner shows that they are best regarded as complements rather than substitutes. The complementarity becomes most apparent when researchers through intensive longitudinal studies identify spatially wider, researchable problems that can be best addressed with rapid rural appraisal techniques.

The choice of method depends largely on research objectives and *resource availability. If the objective is* to derive fairly reliable estimates of household income, there would appear to be no substitute for highly supervised, periodic surveys. By the same token, rapid rural appraisal techniques can be skillfully applied by researchers with perspective to address quite fundamental material issues over time and space (Pingali, Bigot, and Binswanger 1987; McIntire, Bourzat, and Pingali: 1988). In general, rapid rural appraisal is probably the preferred approach when there is a reasonable body of scientific knowledge available for the research domain of interest and where the need is to define subsets of the research domain for technology adaptation. If one is operating closer to the strategic or applied end of the research spectrum where the challenge is to contribute to the body of scientific knowledge from which applied research can lead to technology options, then longitudinal studies would appear to be advantageous. Usually, some of both is probably optimal.

3 The Regions and the Villages

The presentation of research based on village or case study material always runs the risk of drowning the reader in too much location-specific detail. To diminish that risk, we close this descriptive chapter with a section on regional and village profiles that captures what we feel are the salient features of the study regions. The main objective of this chapter will have been served if the reader is successful in conjuring up an image when a village or regional name appears in the text of the analytical chapters that follow.

Historical, Social, and Economic Background

Historical Sketch of the Study Regions

The history of the regions is richly chronicled in the Andhra Pradesh and Maharashtra state gazetteers. The three regions, Mahbubnagar, Sholapur, and Akola, were all ruled in the eighteenth century by the nizam of Hyderabad, the largest princely state in India at Independence. The area forming most of present-day Sholapur district was captured by the Marathas in 1795 (Government of Maharashtra 1977a). Between 1818 and 1848, the British gradually took over control from the Marathas, and it became a Deccan district in the Bombay presidency in 1838. The present Akola district formed part of Berar region in the nizam's kingdom until 1853, when it was ceded to the British in repayment of a loan and then administered as part of the Central Providences (Government of Maharashtra 1977b). The region falling within the boundaries of Mahbubnagar district was governed by the nizam before Independence (Government of Andhra Pradesh 1976).

Cotton played an important economic role in the Sholapur and Akola districts in the late nineteenth century. In response to the so-called cotton famine resulting from interrupted cotton supplies from the United States to Britain during the American Civil War, the area under cotton rapidly expanded in central and western Maharashtra (Borpujari 1973; Benjamin 1973). This dramatic supply response increased the demand for rural credit. A steep decline in cotton prices in the early 1870s coincident with near-famine conditions sparked a farmers' agitation against moneylenders in some villages of the Deccan in the early 1870s (Catanach 1966,1970). That event, known as the Deccan Riots, would have far-reaching implications for the village rural financial markets described in chapter 7. In contrast, a cash crop such as cotton did not dominate the regional economy of the Andhra Pradesh villages.

The history of the study regions is punctuated by famine and scarcity relief works. Famine was widespread in at least two of the three regions in 1876/77, 1896/97, and 1899/1900 (Bhatia 1967). Of the three regions, Sholapur was usually the hardest hit. Bhatia's citations indicate that cereal yields in Sholapur district on several occasions were less than 10 percent of their normal levels in the second half of the nineteenth century.

Population, Migration, and Family Structure

In spite of declining fertility (Nayak 1986), the population of the study villages is still growing. Between 1951 and 1981, the population increase ranged from 35 to 50 percent across the six study villages. Aside from the demographic transition, one of the reasons for sustained population growth in the villages is the relatively low rate of out-migration.

A recent comparison of the 1971 and 1981 Indian census data suggests that migration patterns are qualitatively changing. Migration is increasingly characterized by longer distance movements, greater women's participation, and more urban orientation (Skeldon 1986.). But those emerging trends are hard to detect in the study villages. Compared to other parts of the world, Davis's (1951) conclusion on the immobility of the Indian population still rings true. The bulk of permanent migration is still comprised of the wife moving to the husband's village, often within the same taluka and usually within the same district. Few households, particularly those that own land, pull up stakes and permanently leave the village. In contrast to Caldwell, Reddy, and Caldwell's (1982) findings from their study of demographic behavior in nine red-soil dryland villages in Karnataka, at no time in recent years has net emigration approximately equaled natural population increase in the study villages.

Immigration into the rainfall-assured Akola villages further diminishes the rate of net emigration. About one-third of the households in the Akola sample are either first- or second-generation immigrants, usually from villages located within the same district. A few households, usually landless laborers, still settle in the Akola villages each year. In contrast, recent immigration into the rainfall-unassured Mahbubnagar and Sholapur villages has been negligible.

Seasonal, temporary migration projects a different image. Seasonal migration, frequently within the same state, by one or more (usually male) family members is widespread and appears to be increasing. For example, in the Mahbubnagar village about 40 percent of the households contained an individual who left the village for at least a month to pursue employment opportunities in 1985/86.

We conclude this section with a few comments on family structure. About one-half of the sample households are nuclear; four-tenths are stem, in which one or both parents live with their son's family; and one-tenth are joint-stem, in which the parents reside with more than one married son. The incidence of extended (including stem and joint-stem) households does not vary much from village to village but has increased gradually over time as the sample has aged. This gradual but perceptible change supports the view that "jointness" is primarily determined by the life cycle. Many joint households will eventually split into nuclear households, and many nuclear households once belonged to a joint household.

Caste

Most residents in the six study villages are caste Hindus. Relatively few of the caste Hindus are Brahmins. The majority belong to communities whose traditional occupation is farming. Despite the prevalence of one or two dominant castes, one can find many separate caste affiliations in each village, ranging from fourteen in Kinkheda to twenty-two in Aurepalle (Doherty 1982).

Many rungs in the caste hierarchical ladder are occupied by a few service-caste families who are employed as carpenters, blacksmiths, barbers, water carriers, washermen, goldsmiths, etc. Their composition varies from village to village, but at least a dozen service-caste households live in each village, where they ply their traditional occupations.

Only in Kinkheda do Muslims and Buddhists compose more than 10 percent of the population. Harijans or ex-untouchables, make up 10 to 25 percent of the village population. They are relatively and absolutely more numerous in the Mahbubnagar villages, particularly in Aurepalle.

Measured by population and political power and wealth, one or two castes are dominant in each village. Reddis in Aurepalle and Dokur, Marathas and Dhangars in Shirapur and Kalman, Malis and Marathas in Kanzara, and Kunbis in Kinkheda fit the description of dominant groups in their villages. Two dominant communities, such as Malis and Marathas in Kanzara, in the same village are often political rivals. Political factionalism eroding village harmony and solidarity has intensified following the introduction of formal local government institutions for which elections are often hotly and acrimoniously contended.

The caste hierarchy is dynamic, as some castes perceive themselves in ascendancy and others in decline. Increasingly within the upper castes, material expectations loom large in the perceived hierarchy. Deshmukhs, the landed aristocracy of Maharashtra (Kulkarni 1967), are an apt example of a group in economic decline in Kanzara. They follow traditional caste norms and do not allow their members to engage in manual labor. Several Deshmukh households have sold a lot of their land to other farming communities who do not abide by this restriction.

Undeniably, caste strongly influences many aspects of human endeavor. Whom one marries, where one lives in the village, with whom one eats, and where one fetches water are all conditioned by caste. Although almost all castes own some land (in Aurepalle sixteen of the twenty-two castes own land), caste is a good marker of large landownership in each of the villages. While many higher-caste households do not own much if any land, it is rare to encounter Harijan households owning an appreciable amount of land.

Caste also contributes to explaining some more subtle dimensions of human behavior in the villages. For instance, the oft-repeated observation that members of castes whose traditional occupation was farming are better farmers than those from castes whose traditional occupation was a nonfarming activity is statistically confirmed in chapter 6.

Still, it would be wrong to develop tunnel vision and assign all variation in human behavior exclusively to caste differences among village residents. Caste plays little part in who hires whom (Binswanger et al. 1984), who buys or sells from whom, or even with whom one plays cards (Bhende 1983). In the analytical chapters that follow, the effects of caste in explaining behavioral differences are sometimes complex and often overshadowed by other considerations. The following quote by Binswanger and Singh (1988: 8), who recently examined the intergenerational transmission of wealth in the study villages, is indicative of why simplistic explanations should not be attached to the role of caste in determining economic outcomes:

> Lower caste (adjusted for parental education) leads to lower education, indicating either poorer access to low caste individuals to the education system or poorer commitment to education. Similarly, caste sharply affects how much inheritance an individual receives. In sharp contrast, however, once a person has been given his or her endowment in terms of inheritance and schooling, caste does not strongly affect their individual performance, i.e. caste and ability do not seem to be correlated. Nor does it appear that an individual's performance in the private economy of the villages is constrained by caste.

The caste hierarchy may not be breaking down but it is rapidly eroding at the edges in all the villages. Harijans and upper castes mix in public places, spending leisure time together. Harijans and other scheduled castes are less discriminated against today than they were in the past (Kshirsagar 1983). ("scheduled caste" refers to the lowest-ranking Hindu castes, which were listed in a schedule attached to the Government of India Act of 1935, which legally safeguarded their rights and entitled them to preferential economic treatment.) That observation about lessening caste discrimination over time applies with more force in the Maharashtra villages, where caste restrictions are not followed as strictly as in the Andhra Pradesh villages.

Transactions are increasingly monetarized and becoming more impersonal. Most members of the village service-related castes who ply their traditional occupation in the village are now paid only in cash or receive cash in addition to in-kind remuneration. Most members of these castes supplement their traditional livelihood with earnings from farming and agricultural labor. Several have migrated from the villages. Others have postponed teaching their traditional trade until their son's education is completed.

Consequently, the stock of traditional services offered to village residents is dwindling. As many other village studies have concluded (Adams and Woltemade 1970), the villages are each day less autonomous and more interdependent with the outside world. Interdependence manifests itself in larger farmers going out of their way not to alienate labor households because more exposure to the outside world enhances laborers' realization that other opportunities compete with work in the village casual labor market (Bidinger, Nag, and Babu 1986a).

Education

In the late 1970s, the mean literacy rates and educational levels of respondent households were not that different from the all-India averages (Laufer 1983). For adults nineteen or older, about 50 percent of men and 15 percent of women were literate. About 62, 28, and 8 percent of individuals aged six to eleven, twelve to seventeen, and eighteen to twenty-three, respectively, attended school. For the same age cohorts, the all-India figures were 64, 27 and 6 percent (World Bank 1980).

Also, like much of rural India, an increasing level of education is one of the changing features of village life. Compared to their parents, children are more likely to enroll and spend more time in school. Boys are more educated than their fathers, and girls are more educated than their mothers. About 62 percent of young men aged fifteen to nineteen received at least a fifth grade education in the late 1970s. Only about 7 percent of the men forty or older had advanced that far in school.

The educational transition is occurring much faster in the Maharashtra villages, where education has traditionally been prized more highly. A primary school was established in Shirapur as early as 1848. Presently, the village with the highest net enrollment rate is Kinkheda. In Kanzara and Kinkheda, almost all boys start primary school. In contrast, in Aurepalle and Dokur only about one male child in two enrolled in the first grade in the late 1970s.

Educational inequality by gender is widespread in all the study villages. For each age cohort, women are less educated than men. The educational profile of women age fifteen to nineteen resembles that for men older than forty. Even in Kanzara and Kinkheda the chances of a girl ever enrolling in primary school stood at only about 50 percent in the late 1970s. Still, women have made progress, albeit at a much slower rate than men. About one woman in four in the younger cohort age fifteen to nineteen has attained the fifth standard. For the women forty or older, only about one woman in fifty received a fifth grade education.

Greater access to higher-level schooling within each of the villages is one partial explanation for the increasing level of education, but it only tells part of the story. Since 1955 in Aurepalle, 1954 in Dokur, 1848 in Shirapur, 1870 in Kalman, around 1905 in Kanzara, and 1938 in Kinkheda, villagers have had access to a primary school offering up to a fourth grade education. During much of the time, school was only sparsely attended. For example, no students enrolled in school in Shirapur in 1949/50.

The other and more important part of the story centers on increasing demand for education, which is reflected in a growing awareness that a higher level of education is required for nonfarm employment and for coming to grips with a more modern, literate world. Although some large farmers worry that increasing education will cause irreversible attitudinal change detrimental to the work ethic of the agricultural labor force, most villagers regard education as a good thing for their children. The following excerpt from a study of demographic behavior in nine dryland villages, with soils and climate quite similar to those of Aurepalle and Dokur, in Mysore district of Karnataka probably conveys the feelings of many village residents about education:

> During the first years there is only limited parental ambition for the child and only a slowly growing feeling of a drain on the household's labor resources (although this can change dramatically if the household structure alters)—but a greater, and increasing awareness of the financial cost. By the end of elementary school, if the child (especially a son) is doing well, likes school, and perhaps is developing scholastic ambitions, then the family may think of preparing the child for nonagricultural employment, anticipating a substantial return on their investment. (Caldwell, Reddy, and Caldwell 1984: 40)

Demand would be greater if labor-saving mechanization like what has occurred in the Punjab (Nag and Kak 1985) had decreased the opportunity cost of children's labor. Although only about 15 percent of the children aged five to fifteen earn wage income, most do some household or farm work, usually animal husbandry. Data from time diaries maintained during the first two years of the village studies show that this is particularly true in Aurepalle and Dokur, where children spend fewer hours in school and more hours working in farm and/or domestic activities than in the Maharashtra villages. The economic value of such work has not changed appreciably in recent decades.

The education of the parent clearly matters in the schooling of the child (Laufer 1983). Better-educated mothers are more likely to have daughters who spend more time in school. The same is true for fathers and sons. The influence of the parent's schooling is also confirmed in studies analyzing district data (Rosenzweig and Evenson 1977). But parent's education only helps to augment the schooling prospects of children of the same gender (Laufer 1983). Education of the mother had no effect on her son's schooling; neither did education of the father have much bearing on his daughter's education.

Evidence on the size of returns to investment in education in the study villages is mixed. The research by Binswanger and Singh (1988), cited earlier in this chapter and based on five study regions and ten villages, is consistent with the education of the head of the household having a sizable and significant impact on income determination and asset accumulation. That impact is net of the effects of caste, sex, inherited wealth, and village residence of the household head and is adjusted for ability. On the other hand, education of the head does not usually do a good job in explaining the variation in household performance within a region. Nor are differences in education manifested in substantial disparities in wages paid to agricultural labor. Many household heads in the late 1970s had not attended school. The average years of schooling for the 240 heads of household was only a little over two years. In the future, an increasing level of and variation in education should have more visible consequences in differentiating human behavior.

Infrastructure and Product and Input Markets

While none of the study villages is as blessed with infrastructure as those in irrigated tracts, the villages are generally much better supported by public-sector investment than similar ones in the semi-arid tropics of Africa. None of the villages are located on a paved road, but all are no more than a few kilometers away. Buses ply daily to and from the village or stop a few kilometers away. All the villages are electrified, but relatively few of the households in each village receive electricity, which is primarily used for agricultural purposes. One fair-price shop selling subsidized kerosene, sugar, rice, or wheat is located in each village. One cannot walk very far in any of the villages without encountering a small private shop retailing a few inexpensive consumer goods.

The vast majority of villagers market their produce in nearby regulated markets, which appear to be quite efficient and receive infrastructural support from the government (Raju and von Oppen 1982). Most farmers rely on the auction system in the regulated market and sell when they arc either strapped for cash or when they feel the price in the regulated market is sufficiently remunerative. Farmers normally store and market their crops in piecemeal fashion; with the exception of some crops like groundnut, they seldom sell all their production immediately after harvest.

Marketing inputs, especially seed and fertilizer, leave much more to be desired than does output marketing. Every year in each of the villages the resident investigator received many requests to make arrangements so that farmers could more readily procure desired improved inputs, especially the seed of modern varieties, which were more supply constrained than any item other than primary health care. To our knowledge, a resident investigator has never been asked to assist in marketing a farmer's crop.

Persistent anecdotal evidence from the resident investigators and experience from setting up an experimental input supply depot in Aurepalle in 1981/82 supported Desai's emphasis (1982, 1986) on the importance of supply availability and nonprice considerations in conditioning input use. The importance of seed availability of improved varieties was most noted in groundnut, which has unusually low seed multiplication ratios and limited private-sector participation in seed production.

The Agricultural Setting

Soils and Soil Heterogeneity

The villages are representative in one respect: considerable soil heterogeneity is found within dryland farming communities in India's SAT. The potential for sharply contrasting soil types to exist side by side was noted and succinctly described by Mann and associates in their 1917 study of one village on the Bombay Deccan, which encompasses the Sholapur villages:

> This condition of things is perhaps characteristic, in general lines, of all rocky regions. But in the Deccan the transition from the bare rocky uplands to the smiling valleys with deep soil is sharper than almost anywhere. A few yards will separate sometimes a piece of bare rock giving at the most a very thin grass herbage, and a rich deep black soil capable of growing the biggest and finest crops of sugarcane. We have passed along a road where there was rock on one side, and a crop of sugarcane giving a yield of thirty to forty tons per acre on the other. And such cases abound. (Mann 1917: 8)

Of the study regions, soil heterogeneity is most evident in the Mahbubnagar villages. In Aurepalle, for example, farmers classify village soils into five broad groups (Dvorak 1988). Taking into account mixed and transitional soils and other characteristics, thirteen subgroups can be identified. At the finest level of classification, farmers recognize twenty-one soil categories.

Widespread soil heterogeneity within red-soil villages also is confirmed by detailed soil surveys. For example, in one Alfisol site with soils roughly similar to those in the Andhra Pradesh villages, soil taxonomists classified village soils into twelve units based on soil depth, occurrence of gravel in the profile, subsoil texture, and parent material. Incorporating three additional considerations—surface texture, slope, and degree of erosion—into the classification led to the identification of fifty-two subunits within the same village (Naga Bhushana, Shankaranarayana, and Shivaprasad 1987).

In the black-soil Sholapur and Akola villages, the distinction among soil groups is not as marked as in the red-soil Mahbubnagar villages. Farmers describe soils by the degree to and manner in which they depart from an ideal soil type. Texture and depth are important characteristics in conditioning farmers' perceptions on how soils in the village grade away from the ideotypic soil in the Sholapur and Akola villages. Six major soil types are recognized by farmers in the Sholapur villages. Soils are more spatially homogeneous in the Akola villages, where only three major groups appear in the farmers' taxonomy and where variation in soil depth and texture is significantly less than in the Sholapur villages.

Differences between the soils of the study villages within the same region are most pronounced in the Sholapur villages. Shirapur is better endowed with deep black soil; Kalman has more upland area in shallower and lighter soils which do not have enough soil moisture retention capacity to permit more assured cropping in the post-rainy season.

Wetland, often irrigated, plots display less soil heterogeneity than dryland fields (Dvorak 1988). In the process of agricultural intensification on irrigated fields, farmers' management is likely to result in the modification of soil quality characteristics, leading to a reduction in spatial soil variation among small wetland plots. For example, cultivators in the Mahbubnagar villages spread silt accumulated in tank beds, described later in this chapter, on their irrigated fields. Over time more wells have also been dug in tank beds, providing greater access to irrigation to the most fertile and uniform land in the villages.

Rainfall, Area Variability, and Covariate Risk

Dryland agriculture in the villages is dependent on the southwest monsoon, which usually becomes active around mid-June and recedes by mid-October. The date of the initiation of the monsoon is by no means certain nor is the amount of rainfall to be received. Because farmers plant into a dry soil profile and because delayed planting is strongly associated with yield loss, timely and adequate planting season rainfall is necessary for successful cropping. When the monsoon "plays- truant" or is initially erratic, the planned cropping strategy may no longer be optimal; farmers adapt to emerging information on rainfall events by changing crops or by fallowing land.

Before describing some of the overt consequences (the more subtle ones are discussed in chapters 8 and 10) of rainfall uncertainty, we examine in figure 3.1 the interregional variation in cumulative weekly rainfall over ten calendar years from 1976 to 1985 in the continuous village (in each study region) where rainfall was recorded daily since June 1975.

Compared to Aurepalle and Shirapur, higher and less variable rainfall in Kanzara is manifested in figure 3.1 by the steeper mean rainfall curve, which *rises* sharply at the onset of the rainy season in mid-June, and by the narrower spread in the standard deviations around the weekly cumulative mean, which tapers off when the monsoon recedes in mid-October. Only in one year in ten did total annual rainfall dip below 700 mm in Kanzara. Rainfall was scantier and more erratic in Aurepalle and Shirapur, where the recent rainfall history was characterized by peaks and valleys. Indeed, in Aurepalle, a year of normal rainfall within a standard deviation of the ten-year annual mean was a rare event. Four years in Aurepalle and four in Shirapur were unusually dry. Overall, the study period was marked by some steep shortfalls in rainfall in the Sholapur and Mahbubnagar villages. Nonetheless, a severe and prolonged rainfall deficit like the "never in a hundred years" (Ladejinsky 1977) 1971 to 1973 drought in western Maharashtra did not occur.

In the Mahbubnagar and Akola villages, more than 90 percent of area cultivated is planted during the kharif, or rainy season. Erratic rainfall coupled with deep clay soils in the Sholapur villages makes it much more profitable for farmers to store precipitation in their deeper soils during the rainy season and cultivate crops under a regime of receding soil moisture during the rabi or post-rainy season. The superiority of the farmers' strategy is demonstrated in crop simulation models, which show that sorghum planted in the rainy season will fail two years in five in Sholapur (Binswanger, Virmani, and Kampen 1980). Only the shallower, usually more upland soils, which cannot store enough moisture for successful post-rainy season cropping, are sown during the rainy season.

Although post-rainy season cropping in early October is a surer bet on the deeper Shirapur soils than sowing in the rainy season in mid-June, rainfall during the post-rainy season is also extremely variable. The coefficient of variation (CV) of total growing season soil moisture for Shirapur over the ten-year study period exceeded 50 percent; the CV for Kanzara was only 25 percent.

In the Sholapur villages, the relative importance of rainy and post-rainy season cropping can fluctuate sharply from season to season. During a "normal" rainfall year, rainy season crops account for about 40 percent

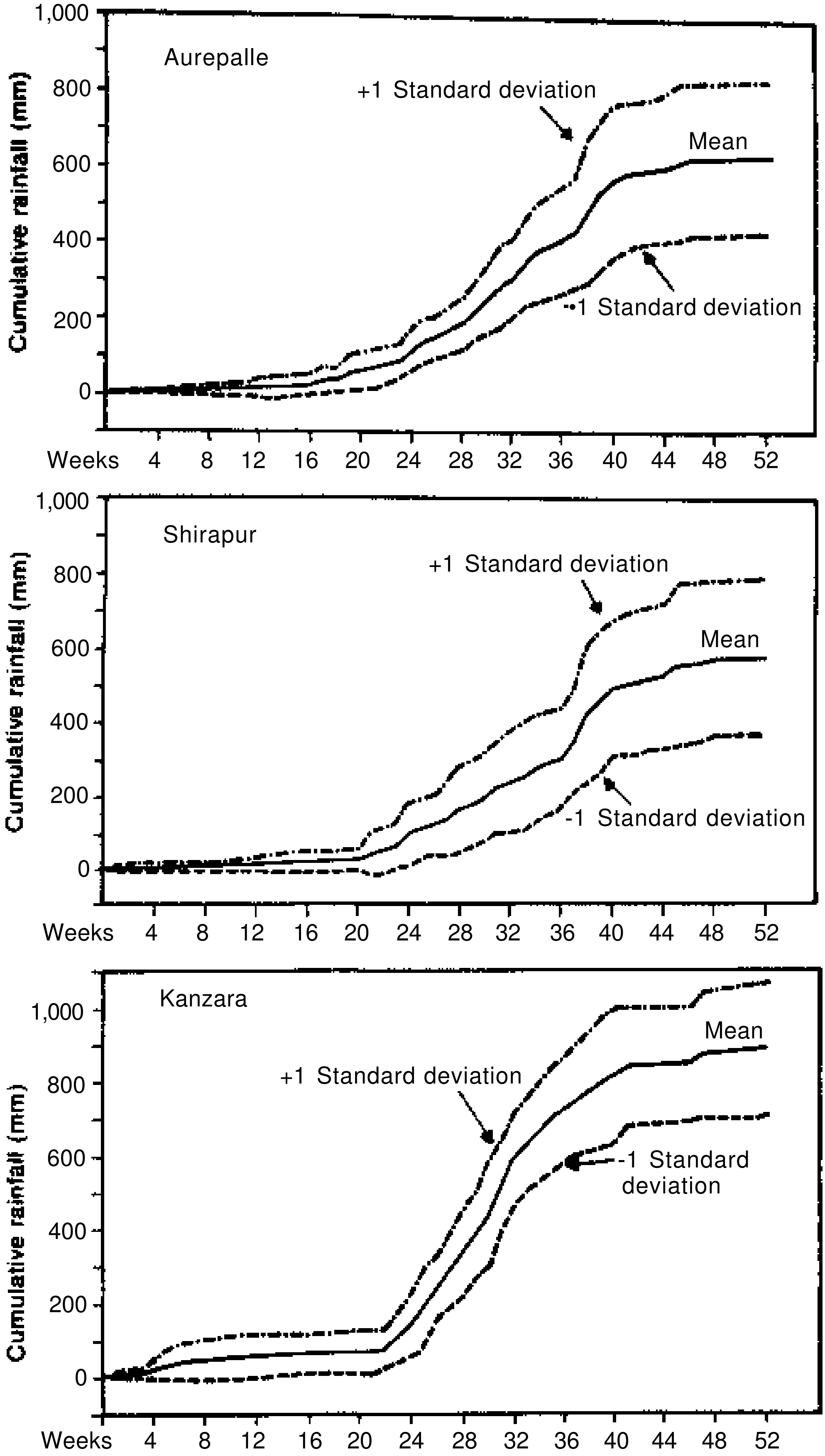


Figure 3.1 Mean cumulative rainfall by week over ten years from 1976 to 1985 by village

of gross cropped area, but during an unusually dry rainy season like 1977/78 the share of rainy season cropping in gross cropped area can fall to less than 10 percent. (A decade later in 1986/87 low and erratic precipitation again compelled farmers in Shirapur to forgo rainy season planting. In response to escalating sorghum fodder prices, farmers, out of desperation to produce some biomass, planted even their lighter upland soils to post-rainy season sorghum, which eventually failed.)

Another prime example of area variability conditioned by rainfall events at planting also occurred in Aurepalle in 1976/77, when farmers substituted a competing and hardy cash crop, castor, for their traditional sorghum crop. In years like 1976/77, when the southwest monsoon is late, the scope for pest damage on sorghum is greatly enhanced and farmers are better off planting castor.

Of the three study regions, the potential for area variability is greatest in the red-soil Mahbubnagar villages because farmers usually have only two to four days to plant at the initiation of the monsoon before the upper soil layers become too dry for germination. Moreover, greater access to minor irrigation works dependent on surface runoff and groundwater recharge in this hard rock region expands the scope for fluctuations in rainfall to translate into area variability.

Interregional differences in the degree of rainfall uncertainty at planting are highlighted in figure 3.2, which presents information on the mean and standard deviation in planting date for dryland fields sown in the rainy season for two continuous villages: drought-prone Aurepalle and rainfall-assured Kanzara. Although the monsoon usually sets in earlier in Aurepalle, it is often not that vigorous; consequently, the simple average standard deviation in planting date across the ten cropping years was about fifteen days (i.e., it takes about one month to plant 95 percent of the dryland fields sown in the village in the rainy season). In contrast, early season planting rainfall is usually adequate in Kanzara; the simple average standard deviation in planting date was only six days. This contrast was based each year on about 75 dryland fields in Aurepalle and 150 in Kanzara. The contrast would be even sharper if we had included all plots sown in the rainy season, as farmers in the Mahbubnagar villages will plant if showers are received in May. May sowings are typically viewed as risky (Binswanger et al. 1982).

High rainfall uncertainty also manifests itself in seasonal crop labor demand patterns that can change markedly from one year to the next. No rain means no seasonal work in crop production. The dependency of seasonal labor demand on rainfall is most vividly illustrated in the red-soil Mahbubnagar village Aurepalle, where total monthly labor use in crop production on respondents' fields is charted in figure 3.3 for five contrasting rainfall years. Labor demand in the slack period from February to May does not fluctuate much from year to year, but seasonal

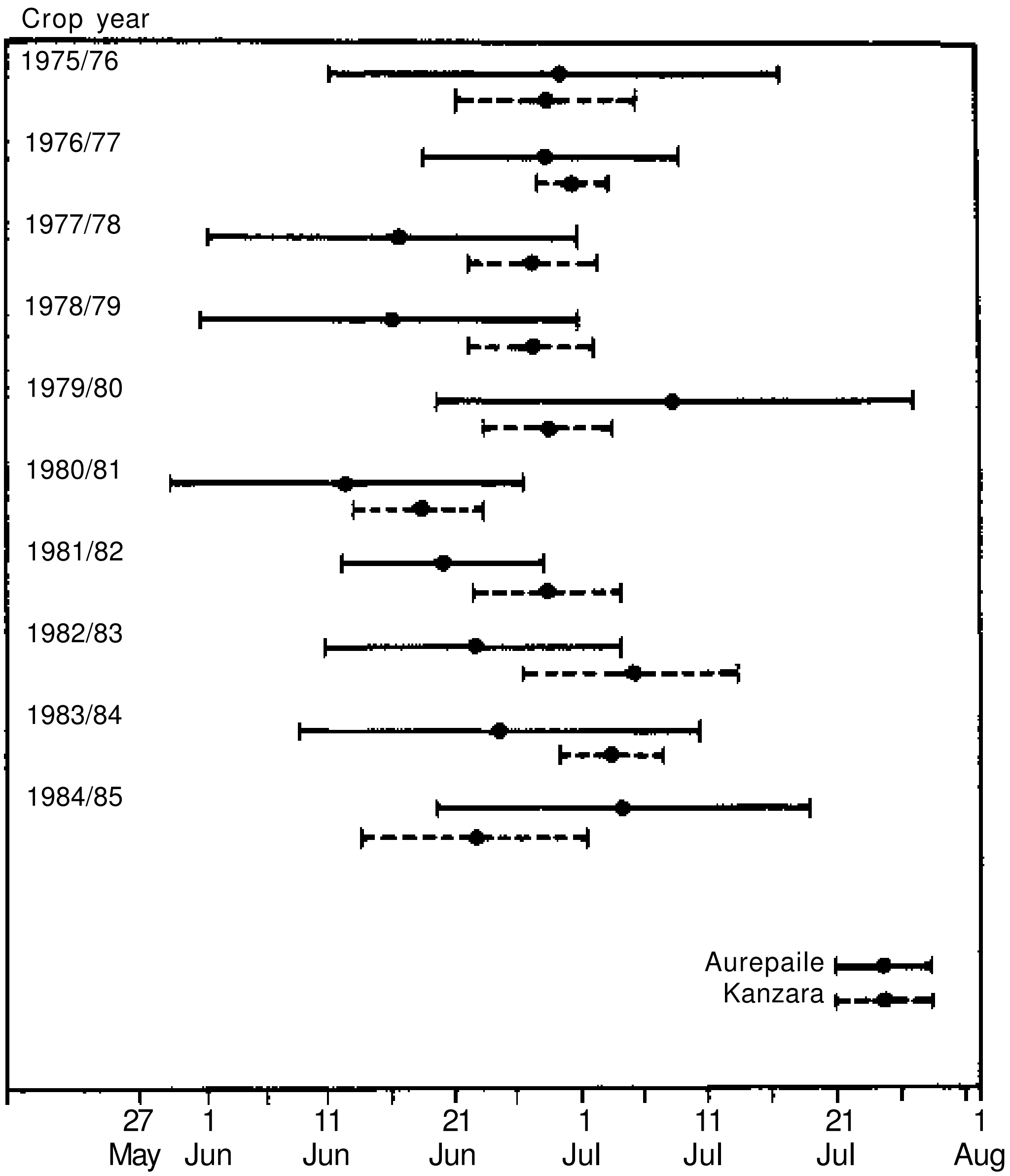


Figure 3.2 Means and standard deviations of planting date during the rainy season for Aurepaile and Kanzara from 1975/76-1984/85

peaks can occur in any month from June to January. Late but abundant early season rainfall in 1976/77 resulted in the aforementioned expansion of castor area, and evenly distributed growing-season rainfall subsequently accentuated the demand for harvesting and threshing labor in January. Prospects for a good crop year in 1977/78 were sharply curtailed by a thirty-day midseason drought and by rainfall below 20 mm in September; thus, June, which was characterized by relatively low but unusually well-distributed planting-season rainfall, was the month of peak labor demand. Heavy end-of-season rainfall in September increased the demand for labor in December and January in 1981/82. In contrast, early season rainfall was more adequate in 1980/81, but negligible end-of-season rainfall lopped off the December to January peak evident in 1981/82. Perhaps the worst drought year was 1982/83, when planting rainfall

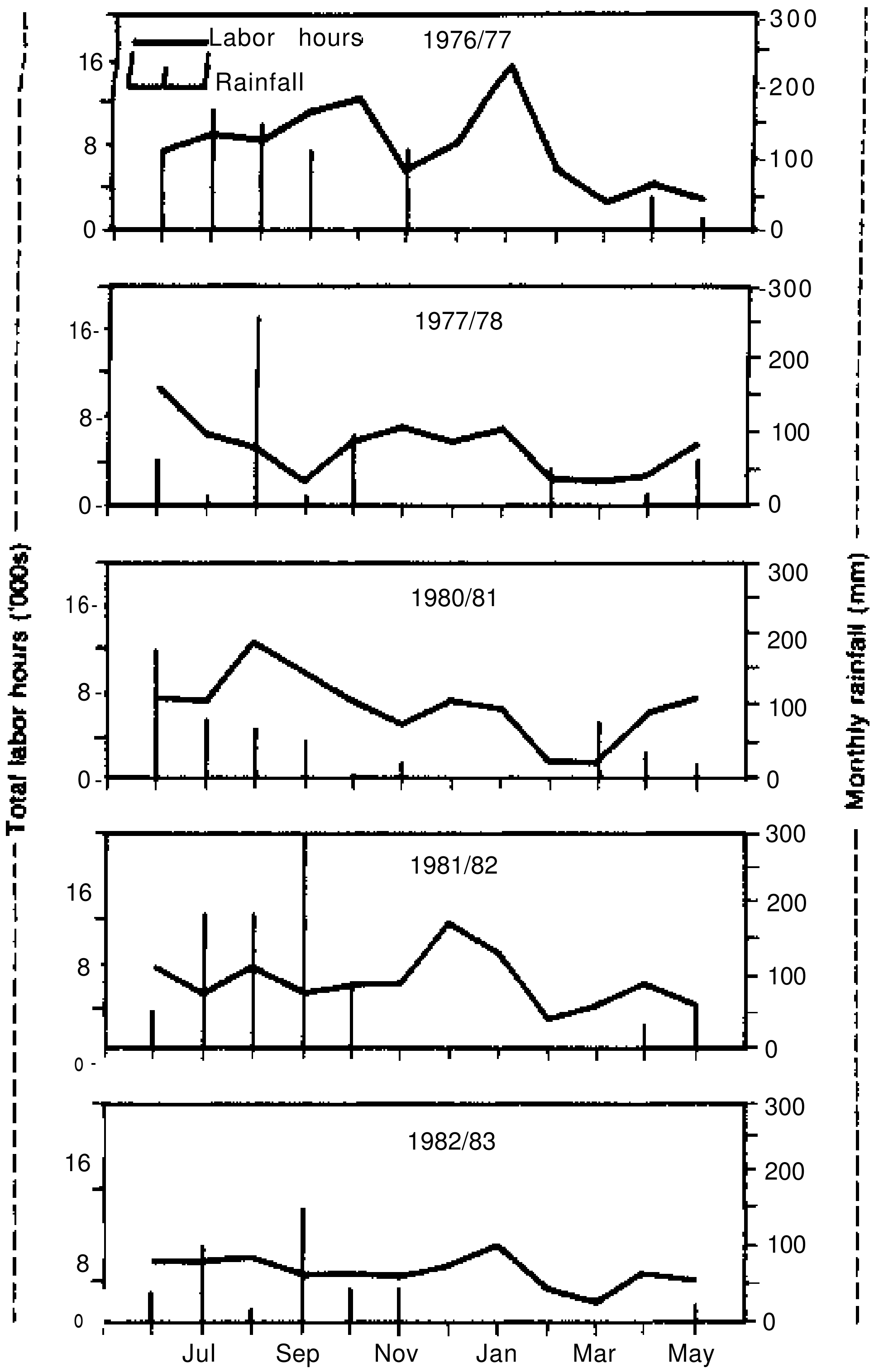


Figure 3.3 Monthly crop labor use and rainfall in Aurepalle for selected years

was sparse and rainfall from July 15 to September 15 did not exceed 100 mm. That drought led to reduced seasonality in labor demand.

Another rainfall-related theme that recurs in several chapters of this book is the less than expected level of covariance in rainfall outcomes across the study regions within India's SAT. The data on annual rainfall do convey a fairly high degree of shared up and down movement across the three villages, particularly between Aurepalle and Shirapur. But more relevant indicators, such as growing-season rainfall and total soil moisture available for crop growth, of how good the year was for crop production, were not that covariate. More often than not, growing-season rainfall was relatively high in one region and low in another. While annual rainfall was significantly correlated at 0.60 between Aurepalle and Shirapur, correlation coefficients between the two villages for either cropping-season rainfall or total soil moisture available, estimated with a weekly water balance model described in Reddy (1979), during the growing season approached zero, ranging from -0.13 to 0.16.

Land

By the early twentieth century, almost all cultivated land in the study villages was owned by individuals in freehold or ryotwari tenure. Land was privately owned, and farmers paid revenue directly to the government without the intervention of intermediaries.

Private property has a longer history in the Maharashtra villages compared to the Andhra Pradesh villages, where well into the nineteenth century feudal landlords called Jamindars leased land to intermediaries, or Maktadars, who in turn auctioned cultivation rights to village farmers (Raju 1981). The turning point in the evolution from a feudal to a freehold system in the Andhra Pradesh villages came in 1881 with the Survey Settlement Act, which recognized individual ownership rights and led to the demise of the Maktadar system. The last stage in the evolution to private property was completed shortly after Independence, when tenancy legislation granted ownership rights to long-term occupants of land.

Based on our 1975 census data in the six study villages, the distribution of cultivated land in the Mahbubnagar villages closely resembles the distribution of farm size estimated from the all-India agricultural census data (Bandyopadhyay 1986). About 60 percent of operated holdings are smaller than 2 ha; only 5 percent of holdings exceed 10 ha. In the more dryland Sholapur and Akola villages, operational holdings above 10 ha are about as numerous as those below 2 ha.

The distribution of owned land is somewhat less skewed in the Sholapur villages than in the Mahbubnagar and Akola villages. Not surprisingly, income is also more equitably distributed in the Sholapur villages (see chapter 4).

Although owned land is inequitably distributed in all the villages, households cultivating more than 20 ha are rare. Sixty-two of the 1,174 (or about one in twenty) households enumerated in the 1975 census cultivated more than 20 ha. Their median operated area was about 35 ha. The largest landholder in the study villages owns 250 acres. He wields less influence in that village than several of the other village elders.

Irrigation

The villages are predominantly dryland, but irrigation figures prominently in the Andhra Pradesh villages, particularly in Dokur, which is more heavily irrigated than we initially thought. In the late 1970s, irrigated land relative to gross cropped area varied from about 32 percent in Dokur to less than 1 percent in Kinkheda (Jodha, Asokan, and Ryan 1977). Irrigation is also steadily increasing in importance in all the villages. In 1975/76 about 12 percent of total gross cropped area was irrigated across the six villages. By 1983/84 the share of irrigated land had increased to 20 percent.

Trends in irrigation in the study villages mirror what has happened in the last thirty years in the hard rock regions of India's SAT. The area irrigated by groundwater is increasing, surface irrigation from small catchment reservoirs called tanks is declining, and electric pumpsets have rapidly replaced animal-drawn and diesel-powered lifting devices.

In response to population pressure and abetted by increasing rural electrification, subsidized electricity, rapid technological change in groundwater pumping and in lift irrigation, and cheap institutional credit, the pace of well sinking and deepening has accelerated in recent decades. For example, by 1984 there were 190 wells inside the Aurepalle village boundaries. Agricultural wells in use increased by 25 percent from 1974 to 1984; electric pumpsets grew in number from 75 to 136 (Wightman, forthcoming). Nonetheless, some wells are very old; their construction predates living memory.

The wells in the hard rock regions of the Deccan are not the more familiar tube wells of the alluvial plains of northern India but are dug wells that provide a much larger area to intercept water-bearing fissures in the granitic strata. They are 25 to 40 ft deep and 15 to 30 ft wide. Compared to that from tube wells, which tap underground aquifers, water yield from dug wells is low and recharge slow. Water is pumped for two to three hours a day. Recharge may take several days.

Wells in the granitic Mahbubnagar villages have a higher water yield than wells of comparable size in the Akola and Sholapur villages, where the substrata are basaltic. On average, as much as 2 to 3 ha are irrigated from a working well in Dokur, while a representative working well in Kalman supplies water to less than 1 ha.

Unlike in Aurepalle and Dokur, where many wells have been financed by village moneylenders, greater access to institutional credit since the early 1950s has spurred well drilling in the Maharashtra villages (Bhende 1983; Kshirsagar 1983). Irrespective of the source of finance, digging and deepening wells and buying electric pumpsets account for a large share of agricultural investment in all the villages.

Most well owners in each village now lift water with electrical pumpsets. A few who are poorly situated geographically, economically, or politically still rely on motes, that is, bullock-drawn rope and leather scoop-lifts, or on diesel-powered oil engines. Electrical pumpsets are preferred by almost all well owners because electricity is more heavily subsidized than diesel fuel. In prices prevailing in the early 1980s in the Aurepalle watershed, the ratio of operating costs for the three alternative lift systems—*motes,* oil engines, and electrical pumpsets—was 5 : 2 : 1 (Engelhardt 1984).

The profitability of well digging varies markedly from well to well. An economic analysis of twenty-eight wells in Aurepalle and in a neighboring village showed an average internal rate of return of 9 percent (Engelhardt 1984). A few wells were dry holes, most were seasonally wet, and some of the more successful ones were perennially wet, supplying water to rainy, post-rainy, and summer season crops. A few of the latter were characterized by internal rates of return exceeding 25 percent. The most profitable wells were either sited on good aquifers and/or located below tanks, small catchment reservoirs which are described later in this section. The latter is an example of conjunctive use of surface water and groundwater. The benefits of conjunctive use are well documented (Dhawan 1986). In particular, wells dug within canal-irrigated tracts are often more profitable than those dug in dryland regions away from sources of surface irrigation.

Shared ownership of wells and pumpsets is the salient example of group action in managing productive resources in the villages (Doherty, Miranda, and Kampen 1982). Joint ownership of wells is prevalent in the Sholapur villages, less common in the Mahbubnagar villages, and rare in the Akola villages. Among the active wells jointly or solely owned by respondent households in Shirapur, Aurepalle, and Kanzara, the average number of owners per well is 4.8, 2.4, and 1.0.

The cost of sinking wells is somewhat greater in Sholapur than in the other regions, which enhances the incentives for entering into joint ventures when farmers are confronted with an imperfect capital market, as they are in the villages. Additionally, the profitability of dryland agriculture in the Mahbubnagar and Sholapur villages pales in comparison to what can be obtained in the Akola villages, where groundwater recharge is also low. In other words, the opportunity cost of not buying or leasing in land for dryland production is much higher in the Akola villages and dampens incentives for investing in wells.

Water use in the jointly owned wells is governed by a fairly simple set of rules that are invariant over time (Doherty, Miranda, and Kampen 1982). Water rights are inherited—division-of-use rights among brothers at inheritance partially explains joint ownership in the Mahbubnagar and Sholapur villages—and marketed, but water is seldom sold to neighboring farmers. Water is much scarcer than land for all but the smallest irrigated farms.

With the exception of Dokur, sole ownership of more than one well is rare. The incentive to own wells is much stronger than the ambition to own land in all the villages, especially in Aurepalle, Dokur, Shirapur, and Kalman. Among villagers, wealth is most readily communicated in the number of productive wells a household owns than in how much land they have.

Small catchment reservoirs called tanks are the other source of water for irrigation in the Andhra Pradesh villages. They are one of the most noticeable features of the landscape of South India in regions where the underlying rock is granite. The largest tank is in Dokur. Its command area approaches 200 ha. Several smaller tanks with command areas less than 30 ha also dot the village landscape in Aurepalle and Dokur.

Like much of South India, irrigation from tanks is declining in importance in Aurepalle and Dokur. Tanks have silted over time. With increasing population pressure, the demand to own land in the tank bed has also risen, resulting in conflicts between farmers in the command area and those in the tank bed, where the most fertile land in the village is located. For example, the area irrigated from the largest tank in Aurepalle has steadily declined from more than 10 ha in the early 1950s to fewer than 2 ha by the early 1980s (Engelhardt 1984). Farmers have encroached on the tank bed and sunk wells in and around the tank, which over time has been increasingly viewed as a percolation structure to enhance groundwater recharge. Still, the large tanks, like the one in Dokur, play a critical role in the welfare of the village. In drought years, such as 1972/73 and 1985/86, the tanks do not fill up and cropped area (under paddy) can fall precipitously.

Draft Power

In all the villages, cultivation, including operations such as plowing, harrowing, and interculturing, is carried out with animal draft power, usually bullocks. Typical of much of India (Vaidyanathan, Nair, and Harris 1982), many households owning small amounts of land do not have bullocks. The dearth of bullocks is most pronounced in the Sholapur villages, where fewer than one landowning household in three owns at least one bullock.

A seasonal market for bullock hiring is incomplete probably because of the synchronic timing of operations in dryland agriculture, which in turn gives rise to a high incidence of covariate demand for draft power among farmers within the same village. Most cropping activities, especially planting, have to be executed within a fairly narrow time frame before the soil becomes either too dry in the red soils in the Andhra Pradesh villages or too unworkable in the heavier clay soils in the Maharashtra villages. As a result, bullock demand is characterized by sharp seasonal peaks, which inhibit the development of a rental market. The seasonality of demand for draft power is more predictable over years than the seasonality of labor demand but more variable within years in all the villages.

Seasonal hiring, mainly by small farmers, is most common in the Sholapur villages, where bullock : land ratios are significantly lower than in the other villages (Ghodake, Ryan, and Sarin 1981). In Shirapur and Kalman, fewer than two bullocks cultivate 10 ha; in Aurepalle and Dokur, more than four bullocks provide draft for the operation of the same amount of land. Indicative of their scarcity, bullocks cost about 100 percent more in Shirapur and Kalman than in the other four villages. Part of this price difference is attributed to better quality bullocks in the Sholapur villages, where the sturdier and heavier *khillar* breed is popular. But more importantly, the cost of maintaining bullocks is much higher in the Sholapur villages.

Like other livestock, trends in bullock numbers or quality are not readily noticeable in the study villages, or have hiring charges changed that much over the last ten years. Perhaps the only trend is the gradual rise in the incidence of ownership of one bullock. In 1975/76 only 5 percent of bullock owners across the six study villages possessed a single bullock. By 1983/84 20 percent of owners had only one bullock. As in other red-soil villages in India's SAT (Hill 1982), single bullocks in the Andhra Pradesh villages are often teamed with cows and buffalos. In the Maharashtra villages, single owners often pool their bullocks into teams and cultivate land on an exchange basis.

Many farm households in the late 1970s were still recovering from the 1971 to 1973 drought in western Maharashtra and in the gradual process of replenishing their bullock stocks. Bullocks are a risky production asset because of soaring maintenance costs and plunging asset values induced by fodder scarcities during drought. Thus, it is not surprising that bullocks are dearer, and interhousehold differences in draft availability are greater in the more drought-prone Sholapur villages. That variation in bullock endowments is one of the forces driving the very active tenancy market in the Sholapur villages (chapter 6). Households without a reliable source of draft power cannot aspire to be tenants in any of the villages, especially in Shirapur and Kalman.

Land Use and Agricultural Intensification

Land use in the study villages reflects a high and increasing population density that is the driving force toward agricultural intensification. Most arable land in the villages is privately owned. Until recently, villagers had access to more common grazing land. Each village still contains some "wasteland" that is primarily used for livestock grazing. The quantity and quality of village commons and open access land have eroded gradually over time (Jodha 1986). For example, in the early 1950s commons land occupied about 20 percent of area in the six study villages. Community land now accounts for about 10 percent of the area in those villages.

Rainfall permitting, farmers annually cultivate almost all their land in the Sholapur and Akola villages. Fallowing of upland fields is still common in the rainfall-unassured Mahbubnagar villages, which have more marginal soils and more access to irrigation than the Maharashtra villages. In both Aurepalle and Dokur about one-quarter of operated area was fallowed from 1975/76 to 1983/84. The fallowing interval is shortening: three-to-four-year fallows were common in the early 1950s; now they are rare (Jodha and Singh 1988).

Groundwater irrigation has increased gradually in all the villages, at a faster pace in the Andhra Pradesh than in the Maharashtra villages. Still, cropping intensity has not changed appreciably in any of the villages because relatively few wells are perennially wet.

Variation in cropping intensities in the villages is attributed mainly to differences in irrigation potential. About 15, 10, and 7 percent of the land in the Mahbubnagar, Sholapur, and Akola villagers, respectively, is multiple cropped in more than one season within the same cropping year.

In principle, more land in the Akola villages could be cropped sequentially in the monsoon and postmonsoon seasons, but in many years there is not enough moisture in the upper soil layers to establish the second crop after the first crop is harvested. Farmers prefer the surer, more resource-efficient alternative of intercropping longer-duration species (Reddy and Willey 1982). Sequential cropping is restricted to a few low-lying fields each year and is highly dependent on the receipt of timely rains in October.

Everything that grows on a farmer's land is used in one form or another. Cereal straw and stubble are never burned in the field. By-product value derived from prized alternative uses limits the adoptability of technologies such as green manuring and mulching that rely on crop residues to intensify crop production. Before the introduction of cheap and available inorganic fertilizer, some farmers in the Andhra Pradesh villages green manured with sun hemp, a legume, on their irrigated paddy fields. Today, green manuring and mulching are practiced only on the highest value, irrigated, small orchard crops in the study villages. Biomass scarcity also restricts the applicability of minimum tillage and no-till technologies.

Agricultural Operations and the Crop Calendar

Like the soils and the rainfall, the sequence of agricultural operations during the cropping season varies from region to region. Most land in the study villages is plowed before the onset of the monsoon. The term *plowed* should be interpreted broadly because the implement used is the wooden country plow, which is also used for sowing. In the Sholapur and Akola villages, farmers every three to five years carry out a deeper plowing following the post-rainy season harvest, when the soil is still soft enough to till. Deep plowing after the post-rainy season harvest is the only recommendation that has survived in the study villages from the

Bombay dryland farming practices researched and extended in the 1930s (Kanitkar, Sirar, and Gokhale 1960).

With the onset of the monsoon in June, farmers in Dokur and Aurepalle have to plant their cereal crops as soon as sufficient soil moisture accumulates to allow seedling emergence. Castor, an oilseed suited to marginal dryland growing conditions, is planted somewhat later in June or in early July. The cereals are harvested after the monsoon recedes in October. Castor pickings, of which there may be as many as ten, extend from September into January. Irrigated crops are strong competitors for labor during July and October, when paddy is transplanted, weeded, and harvested.

Drought represents a severe constraint to rainy season cropping in the Sholapur villages, where the presence of deep, black soils enhances the attractiveness of post-rainy season cropping. Farmers plant more drought-tolerant crops, such as pigeon pea and pearl millet, on their fields with lighter soils. (On average, one field in four, planted in the rainy season, will not be harvested because of crop failure [Singh and Walker 1984].) They save their better (in this case deeper) fields, usually located lower in the landscape, for more certain post-rainy season cropping. In July and August, Sholapur farmers use a blade harrow to control weeds on the fields targeted for post-rainy season sowing in late September or early October. Planting takes place when three events coalesce: (1) the soil becomes workable for tillage, (2) moisture in the upper profile is sufficient to establish the crop, and (3) the Nakshtra occurs, a fortnight that, according to Hindu astrology, is propitious (Bhende 1983). The post-rainy season, or rabi, crops, mostly sorghum and some safflower, are harvested in February.

Dryland farming in the Akola villages is less at the mercy of the monsoon. Planting is usually over by the first week of July with the sowing of local sorghum, which follows the planting of cotton, hybrid sorghum, pigeon pea, and other monsoon season, or kharif, crops in the third week of June (Kshirsagar 1983). Farmers weed, hoe, spray or dust pesticide, and apply fertilizer in July and August. Mung bean is harvested in September, hybrid sorghum in October, cotton in November and early December, and pigeon pea and local sorghum later in December. The mix of short- and long-duration crops grown in an assured-rainfall environment imparts a great deal of stability to labor demand, which is seasonally more buoyant in Kanzara and Kinkheda than in the other villages (chapter 5).

Cropping Patterns, Yields, Supply Response, and Crop Rotations

Many different crops arrayed in varying patterns are grown in the study villages, but, as in much of India's SAT, the crops that dominate the village landscape are coarse cereals, pulses, oilseeds, and cotton. Row intercropping at least two species in the same field during the same season is popular in all the villages, especially in the more rainfall-assured Akola villages. Intercropping is common in the rainy season and rare in the post-rainy season, when the incidence of terminal drought stress is high for all crops. Intercropping sorghum and safflower in the post-rainy season is restricted to the most fertile and deepest rainfed fields in the Sholapur villages (Dvorak 1988).

In spite of what often seems to be a bewildering array of cropping combinations, several cropping systems are commonly grown by many of the farmers in each of the villages (table 3.1). The cropping systems designated as "common" in table 3.1 are the ones most frequently found in each village, but they are by no means dominant and usually occupy less than 50 percent of cropped area in any cropping year, as dryland agriculture is quite diversified.

Based on their input use intensity in table 3.2, the common cropping systems in table 3.1 range from traditional, low-input cropping systems to modern, intensive cropping systems. Traditional cropping systems embrace the rainy season cereal/pulse intercrop in Aurepalle and the post-rainy season sorghum systems in Shirapur and Kalman. At the other end of the spectrum, we have irrigated paddy production in Dokur and Aurepalle and hybrid sorghum in Kanzara and Kinkheda.

Perhaps the most intriguing of the common village cropping systems is post-rainy season sorghum in the Sholapur villages. Post-rainy season, or rabi, sorghum production in the predominantly rainfall-unassured, deep black-soil regions of Maharashtra, Karnataka, and Andhra Pradesh is one cropping system that truly conveys a sense of timelessness. The uptake of improved inputs is negligible (table 3.2).

In chapter 8, we make a few disparaging comments about the traditional cereal/pulse intercrop in Aurepalle and the extensive cotton/pigeon pea/sorghum intercrop in the Akola villages. Those two traditional systems are rapidly losing favor with farmers. The same cannot be said of post-rainy season sorghum produced in the difficult environment of receding soil moisture. We would be hard pressed to come up with a consistently more profitable alternative that produces both grain and straw, which in most years contribute equally to the value of output.

Unlike other types of coarse cereals, the competitive economic edge of rabi sorghum has not eroded over time. The crystalline grain of local types like M 35-1 is highly preferred in Maharashtra, which is the main producing and importing state of sorghum in India (Raju and von Oppen 1982). Its fodder is also prized. During some months in the 1980s, rabi sorghum straw in Shirapur and Kalman was selling for more on a weight basis than kharif hybrid sorghum grain produced in Kanzara and Kinkheda.

Rabi sorghum accounts for about 45 percent of sorghum area and 35

Table 3.1. Salient features of common village cropping systems

Village	*Cropping System*	*Component Description*	*Season*	*Irrigated or Dryland*	*% Gross Cropped Area'*
Aurepalle	Sorghum/pearl millet/pigeon pea intercrop	Row intercropped; 4 rows of sorghum and millet mixed in the same row to 1 row of pigeon pea	Rainy	Dryland	*22*
Aurepalle	Castor	Sole cropped	Rainy	Dryland	25
Aurepalle	Paddy	Sole cropped	Rainy, post-rainy, summer	Irrigated	18
Dokur	Paddy	Sole cropped	Rainy, post-rainy, summer	Irrigated	48
	Groundnut	Sole cropped	Post-rainy	Irrigated	17
Shirapur	Sorghum	Sole cropped	Post-rainy	Dryland	42
Kalman	Sorghum	Sole cropped	Post-rainy	Dryland	40
Kanzara	Cotton intercrop 1	Row intercropped cotton :pigeon pea:sorghum (12:2:1)	Rainy	Dryland	22
	Cotton intercrop 2	Row intercropped cotton:pigeon pea (12:2); hand dibbled	Rainy	Dryland	17
	Cotton intercrop 3	Row intercropped cotton:mung bean: pigeon pea (5:5:2)	Rainy	Dryland	6
Kanzara	Hybrid sorghum	Sole cropped	Rainy	Dryland	6
Kinkheda	Cotton intercrop 1	Row intercropped cotton :pigeon pea : sorghum (12:2:1)	Rainy	Dryland	33
Kinkheda	Local sorghum intercrops	Various row arrangements; local sorghum the main crop	Rainy	Dryland	31

[a]Refers to 1975/76-1984/85 for Aurepalle, Shirapur, and Kanzara; 1975/76-1979/80 for Dokur, Kalman, and Kinkheda.

percent of production in India. After upland rice in East India, it is the second most important and most difficult (technologically speaking) production nut to crack of any common rainfed cropping system in India. In the immediate future, a high priority is attached to research on fertilizer timing and placement (Dvorak 1986). Several of the issues relating to improved performance in post-rainy season sorghum revolve around planting date (Dvorak 1986). Response to fertilizer is well documented

Table 3.2. Input use, yields, and net returns in the common village cropping systems

		Input Use (% plots)			*Output*		
Village	*Cropping System*	*Fertilizer*	*Manure*	*Pesticide*	*Median Yield (kg/ha)*[a]	***Mean Net Return (Rs/ha)***[b,c]	*Observations (N)*
Aurepalle	Sorghum/pearl millet/pigeon pea intercrop	4	21	3	170 130 30	430	270
	Castor	14	32	16	270	540	269
	Paddy	91	34	7	3,090	2,380	144
Dokur	Paddy	84	28	5	4,030	1,510	344
	Groundnut	44	7	30	1,520	1,710	86
Shirapur	Sorghum	1	5	1	330	660	721
Kalman	Sorghum	6	6	0	350	530	611
Kanzara	Cotton/pigeon pea/local sorghum	21	13	1	150 50 40	600	221
	Cotton/pigeon pea	53	21	16	250 80	990	178
	Cotton/mung bean/pigeon pea	78	32	29	250 210 100	1,620	69
	Hybrid sorghum	74	20	36	1,280	1,090	137
Kinkheda	Cotton/pigeon pea/local sorghum	6	22	1	170 70 40	600	153
	Local other crops	1	23	0	220	390	176

[a]Refers to the median grain yield of each intercropping component in the order given in the second column of the table. The median was taken because for some cropping systems yield distributions are severely positively skewed.
[b] Plots for the same years as in footnote a of table 3.1.
[c]Net returns to own farm resources (i.e., land, capital, family labor, and bullocks).

with an early planting date in mid-September. But farmers may not be able to sow their fields at that time because of waterlogging and seedling pest infestation. With the farmers' late planting date and without irrigation, fertilizer response is problematic, and it is hard to improve on M 354, which is more disease, pest, and drought tolerant than the vast majority of other genotypes. Nevertheless, rabi sorghum's resistance to technical change is largely a problem unique to India, as sorghum is produced under a receding moisture regime in few other developing parts of the world.

In the traditional cropping systems, grain yields are miserably low (table 3.2). Because of a high incidence of crop failure, most of the yields of the components in the traditional cropping systems are positively skewed. Post-rainy season sorghum in Shirapur is an extreme case: the mean yield exceeds the median by 66 percent (Walker and Subba Rao 1982a).

The same farmers who harvest dryland crops with yields ranging from 200 to 400 kg per ha receive paddy yields from 2 to 4 tn per ha in Aurepalle and Dokur. That simple observation of the contrast in productivity differences between dryland and irrigated agriculture for the same farmer bears eloquent testimony to farmers' rationality. One would be hard pressed to argue that custom or tradition constrains dryland productivity when the same farmer obtains yields approaching 4 to 5 tn using HYVs (high-yielding varieties), fertilizer, and other improved management practices on irrigated land.

Two other yield-related issues warrant comment. First, too much rainfall received at the wrong time can have a devastating effect on yield. For that reason, annual rainfall data do not do a particularly good job in communicating yield consequences. For example, although rainfall was heavy in Aurepalle in 1981/82, grain yields of local sorghum, the main dryland cereal, were lightest in that year. Abundant and sustained rain in late September and early October precipitated a sharp rise in insect and disease infestation. Second, desi or upland cotton, in the rainfall-assured Akola villages stands out as a stable yielder. At 30 percent, the CV of cotton yields over time was about the same order of magnitude as irrigated paddy yields in the Mahbubnagar villages (Walker and Subba Rao 1982a). This level of yield stability is obtained in largely unsprayed conditions in a region where cotton has been grown for more than one hundred years. Intercropped cotton in the Akola villages fits the stereotype of a low and stable yielding cropping system.

We have witnessed both subtle and more dramatic systematic changes in cropping patterns over the last ten years. The rising trend in the price ratios of pulses and oilseeds relative to coarse cereals is responsible for many of those changes. One of the more subtle supply responses occurred in the Akola villages in the late 1970s, when the price of pulses, particularly pigeon pea, moved sharply upward. The density of pigeon pea rows in farmers' traditional cotton/pigeon pea/sorghum intercrop increased, suggesting that spatial arrangements even in traditional intercropping systems are not cast in the agronomist's technical mortar but are partially determined in response to economic incentives. A more significant but related change also took place in the Akola villages in the late 1970s and early 1980s, when farmers began in earnest to substitute a cotton/mung bean/pigeon pea intercrop sown in a 5 : 5 : 2 row ratio [c]or their traditional cotton/pigeon pea/sorghum intercrop planted in a

10 : 2 : 1 row ratio. Between the mid-1970s and early 1980s, mung bean production increased about tenfold. Cotton production has remained about the same, while local sorghum area and production have sharply declined. The expansion in mung bean area was stimulated (to a considerable extent) by a 75 percent increase in its farmgate price between 1975 to 1977 and 1978 to 1980. During those two consecutive three-year time periods, the price of local sorghum grain only rose by 4 percent.

With regard to impact on the village economy, perhaps the most dramatic change took place in Kalman in the early 1980s, when more than thirty well owners financed by a state grape growers' association converted some of their command area to vineyards. Sunflower, a relatively new oilseed crop, has also made some inroads in dryland agriculture in the Sholapur villages.

This section on cropping patterns would not be complete without posing the questions, To what extent do farmers practice crop rotation to avoid pest and disease buildup or to take advantage of residual nitrogen (fixed by rhizobia associated with pulses), which can be used by cereals? Although farmers are aware of the value of crop rotations and although they say they try to practice them, the data on plot histories suggest that farmers are only partially successful in putting what they say into practice (Jodha and Singh 1988). Again, the main reason explaining the discrepancy between intentions and actions is the recurring theme of area variability, mainly in response to agroclimatic events at planting.

Input Use and Technical Change

The most dynamic element of technical change has been varietal adoption. One can list hybrid pearl millet and modern castor varieties in Aurepalle, improved paddy varieties in Aurepalle and Dokur, and the sorghum hybrids and improved upland cotton cultivars in Kanzara and Kinkheda. Fertilizer and pesticide use (from a low base) is also increasing in the Mahbubnagar and Akola villages. Dryland agriculture in the Sholapur villages stands out as being technologically stagnant, and not much has changed in dryland agriculture in Dokur, where farmers focus all their energy and resources on irrigated crop production.

Although masked by year-to-year variability in the production environment, significant technical progress has been made in paddy production in the Mahbubnagar villages and sorghum in the Akola villages. To a considerably lesser extent, castor in Aurepalle and upland cotton in the Akola villages have also benefited from technical change. In contrast, the sorghum yields in the rainfall-unassured Mahbubnagar and Sholapur villages have fluctuated around a constant level, indicative of no technological advance.

Seeds First-generation improved varieties and hybrids of all the major cereals were released in India in the mid-1960s. The wheat HYVs, about

Table 3.3. Diffusion of modern hybrids and varieties in the study villages

			Adoption			
Village	*Crop*	*Variety*	*Year of First Adoption*	*Years to 50% Diffusion*	*Cumulative Adoption Level in % in 1984*	*Farmers (N)*
Aurepalle	Paddy	Hamsa	1968	3	too	17
		Mashuri	1971	4	71	17
	Castor	Aruna	1974	8	78	36
Dokur	Paddy	Hamsa	1972	10	50	28
		Mashuri	1976	1	100	28
Kanzara	Sorghum	CSH-1	1964	7	100	30
		CSH-9	1981	4	57	30
	Cotton	B-1007	1966	9	100	30
		DHY-286	1973	7	77	30
		AHH-468	1981	4	80	30
Kinkheda	Sorghum	CSH-1	1965	14	76	29
		CSH-9	1981	4	50	29
	Cotton	B-1007	1964	15	79	29
		DHY-286	1973	8	59	29
		AHH-468	1981	3	66	29

which so much has been written, were the stellar performers. But the coarse cereal HYVs have also registered a number of successes in the major producing states. Contrary to popular belief, the adoption of coarse cereal HYVs is not restricted to a few isolated irrigated pockets. Improved cultivars account for more than 60 percent of rainy season sorghum production in the states of Maharashtra and Karnataka, pearl millet production in Gujarat, and finger millet production in Karnataka (Walker and Singh 1983; Jansen 1988). Less than 10 percent of that area is irrigated in those major producing states.

Adoption of high-yielding paddy varieties and sorghum hybrids is widespread in the Mahbubnagar and Akola villages, respectively (table 3.3). The majority of farmers who grow those crops in those villages are now using second- and third-generation improved cultivars like sorghum hybrids CSH-9 and CSH-11. These later releases are often characterized by a much shorter adoption cycle than their first-generation counterparts. For instance, CSH-9, a sorghum hybrid with improved consumer acceptance, was adopted by half the sorghum growers in Kanzara and Kinkheda within four years of its introduction into those villages. It took farmers much longer to accept CSH-1, which represented a radical phenotypic departure from their local varieties; the mean adoption lag was considerably longer, especially in Kinkheda (table 3.3).

In terms of number of releases, varietal change in cotton in the Akola villages has the richest history. Farmers are not allowed to gin their own cotton and are compelled to purchase seed annually from the state cotton organization. This short-circuits the diffusion process but also increases the risk that farmers will not have access to locally adapted improved seed on a timely basis.

For the seed of some modern varieties and hybrids, farmers would be willing to pay several times more than the market price. Area planted to castor hybrid Gauch-1, released by Gujarat Agricultural University, was clearly limited by seed availability in Aurepalle in the late 1970s and early 1980s.

Conspicuous for their absence in table 3.3 are other modern releases such as the post-rainy season sorghum HYVs in the Sholapur villages, the rainy season sorghum hybrids in the Mahbubnagar villages, and the cotton hybrids in the Akola villages. The main varietal type sown in post-rainy season sorghum production is Maldandi, or M 35-1, an improved selection of local germ plasm released by the Sholapur research station in 1933. A few farmers in Shirapur and Kalman have tried high-yielding rabi sorghum hybrids and varieties on their rainfed fields, but they have reverted to local types. Those HYVs now only find a home on a few irrigated plots in each village.

Sorghum hybrids do not perform well in the red-soil Mahbubnagar villages. They are afflicted by numerous disease and insect pests and are regarded by villagers as having inferior grain and fodder quality. Indicative of the strength of this perception is the fact that sorghum hybrids are the only cereal type for which landless laborers in Aurepalle and Dokur refuse to accept wage payments in kind. One or two farmers annually experiment with the hybrids in each village and then switch back to their local varieties.

The cotton hybrids are simply too intensive in their demands for plant protection, soil fertility, and water to permit widespread dryland cultivation in the Akola villages. They are grown annually by the richest farmers on a few irrigated plots in each village.

Fertilizer Irrigation and fertilizer go hand in hand. In the late 1970s, the average level of fertilizer consumption in the 192 districts of India's SAT stood at around 32 kg of nutrients, mostly nitrogen, per ha of gross cropped area. The 78 more heavily irrigated SAT districts consumed on average about three times more fertilizer than the 114 less irrigated SAT districts—58 to 19 kg (FAI [Fertilizer Association of India] 1979).

The use of fertilizer in the study villages exemplifies those all-India results. Mean nutrient consumption (kg/ha of gross cropped area) varied from a meager two in the drought-prone Sholapur villages to a more hefty twenty-five in the more irrigated Mahbubnagar villages. In the

Mahbubnagar, Sholapur, and Akola villages, irrigated land, which comprises about 40, 10, and 5 percent of gross cropped area, laid claim to about 98, 75, and 37 percent of fertilizer used, respectively. Only in the more rainfall-assured Akola villages do dryland crops receive an appreciable amount of fertilizer. Even though the irrigated plots command an overwhelming share of fertilizer resources, there is still considerable room for expanding fertilizer use, particularly in the Sholapur villages, where only about 30 percent of irrigated area was fertilized from 1975/76 to 1984/85. That statement also applied to Aurepalle and Dokur in the mid-1970s, when only 60 percent of irrigated area was fertilized (Jha and Sarin 1984). But by the mid-1980s, nine irrigated fields in ten received fertilizer, and the rate of application was as high as 120 kg of nitrogen per ha in Dokur in 1983/84.

Although fertilizer use in dryland agriculture is low, it is increasing in the Akola villages and (to a much lesser extent) in Aurepalle. More fields are receiving fertilizer in Kanzara and Kinkheda than in the past. The rate of application on those rainfed fields has risen from about 20 to 35 kg of nitrogen per ha. In Aurepalle, the percent of dryland fields fertilized has risen dramatically from 3 percent in the mid-1970s to 50 percent by the mid-1980s. Still, dosages are very low, averaging 10 kg of nitrogen per ha fertilized.

Again, the diffusion of fertilizer in the study villages is highly correlated with access to irrigation. About half the farmers in Dokur began using fertilizer prior to 1959, considerably before the more fertilizer responsive paddy HYVs became available in the mid-1960s. Even today some farmers without irrigation in Shirapur and Kalman have never used fertilizer. Fertilizer adoption in the Akola villages was contemporaneous with the diffusion of the sorghum hybrids in those villages.

Few of the farmers in the sample have applied fertilizer every year. Use rates are strongly associated with time of adoption. The early adopters are the ones who persistently use more fertilizer. The late adopters never seem to catch up. Unlike the pattern of the diffusion of the HYVs, differences in fertilizer use appear to endure.

Manure Farmers in the study villages value manure highly but apply far less than what they view as desirable because of supply scarcities arising from limited fodder availability, which restricts livestock production. The high cost of transporting manure, which is not actively traded in the villages, and the end use of dung cakes for fuel also constrain availability for field application.

Few fields are manured every year. The chances of a field receiving manure in a cropping year range from about one in four in the Mahbubnagar villages to one in sixteen in the Sholapur villages.

Interregional differences in manure coverage reflect disparities in village livestock endowments. Manure deprivation is especially acute in dryland fields in Shirapur and Kalman. The majority of fields cultivated each year by respondent households in Shirapur were not manured once during the ten-year study period.

While irrigated land still claims a disproportionate share of manure applied in the villages, the allocation of manure is not as heavily tilted toward irrigation as is the distribution of inorganic fertilizer. Rainfed fields, comprising 80 percent of gross cropped area in the study villages, received 56 percent of applied manure compared to only 30 percent of the inorganic fertilizer.

When a field is manured, the rate of application is about twice as much on irrigated land, 6 compared to 3 tn per ha. Both rates are considerably below what farmers on average perceive to be the proper dose, about 6 and 9 tn per ha on rainfed and irrigated land, respectively (Jha and Sarin 1984).

Because manure supplies are intimately linked to livestock production, one should be able to draw inferences about trends in manure supplies from livestock growth rates. None of the villages have experienced a significant growth in livestock since we started the studies in 1975. Similarly, manuring coverage and use intensity do not display any discernible trends in the villages.

Pesticide Results from several field studies show that only a small minority of farmers practice chemical control in dryland production tracts (Rastogi and Annamalai 1981). Farmers who spray intensively are usually located in irrigated pockets within dryland regions. But that picture is changing as proportionally more farmers are applying pesticide on their dryland crops. Although varietal resistance offers promise especially to reduce disease losses for resource-poor farmers, chemical control will remain the cornerstone of any pest management strategy in the immediate future.

Farmers in the study villages recognize the role of pests as yield reducers and have relied on several elaborate pre- and postharvest traditional resources to protect against and mitigate the effects of pest attack (Bhaskar Rao and Mueller 1986). The effectiveness of those measures is difficult to gauge. Traditional control measures often were based on material like neem leaves, which were readily available in the village. With rising population pressure, those materials have become dearer. More cost-effective spraying equipment, such as ultra-low-volume sprayers, have also recently become available.

The dynamic cost of chemical control in increasing pest resistance to insecticides can be large (Metcalf 1986). The size of that cost will largely be determined by what happens in irrigated agriculture, where pesticide use is much higher than in dryland agriculture.

Although expenditure on fertilizers is about nine times greater than expenditure on pesticide and although farmers are much further along in the fertilizer diffusion process, most of the comments on fertilizer use in the previous subsection also apply to pesticides. Pesticides are more widely and increasingly used in the Mahbubnagar and Akola villages.

Like fertilizer, pesticides are applied disproportionately to irrigated crops. About one irrigated field in six was dusted or sprayed; comparable odds for a dryland field receiving chemical control were one in sixteen. The dryland cropping systems where chemical control was applied with any degree of regularity were rainy season hybrid sorghum in the Akola villages and castor in Aurepalle.

The adoption pattern for pesticide use is also S-shaped, but the start of first use and the rate of diffusion are much later and lower than for fertilizer in the study villages. By 1985 more than a third of the farmers in the sample had still never dusted or sprayed. Only two farmers in the sample sprayed every cropping year from 1975/76 to 1984/85. Most of those who sprayed did so only sporadically, suggesting that chemical control for them often was ineffective or that pest infestation was extremely variable. Chemical control in all the villages can be problematic because farmers often do not know when to spray or do not have access to the right equipment and insecticides on a timely basis.

Implements and Machinery In contrast to biological and chemical innovations, the implements employed by villagers to cultivate their fields are essentially the same as their forefathers used. The staple implements are the metal-tipped country plow, the blade harrow, and the country seed drill. Collectively, they cost around Rs 200 and are readily made from local materials. The large stock of hand-tool and animal-drawn "relics" housed in various agricultural engineering museums in universities across India attest to the cost effectiveness of these simple traditional implements.

Aside from electrical pumpsets and backpack sprayers, threshers are the only agricultural machines experiencing widespread use in any of the study villages in recent years. The bulk of sorghum, wheat, and mung bean is threshed by machine in the Akola villages. The demand for machine threshing is constrained by the size of the harvest in each village. In the mid-1980s, two threshers were operating in each of the Akola villages. The consequences of introducing threshers into Kanzara are described in chapter 10.

The pace of tractorization in the villages is very slow. Less than 1 percent of the land in the villages is prepared by tractor. By 1986, among farmers in the study villages, four in Dokur and one in Kinkheda owned tractors. A handful of farmers in the study villages had bought tractors, found them unprofitable, and subsequently sold them.

Other Agricultural Enterprises

The preceding emphasis on annual crops is derived from their importance in household income generation. Animal husbandry does not yet figure that prominently in the economies of the study villages. On average across the six study villages, livestock contributes at most only about 15 percent to household income and 8 percent to total household wealth. Several households in each of the villages own sheep and goats and rely heavily on income from livestock trading. But for most households, livestock sales supplement labor earnings or crop revenues (chapter 4).

Dairy production and marketing in the study regions are not nearly as developed as in Gujarat, where milk production strongly influences the economic welfare of many village households. Much of the value of the large ruminants, including bullocks and even cows and buffalos, is derived from their use as animal draft.

We would be surprised if livestock did not contribute more to village welfare in the future. The few families who herd sheep and goats in each village have prospered because of a strong upward trend in mutton and goat prices. Simultaneously, fodder in the Sholapur and Mahbubnagar villages has become much dearer mainly in response to expanding urban demand for milk. In the Sholapur fodder market, for example, prices have more than kept pace with inflation, increasing fourfold over the last twenty years. Some shepherd families in Dokur have even bought land on which to grow fodder.

In the longer term, tree crops should also loom larger in the agriculture of the study villages. Currently, trees are important revenue earners in pockets of India's SAT. Of the study villages, we can single out Aurepalle, which has about two thousand productive toddy palm trees. The milky juice of the palm fruit is fermented and sold as palm liquor, or toddy. About one-quarter of the village population is engaged in toddy tapping, which is a traditional caste occupation (Mohan Rao 1983).

The toddy trade is heavily regulated by the state, which allocates tapping rights directly to households. Tapping rights are embodied in renewable licenses issued by the government. As we will see in chapter 4, the loss of tapping rights for even a year can result in a severe shortfall in income. Demand for toddy is brisk and over the last ten years annual cropping has been primarily a subsidiary occupation for toddy-tapping households.

Integrated agroforestry systems, like the Prosopis cineraria-pearl millet system encountered in large tracts of Rajasthan (Mann and Saxena 1980), are not found in the study villages. Tree density is higher in the red-soil study villages where babul (Acacia nilotica) is often left in farmers' fields to provide wood for house construction or for plowshares.

Although the villages are increasingly denuded of vegetation, a di-

Table 3.4. Key descriptive phrases distinguishing the study regions and villages

Region and Village					
Mahbubnagar		*Sholapur*		*Akola*	
Aurepalle	*Dokur*	*Shirapur*	*Kalman*	*Kanzara*	*Kinkheda*
Rainfall unassured; pronounced rainfall uncertainty at sowing		Rainfall unassured; frequent crop failure		Rainfall assured	
Red soil; marked soil heterogeneity		Deep black soils in lowlands; shallower lighter soils in uplands		Black soils; fairly homogeneous	
Kharif, or rainy season, cropping		Rabi, or post-rainy season, cropping		Kharif cropping	
Paddy, castor, and local kharif sorghum		Rabi sorghum		Upland cotton, mung bean, and hybrid sorghum	
Agricultural intensification around dug wells and tanks		Some dug wells		Limited irrigation sources in 1970s and early 1980s	
Neglect of dryland agriculture		Technologically stagnant		Sustained technical change in dryland agriculture	
Harijans and caste rigidities; inequitable distribution of land ownership		Tenancy; dearth of bullocks; more equitable distribution of land		More educated	

minishing supply of wood for household fuel consumption has been offset to some extent by the widespread diffusion of *Prosopis juliflora* in some of the study villages. *P. juliflora* is not cultivated in farmers' fields but readily establishes itself along fence rows and on marginal village lands. It is widely adapted and coppices profusely.

Consistent with the accumulating experience on social forestry in India (Blair 1986), villagers prize trees for their commercial wood or fodder potential. They pay little heed to species suitability for household fuel wood production as interest centers on eucalypts for small commercial timber and pulp wood and on small orchard species for fruit.

Region and Village Profiles

The information presented in this chapter should have instilled in the reader a greater awareness of the agriculture of these semi-arid tropical regions and villages. To increase the chances that the reader will leave this chapter with an appreciation for interregional and intervillage differences (such an appreciation is crucial to assimilating the findings from the analytical chapters which follow), key descriptive phrases distinguishing the study regions and villages are listed in table 3.4. Table 3.4 is a reference table. It should be turned to when the regional names Mahbubnagar, Sholapur, and Akola and the village designations Aurepalle, Dokur, Shirapur, Kalman, Kanzara, and Kinkheda no longer ring a bell.

Part Two Welfare and Factor Markets

4 Income, Consumption, and Wealth

Assessing how villagers in these poor dryland regions have fared materially since 1975 is the focus of this chapter. The raw material for economic appraisal are longitudinal household data on income, consumption, and wealth. The dynamics of household economic welfare are evaluated from village comparisons across the different dryland production regions and from group comparisons within the study villages. Because these comparisons are rich in empirical content, readers, who are susceptible to numerical indigestion and who find definitions, caveats, and procedures tedious, are advised to peruse the topics of their interest and proceed directly to the concluding section.

Four major economic issues are addressed: (1) levels of income, consumption, and wealth; (2) trends in income, consumption, and wealth; (3) volatility in income and consumption; and (4) economic mobility. In the background of the analysis of these issues looms the larger concern of rural poverty. To provide context and perspective to the results of this chapter, we begin by briefly reviewing selected aspects of and research on rural poverty in India.

Setting the Stage

Although India has made substantial progress on a number of fronts since Independence, rural poverty is widespread, with 200 to 300 million rural people below the poverty line. The adjective "massive" is justifiably still used to describe rural poverty (Rath 1985).

Both the central and state governments have invested in several initiatives explicitly or implicitly aimed at improving the lot of the rural poor (Dandekar 1986). Immediately after Independence and into the 1950s, legislative reforms were promulgated to eliminate feudal institutions, and equal opportunity safeguards were passed to improve the chances that groups such as scheduled castes and tribes, which were discriminated against, would have better access to the economic and social pie. The abolition of untouchability, bonded labor, and intermediary tenancies reflected the spirit of those reforms.

In the 1960s in response to food shortages, production-oriented programs such as the Intensive Agricultural District Program and the eminently successful High Yielding Varieties Program were initiated mostly in the better-endowed, irrigated regions. In the 1970s, the emphasis shifted to direct poverty alleviation efforts, focusing on the poorer groups within regions and on those regions which had largely been bypassed by the green revolution in wheat and rice. Acronyms such as the SFDA (Small Farmers Development Agency) and the DPAP (Drought Prone Areas Program) became synonymous with intraregional and interregional equity concerns.

In the late 1970s and on into the 1980s, distributing productive assets to the rural poor through the Integrated Rural Development Program (IRDP) has been the main plank in the Government of India's direct assault on rural poverty. Generating employment mainly through rural works programs and subsidizing investment in economically backward regions represent other elements in the Center's (or the federal government's) strategy of poverty alleviation in the Sixth (1980 to 1985) and Seventh (1985 to 1990) Five-Year Plans.

The state governments have also carried out some enterprising endeavors to tackle rural poverty. Prominent among these in the study regions are the Employment Guarantee Scheme, formally started in 1977 in Maharashtra, and the "rice at Rs 2.00" food ration and subsidy scheme, which commenced in 1984 in Andhra Pradesh.

Several of these public-sector undertakings are sizeable in coverage and/or budget. For example, the Maharashtra Employment Guarantee Scheme (MEGS) is one of the largest and most sustained public works ventures in recorded history (Lieberman 1984). In the early 1980s, between 10 and 13 percent of the Maharashtra state government's budget was allocated to the MEGS. In the Sixth Plan, about Rs 45,000 crores (including credit subsidies), equivalent to about U.S. $40 billion, was spent on the IRDP, which has easily eclipsed all previous rural development programs in economic ambition.

Although the thrust of this chapter is not to evaluate the consequences of these schemes on rural poverty in the study regions and villages, the issues that impinge on the success of direct intervention by the public sector to alleviate poverty are clearly germane to the substance of the chapter and much of the rest of the book. Four overriding concerns include (1) the size and the quality of economic growth conducive to poverty alleviation, (2) the level of investment in direct poverty alleviation compared to other government expenditures, (3) the investment mix in direct poverty alleviation programs, and (4) the degree to which the poor gain relative to others, particularly with regard to the interregional distribution of benefits, in national poverty alleviation programs like the IRDP. The philosophy underlying direct government intervention is based largely on the argument that economic growth in and of itself will not generate enough in the way of trickle-down benefits to lift substantial numbers of rural households above the poverty line. Many, such as Lal and Rajapatirana (1987), would argue that inefficient government policies, especially those oriented toward capital-intensive import substitution, have constrained and biased the nature of economic growth to such an extent that the trickle-down hypothesis cannot be tested fairly.

While the size of public-sector investment in some of the poverty relief measures is unprecedented in absolute terms, economists such as Dandekar (1986) and Parthasarathy (1987) contend that such government expenditures are dwarfed by the size of the rural poverty problem. For example, the IRDP, by far the largest rural development program since Independence, accounted for only 1.4 percent of the outlay of the Sixth Plan (Deolalikar 1986a).

Turning to the issue of the appropriate mix in the portfolio of public-sector poverty alleviation programs, the concept of distributing productive assets, mainly dairy cattle, to generate sustained self-employment for the rural poor—the basis upon which the IRDP is founded—has been severely criticized. For instance, Rath persuasively argues that "at the end of seven years of operation of IRDP, only about 3 percent of the poor households in rural India would have been helped to live above poverty even if for a while only" (1985: 243). Rath (1985), Dandekar (1986), and several other analysts contend that the Center should spend more on generating rural employment and less on subsidizing asset acquisition. Focusing on differential regional impact, a summary of results of IRDP evaluation studies indicates that the program has been more successful in meeting its objectives in more developed rural regions, better endowed with complementary infrastructure (Subbarao 1985).

While those four poverty-related issues have generated considerable debate and a diversity of views, a consensus is readily discernible that the incidence of poverty, narrowly defined by Dandekar and Rath (1971) as the proportion of the population falling below a monthly expenditure line of Rs 15 per capita in 1960/61 prices (at that time the level of expenditure required to procure 2,250 calories per capita per day), has shown no detectable trend (Ahluwalia 1985; Bussink and Subbarao 1986; Dandekar 1986). What is visible in charting the incidence of absolute poverty over time are strong repetitive movements in which rural poverty has risen or fallen, often sharply, within periods of three to six years (Mellor and Desai 1985). The estimates of Mellor and Desai are consistent with a marked decline in poverty in the late 1950s, a steep rise between the early and mid-1960s, a sharp fall to the early 1970s, and a moderate increase from the early to the mid-1970s. The most recent data from the quinquennial National Sample Survey (NSS) of consumer expenditure indicate a modest decline in the incidence of poverty between 1977/78 and 1983/84 (Dandekar 1986). Mellor and Desai (1985) underscore the importance of accelerated agricultural growth and resulting food price stability in explaining cyclical downturns in the incidence of poverty. They see the impact of land reforms and area expansion as being associated with if not responsible for the fall in poverty in the late 1950s and the green revolution as the motivating force behind the reduction in poverty in the late 1960s.

Much of the discussion on the state of rural welfare in India has been confined to the measurement of poverty based solely on the level of consumption expenditure (Bussink and Subbarao 1986). Not much is known about what has been happening to the quality of rural life over time. In-depth village studies have generated some useful information in some regions. For example, with retrospective survey data from two villages in Rajasthan, Jodha (1988) has documented improvement in household welfare on a number of qualitative indicators even though the quantitative incidence of poverty did not fall from 1964-1966 to 1982-1984. Even for households whose real income had declined, the qualitative data were consistent with considerable social and economic progress. Reliance on exploitative patron-client relationships decreased over time, marketing flexibility increased, household liquidity deepened, consumption patterns diversified, and consumer durables loomed larger in household assets.

Initial findings by the National Council of Applied Economic Research (NCAER 1986) from a large national retrospective survey of more than three thousand rural households have also illuminated several dimensions of rural income between 1970/71 and 1981/82. Although life cycle effects to some extent cloud these findings (Parthasarathy 1987), the empirical evidence from the NCAER study is persuasive on the following points pertaining to changes in real household per capita income:

1. The lower income deciles in 1970/71 experienced real income growth between 1970/71 and 1981/82. Mean real income per capita for the lowest decile more than doubled; for deciles 2,3,4, and 5, the increase was not as pronounced but still substantial, ranging from 24 to 66 percent over the 1970/71 income levels. For the highest three deciles in 1970/71, mean per capita income declined. The fall was steepest for the top income decile, for whom the average percent change in real per capital income was about -40 percent.
2. Differences in real income growth among decile groups were also reflected in changes in per capita consumption expenditure, which increased proportionately much more for the lower income deciles.
3. The income gap estimated between the landed and landless narrowed as mean household per capita income for the landless households rose by 21 percent while the per capita income of landowners only increased by 5 percent. The large farm group incurred a drop in real income as

smaller farm households fared relatively better than their larger counterparts between the two periods.

4. Nonagricultural income loomed larger in 1981/82, rising from 20 to 27 percent of total income; the share of agricultural income fell from 60 to 53 percent. Seventy percent of the increase in real household income between the two periods was attributed to the rise in nonagricultural income.
5. A high incidence of reshuffling of households in the income ranking was recorded between the two survey years. At the extremes, one-third of the households in the bottom decile moved into one of the top five deciles, and one-quarter of those in the top decile slipped into the lower half of the household per capita income distribution.
6. Although many households substantially changed position in income rank between the two survey years and although the income gap narrowed between the poorer landless households and the generally richer landed households, income inequality measured by the Gini concentration ratio did not change noticeably between 1970/71 and 1981/82.

While transitory and life cycle effects are clearly responsible for some of these findings, the NCAER evidence provides a valuable point of reference from which to evaluate the empirical results which follow from the panel households in the study villages.

A similar benchmark can be established for trends in rural wealth over time. Based on the Reserve Bank of India's debt and investment surveys, Dantwala (1987) has recently synthesized the evidence as follows. Total assets per rural household grew at a real rate of about 4 percent per annum between 1971 and 1981. Except for an increase in consumer durables from 4.2 to 6.6 percent for cultivator and 11.5 to 15.8 percent for noncultivator households, no significant change in the composition of assets took place between 1971 and 1981. The ratio of the average value of all assets between cultivator and noncultivator households fell from 5.59 in 1971 to 4.96 in 1981. But inequality, as measured by Gini concentration ratios, in total asset holding remained constant between 1971 and 1981. These trends in rural asset holding also receive some support from recent microstudies reviewed in Subbarao (1987a).

Findings from the NCAER retrospective survey of rural household income and the Reserve Bank of India's debt and investment surveys can be pieced together to tell a coherent story of national trends in rural household income and wealth from the early 1970s to the early 1980s. Important points in that story would include a moderate rate of growth in both household income and total assets, greater relative gains made by rural landless compared to farming households, and no visible reduction in inequality. How well the microevidence from the poor dryland study villages reflects these national trends is the subject of much of the rest of this chapter.

Data, Definitions, Procedures, and the Length of Time Series

Measuring household income is data intensive and fraught with difficulties in both developing and developed countries (Jodha 1976; Radner 1983). (These problems have not deterred planners from recommending that household income should be the main criterion in targeting IRDP beneficiaries based on the *antoyodaya* principle of giving preference to the poorest of the poor [Rath 1985].) Response error usually leads to underreporting of income in single interview surveys. With the village study data, the high periodicity of interviews—every three to four weeks—should have helped to reduce several sources of nonsampling error, particularly memory bias in recalling transactions. The double entry bookkeeping framework of the transactions schedule was also exploited to check whether households systematically underreported income. For most households, the sum of net-cash and in-kind balances across rounds and years oscillated around zero. Some households did accumulate negative liquidity balances over time, indicating that income was underreported. Reasons for discrepancies in imputed cash flow were readily identified but not so easily rectified. For example, a few farmers in one village regularly added water to milk, thereby increasing the volume of their dairy sales. This behavior was never admitted publicly but was acknowledged privately.

Income is defined as net returns to family-owned resources, encompassing family labor and owned bullocks, capital, and land (Singh and Asokan 1981). Earnings and expenses from farm and nonfarm activities are considered in estimating household income. Both monetary and imputed values of all traded and nontraded goods, such as crop by-products and manure, figure in the computation of household income.

While our definition is broader than most, it is not as comprehensive as the definitions commonly used by household economists (Kusnic and Da Vanzo 1982). We do not adjust income for the value of housing services from living in one's own house, the value of time that adults spend in housework, or the value of leisure, nor (as discussed in chapter 3) have we accounted for all income provided through open access and common property resources.

Income, consumption, and wealth are expressed per person or per capita and not per household. We made no attempt to convert to equivalence scales to adjust for the age and gender composition of the household. Not using equivalence scales should lead to underestimating welfare for households with more members and more children because of potential economies of scale in consumption and because of children costing less than adults (Deaton and Mullbauer 1982).

The description of levels of trends in income, consumption, and wealth is based on data for nine cropping years from 1975/76 to 1983/84 for one continuous village in each region. Income data for the tenth cropping year (1984/85) were not processed when we empirically examined levels, trends, fluctuations, and mobility. Incorporating the 1984/85 data should not alter appreciably the results of our analysis. Moreover, the transactions, labor, and cultivation data were not collected as frequently in 1984/85 as in previous years; thus, the data for that year are less reliable than for the other nine years.

Data, collected routinely as described in chapter 2, were also available to estimate income for households in the noncontinuous villages in each region for the first two cropping years, 1975/76 and 1976/77. Analysis of those data showed that the income profiles were very similar for the study villages within the Sholapur and Akola regions; however, because of greater access to irrigation, Dokur's income profile differed from Aurepalle's (Singh, Asokan, and Walker 1982). Where appropriate, we refer to that analysis of the first two years' income data for the six villages to highlight those similarities and differences.

Estimates of household income were also generated for Dokur, Kalman, and Kinkheda for the cropping years 1977/78 to 1983/84. Those estimates were based on retrospective surveys canvassed in 1983/84. Although those estimates are not nearly as reliable as comparable year estimates for the continuous villages, analysis by Singh and Binswanger (1988) of income dynamics based on the six-village, nine-year sample largely supports and complements our results founded on the three-continuous-village, nine-year sample.

The measurement of consumption expenditure draws on data from Aurepalle, Shirapur, and Kanzara from 1976/77 to 1981/82. Consumption data were not reliable in 1975/76 and were not collected in such meticulous detail after 1982.

Income, wealth, and consumption expenditure are expressed in real terms in this chapter. The data on income and consumption expenditures were deflated by village-specific consumer price indices, consisting of food and nonfood price indices weighted by their respective average budget shares. Nonfood price indices were taken from the Consumer Price Index for Agricultural Labor (CPIAL) compiled by the Directorate of Economics and Statistics (1982) for each state in India. The village-specific food price indices were calculated from primary data from dietary surveys described in chapter 9 and in Ryan et al. (1985) and from expenditure data collected in the transactions schedule. The representative commodity baskets, upon which the food price indices are based, are given in appendix table 3 of Walker, Singh, Asokan, and Binswanger (1983).

The estimated consumer price indices told essentially the same story on inflation across the three villages: negligible to mild inflation during the mid- to late 1970s, rising inflation from 1979/80 to 1981/82, and consumer price stagnation in the early to mid-1980s. For example, in Aurepalle, the estimated consumer price indices for each of the nine cropping years from 1975/76 to 1983/84 for landless labor households were 100, 117, 115, 104, 138, 157, 159, and 143. Net wealth was converted into constant prices by village and asset-specific deflators depending on the type of asset. The deflator for buildings, land development (such as well repair and construction), and financial assets was the CPIAL, because deflators per unit of investment could not be constructed for these assets.

One last bookkeeping concern warrants more explanation. In the intervillage comparisons, one should adjust the household data by the proportions of the cultivators and landless labor households in the sample in table 2.1. Cultivator households are three times as numerous as landless labor households in the sample, but the ratio of cultivator to landless labor households in the village populations in 1975 was about 2:1. But cultivator households on average have more members than landless labor households. Those differences in household size largely offset the disproportionate sampling of cultivator households relative to their numerical strength in the village household population. In other words, the population of each study village is characterized by a ratio of about 3:1 cultivator to landless labor members, although the household ratio is closer to 2:1. Because the unadjusted data more truly reflect the composition of people in the village, we have not corrected for the small intervillage differences in the sampling fractions recorded in table 2.1.

Aspects of Income, Consumption, and Wealth

The data on the size of real household per capita income, consumption, and net wealth for the three villages are summarized by the Tukey box diagrams depicting seven bits of information in figure 4.1. Each diagram provides information on the level of the tenth, twenty-fifth, fiftieth, seventy-fifth, and ninetieth percentiles in each village sample and the data points for the outliers below the tenth and above the ninetieth percentiles (Tufte 1983; Cleveland 1985). (The lower line outside the box corresponds to the tenth percentile, the lower edge of the box to the twenty-fifth percentile, the middle line in the box to the fiftieth percentile, the upper edge to the seventy-fifth percentile, and the upper line to the ninetieth percentile.)

As expected, median income (at the fiftieth percentile in figure 4.1) was higher in Kanzara, where agricultural growth has been more marked, than in Aurepalle or Shirapur. The poorest households came from Aurepalle. The richer households in Shirapur were absolutely less well off than those from the same relative income bracket in Aurepalle and Kanzara. The tightly clustered low income levels in Shirapur reflect widely shared poverty.

Saying that rural income is low in the three villages is an understate-

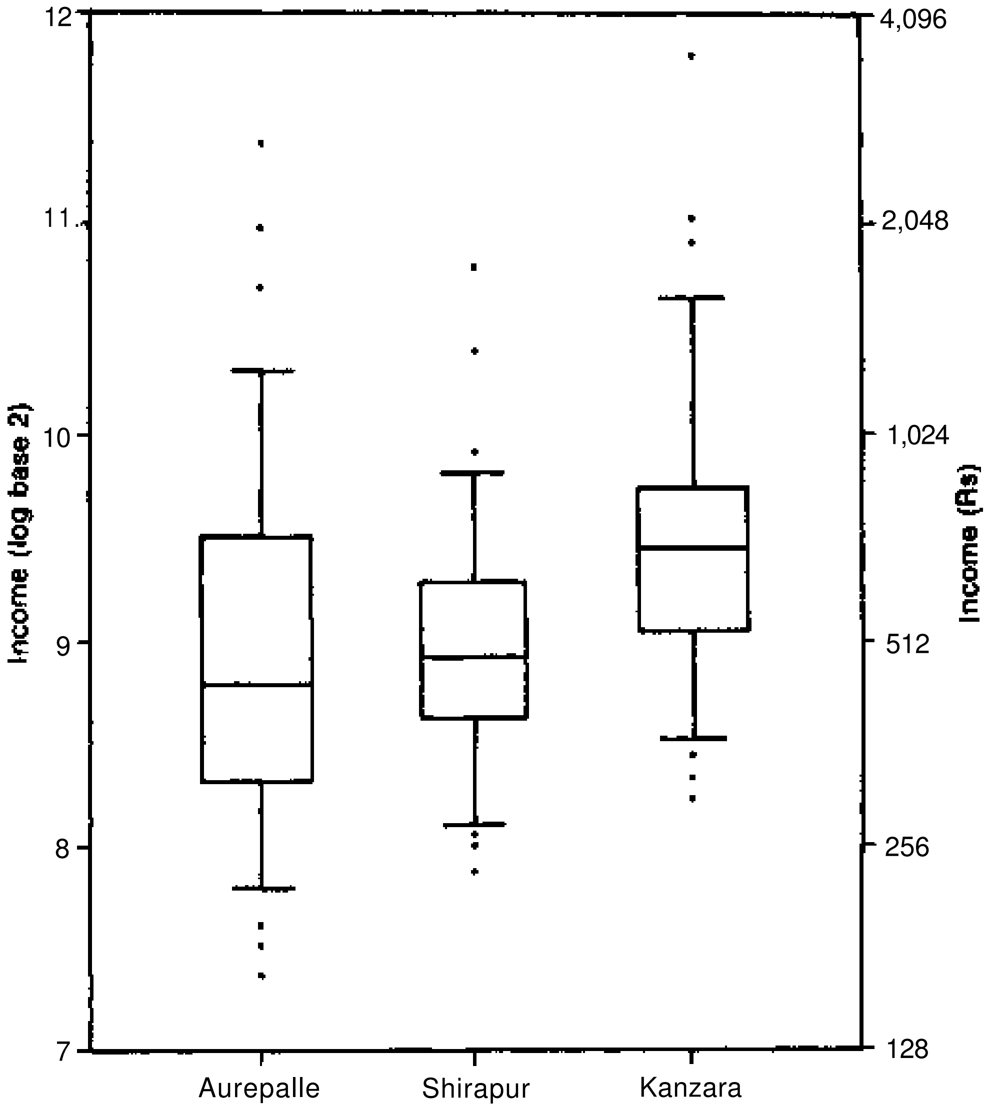


Figure 4.1 Empirical distribution of real per capita household income by village from 1975/76-1983/84

ment. The three-village mean per capita income estimate of Rs 700 over the nine-year period translated into only about U.S. $80 in 1977 prices and was considerably less than the all-India per capita income figure of Rs 1,080 for 1977 (Directorate of Economics and Statistics 1979).

The average median per person income of about Rs 500 in 1975 prices (equivalent to about U.S. $60) is a better indication of central tendency given the skewed distribution of income in the villages. Such stark poverty in predominantly dryland villages, where historical rates of agricultural growth have been low, is not surprising. Much, but not all (Bardhan 1985), of the empirical evidence in India suggests that the incidence of poverty is strongly and inversely associated with the rate of agricultural growth (Mellor and Desai 1985).

Intervillage disparities in the mean level of household income are largely manifested in the village labor market described in the next chapter. Availability of off-farm employment opportunities, particularly for women, also contributed to intervillage income variation. The main difference was the Maharashtra Employment Guarantee Scheme, Unlike men's, women's participation in private sector off-farm employment was negligible in all the villages, but work in the public-sector MEGS substantially enhanced off-farm employment opportunities for women in Shirapur and Kanzara. From 1979/80 to 1983/84 work in government-sponsored public works projects accounted for about 19 and 25 percent of men's and women's wage employment in Shirapur and 14 and 6 percent in Kanzara.

Composition

Crop revenues and labor earnings were the two dominant income sources in the study villages. With the exception of large farm households in Aurepalle and to a lesser extent in Dokur and Kanzara, cultivator households also relied heavily on labor market earnings primarily in the village labor market for casual agricultural labor. Almost all households derived some income from the sale of livestock, especially goats, but, except for shepherd households, livestock production or animal trade was not as important as crop or labor income in any of the villages.

Nonfarm pursuits, either from labor market earnings in the private sector or from nonagricultural self-employment, did not figure heavily in household income for the vast majority of households, with the exception of toddy tappers in Aurepalle. In none of the villages did the mean share of nonfarm income exceed 30 percent. Women brought home little if any nonfarm income.

Nonfarm income is undoubtedly underestimated in these village studies because the few households that reported trading or other nonfarm activities as their principal occupation (refer to table 2.1) were excluded from the sample. Still, the importance of nonfarm income is meager compared to what is commonly reported for other rural villages in developing countries (Chuta and Liedholm 1979; Shand 1986).

Consistent with Visaria's (1980) findings on unemployment being concentrated among participants in the casual village labor market, the poorer households relied more heavily on labor earnings. Labor income shares were significantly and inversely correlated with household per person income (table 4.1).

Not unexpectedly, food bulked large in the composition of consumption expenditure. The level of poverty is communicated by median food shares exceeding 60 percent of consumer expenditure (figure 4.2). Food expenditure accounted for more than 60 percent of total expenditure for the vast majority of households in the three villages, especially Aurepalle. Also not surprisingly, the value of land comprised the bulk of total asset value in the three villages. The share of land in total assets was as high as 80 percent in poor dryland Shirapur; in more prosperous and rainfall-assured Kanzara asset holdings were more diversified as land's share was

Table 4.1. Correlation coefficients between cropping year income shares (%) by source and per capita income from 1975/76 to 1983/84 by village

	Village[a]		
Income Source	*Aurepalle*	*Shirapur*	*Kanzara*
Crop	0.52**[b]	0.26**	0.36**
Livestock	0.28**	0.16*	0.31**
Labor	-0.51**	-0.42**	-0.40**
Trade and handicraft	-0.06	-0.35**	-0.06
Transfer	-0.10	-0.07	-0.02

[a]Correlation coefficients were estimated over cropping year by household observations: 315 for Aurepalle, 297 for Shirapur, and 324 for Kanzara.
[b]** indicates statistical significance at the 0.01 level.

63 percent, which approaches the all-India share of 62 percent in 1981 (Dantwala 1987).

Farm Size

Perhaps the most striking finding in comparing mean income levels across the three villages by farm-size classes was the parity in average income among the landless labor, small farm, and medium farm groups whose stratification is described in chapter 2. Only in Aurepalle were the landless significantly worse off than households that farmed some land. Large farm households, particularly in Aurepalle and Kanzara, did enjoy significantly higher per person income compared to the other groups in each village.

Apparently, in these dryland villages the resource base of small- and medium-size holdings was not sufficiently well endowed to enable their owners to attain higher per capita income levels than landless labor households. These results suggest that Hayami's (1981) vision of a conflict emerging between landless labor and cultivator households in rural India may apply somewhat differently in dryland regions where ownership of relatively larger amounts of land is a prerequisite for sharp group differences in income to emerge. Still, mean per person income (while significantly higher) for the large farm households was only 115 percent greater than for the other groups. Several large farm households also fell below the poverty line in each village.

Because land figured so prominently in the composition of wealth, variation in farm size translated more directly into disparities in asset holdings. Across the three villages, the ratio of net wealth per capita among landless labor, small farm, medium farm, and large farm cultivator households was about 1:3:6:14. Differences in wealth by farm size were most marked in Aurepalle, where a ratio of 1:3:10:20 prevailed.

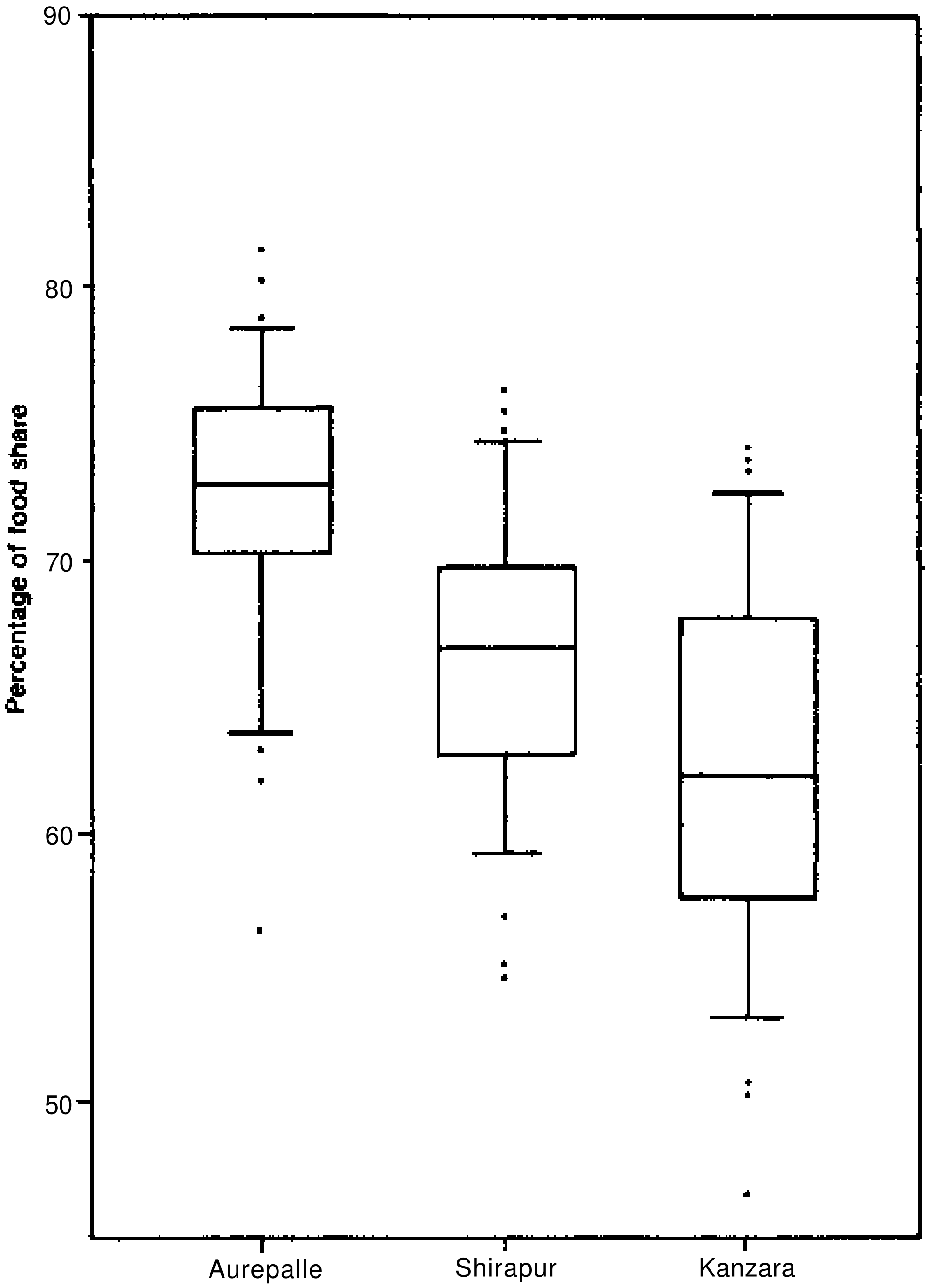
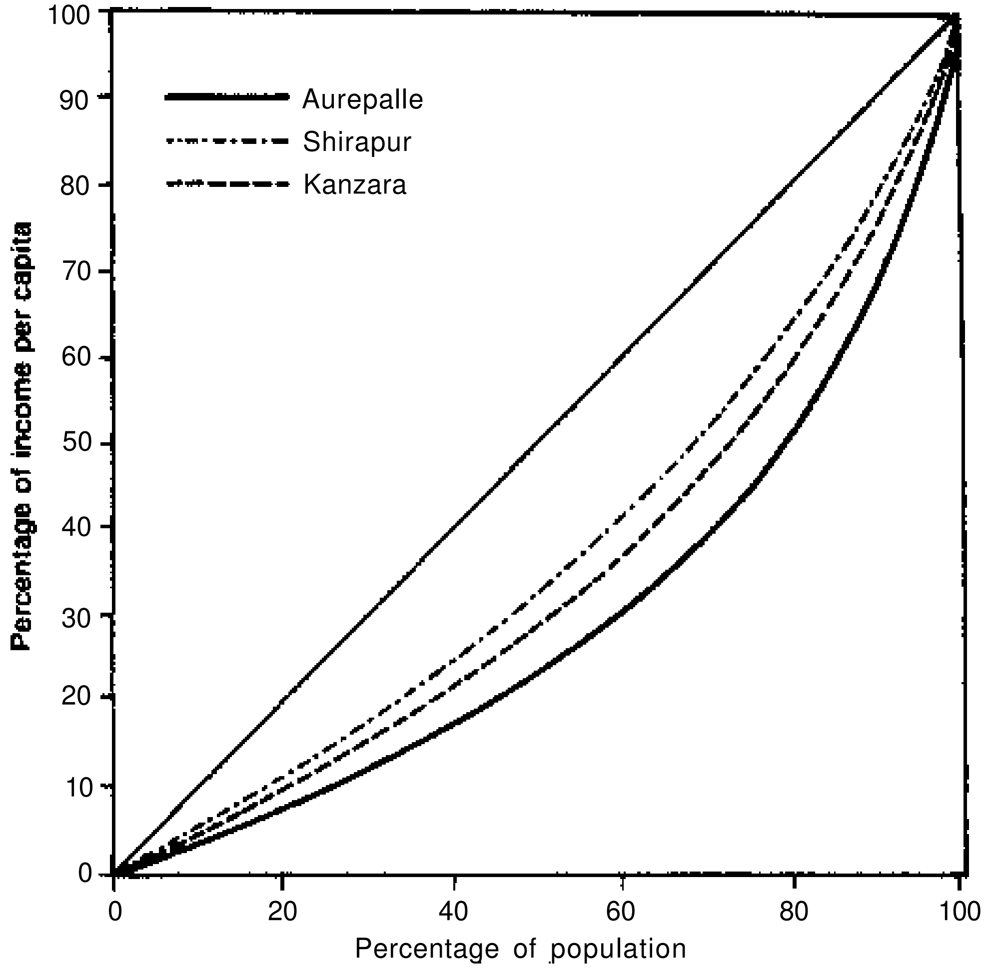


Figure 4.2 Empirical distribution of mean household food shares from 1975/76 to 1983/84 by village

Inequality

Drawing concrete inferences about inequality from a sample of forty households in each village is a tenuous exercise; therefore, inferences reported in this section should be viewed with caution. But one result is clear from the Lorenz curves drawn in figure 4.3: Income and wealth were more equitably distributed in Shirapur than in the other villages. In Shirapur, greater access to rural works employment, stagnating rainfed agricultural productivity, and costlier and riskier investment alternatives in well irrigation combine to reduce the scope for differences in land and human resources to express themselves.



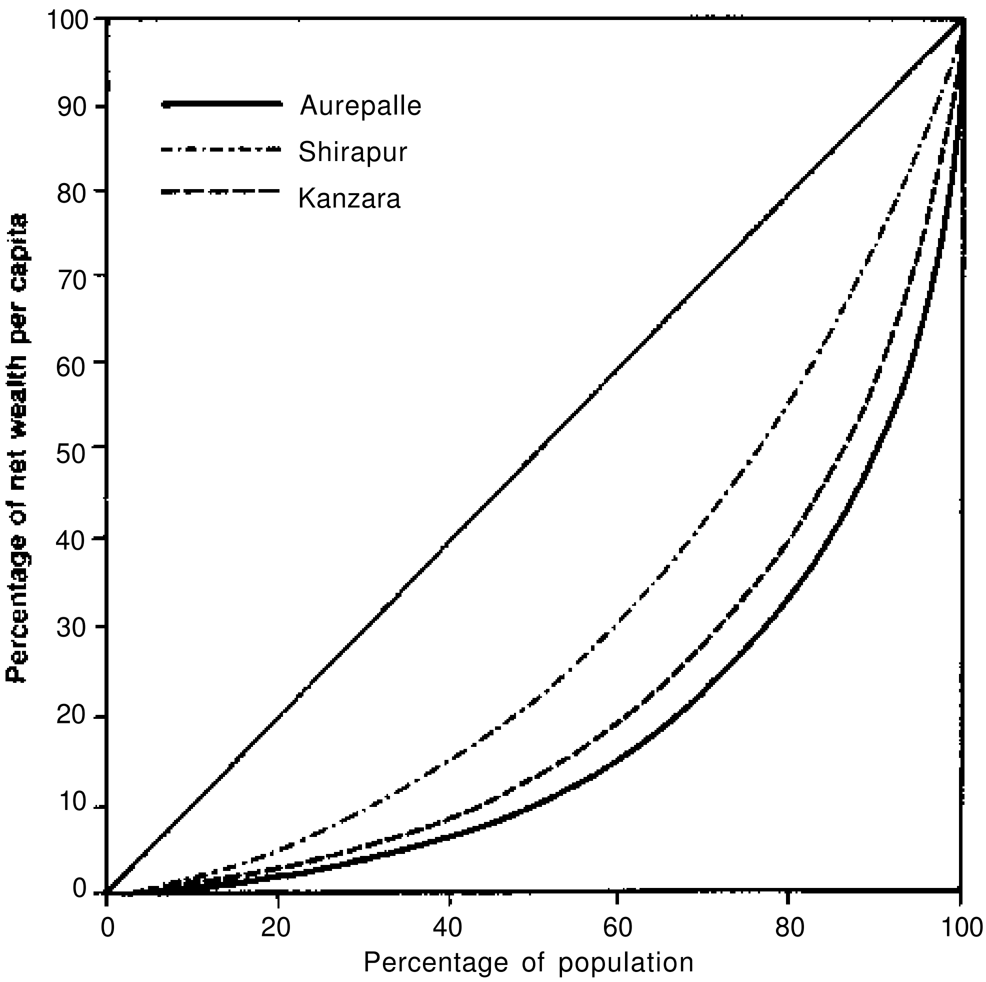


Figure 4.3 Lorenz curves showing the interpersonal distribution of real per person income and real per person net wealth by village from 1975/76 to 1983/84

Absolute Poverty

For a region as impoverished as India's SAT, absolute poverty may be a more meaningful index of human welfare than inequality (Fields 1980). Estimates of absolute poverty and the resulting intervillage comparisons are sensitive to the criterion—either income or consumption—and the poverty index used for evaluation. First, we followed the normal practice of using the Dandekar and Rath (1971) poverty line of a monthly per capita expenditure of Rs 15 in 1960/61 rural prices to quantify the incidence of absolute poverty in the study villages. Based on consumption expenditure, about three-fourths of the households fell below the poverty line from 1976/77 to 1981/82.

Based on a net income criterion, the incidence of poverty was substantially less, ranging from 61 percent in Aurepalle to 43 percent in Kanzara. When absolute poverty was estimated on an income criterion for the first two years across the six villages, Kanzara and Dokur—the most technologically advanced and the richest villages—exhibited the lowest incidence of absolute poverty. Ironically, in Shirapur, where inequality was least, absolute poverty was greatest during 1975 to 1977 before the demand for off-farm employment increased. For those two years, the three villages with the more equitable distribution of income were characterized by the highest incidence of absolute poverty (Singh, Asokan, and Walker 1982). Where average levels of income were as low as they were in 1975/76 and 1976/77, income inequality was negatively associated with the head-count measure of absolute poverty. This inverse relationship, based on crosssectional data, was also confirmed by Singh (1986) for seven dryland villages from 1980 to 1984. The estimated correlation coefficient between the Dandekar-Rath head-count measure and the Gini concentration ratios across the seven village observations was -0.63, which was statistically significant only at $p = .12$. We expect that a larger village sample size would have given statistically more significant results.

The trade-off between the head count and the Gini concentration ratios simply reflects the smallness of the village economic pie. Distributing the pie more equitably could result in wider shared poverty when poverty is measured by the head-count ratio and when the poverty line substantially exceeds the median level of household income per capita. This conflict is analogous to violating the transfer axiom: a transfer from a rich to a poor person should decrease the poverty index (Hagenaars 1987).

The inverse association between income inequality and absolute poverty vanishes in these poor dryland villages when we use an index that incorporates information on relative inequality; that is, how poor are the poor relative to themselves and to the poverty level. Such a measure is the commonly used Sen index (1973), which admits two other dimensions of poverty: (1) the size of the income gap (i.e., the difference between the poverty line and the mean income of the poor) and (2) relative income inequality among the poor. The Sen Poverty Index is defined as P = H[I + (1 - 1) G], where H is the head count of the poor, I is the average income shortfall of the poor, and G equals the Gini coefficient of income inequality among the poor. When normalized so that I is expressed as a proportion or a poverty gap ratio, the index is bound from 0.0 to 1.0. The Sen index increases as the proportion of individuals falling below the poverty line increases, as the gap between the poverty line and the average income of the poor widens, and as relative income inequality among the poor rises.

Using the Sen index changed the intervillage ranking on the incidence of absolute poverty. Because the Sen index gives more weight to the degree of equity within the rural poor and because most households fell below the monthly expenditure poverty line from 1976/77 to 1981/82, Shirapur had the lowest mean Sen index (0.39) averaged over the six years. Aurepalle had the highest—0.49. This result was more in tune with the village consumption expenditure and wealth distributions than with the income distributions presented in figure 4.1: Absolute poverty during the period of analysis was more acute in Aurepalle than in Shirapur.

A different picture emerges when we use a third criterion, recently proposed by Lipton (1983a), to measure absolute poverty. Upton's measure comprises two components: the percent food outlay in total consumption expenditure and a standard of nutritional adequacy. The "ultra-poor" are defined as those households with food shares exceeding 70 percent with caloric adequacy falling below 80 percent of their recommended dietary allowance. Lipton suggests an 80-80 cutoff point, but only 2 of the 104 households in the continuous sample had food shares greater than 80 percent (figure 4.2).

When we apply Upton's food share/nutritional adequacy yardstick to the expenditure data and the dietary recall information described in chapter 9, we find that about one individual in three in Aurepalle would be classified as ultra-poor, while a comparable ratio for Shirapur would be one in twelve and for Kanzara one in thirty-three. Those intervillage differences are sizable primarily because only in Aurepalle did the majority of households have food shares exceeding 70 percent (figure 4.2).

Caloric adequacy and food shares for individuals were significantly and inversely correlated at about 0.20 for all the villages, and statistical estimates based on contingency tables suggest that we cannot reject the null hypothesis that individuals belonging to households with food shares less than 70 percent were better nourished than those belonging to households with food shares greater than 70 percent. As we shall see in chapter 9, the level of "permanent" consumption expenditure does matter in explaining the individual variation in nutritional adequacy, but the relationship does not appear to be of the threshold variety, or at least evidence is not compelling that the threshold occurs at a 70 percent food share.

For the same time period, estimates, based on consumption expenditure data from the NSS, of absolute poverty in rural India were considerably lower than those recorded in the study villages. For 1977/78, about 39 percent of the Indian rural population fell below the Dandekar-Rath poverty line, and the Sen index was about 0.14 (Ahluwalia 1985). Because of differences in sampling and defining consumption expenditure, our estimates are not strictly comparable to those based on the NSS data. Nevertheless, the level of absolute poverty in the richer study villages such as Kanzara and Dokur appeared to exceed by a substantial margin the lower all-India rural average estimates.

Trends

Because the household panels aged over the nine-year period of analysis, life cycle patterns of income, consumption, and wealth could mask or even lead to spurious conclusions about trends in those same variables. If, for example, household income per capita was highest for the age group forty-one to fifty and many households selected in the sample were just entering that age group, the income data could show an absolute improvement over time which would have no bearing on income trends. (The significance of experience in explaining the variation in men's wages in the casual labor market indicates that life cycle effects may even be present for the poorest labor households; see chapter 5). To partially account for life cycle effects, we regressed real per capita net household income from 1975/76 to 1983/84 on age group variables (less than thirty, thirty-one to forty, forty-one to fifty, fifty-one to sixty, and over sixty) and on a linear trend variable. The estimated coefficient of the trend variable should provide a fairly clear picture of what was happening to real household per capita income from 1975/76 to 1983/84.

Intervillage Contrasts

The estimated coefficients of the linear trend variable were surprisingly similar across the three villages. From 1975/76 to 1983/84, real per capita income increased by about Rs 30 per year in Aurepalle, Rs 23 per year in Shirapur, and Rs 25 per year in Kanzara. These absolute figures were equivalent to about U.S. $3 per year in 1975 prices and to a growth rate ranging from 3 to 5 percent per annum. The slow upward income trend was statistically significant at $p < .05$ for Aurepalle and Shirapur and $p < .10$ for Kanzara.

Reasons for the slow but perceptible upward trend in real income for the continuous household sample vary from village to village. Growth in income and consumption expenditure was quite pronounced in Kanzara, especially after 1980. The uptake of improved technologies, including new crops like mung bean, modern cultivars such as sorghum hybrids, and improved inputs such as inorganic fertilizers and pesticides, has been fairly rapid throughout the period in Kanzara and has paved the way for some sustained income growth (chapter 3). Rising cash crop prices, primarily of mung bean and cotton, also played a prominent role in income growth. We expect that a similar, modest upward trend would be shown for nearby Kinkheda, although the diffusion of improved technologies has been somewhat slower than in Kanzara.

In Shirapur, the rise in real income in the late 1970s is largely attributed to an expansion in public-sector, food-for-work employment in the late 1970s and an increase in off-farm employment, mainly in construction labor. Nonetheless, one could argue that the slow, positive, real income trend estimated in Shirapur was simply part of a long depletion-replenishment cycle (Jodha 1975). During the period of analysis, households in Shirapur were still recovering from the prolonged drought in 1971 to 1973.

Casual historical empiricism supports the cyclical argument. When we convert the mean income estimate from 1975/76 to 1983/84 for households in Shirapur into sorghum grain equivalents per household, we find that the mean number of sorghum grain equivalents is identical to what Mann (1917), using comparable income concepts, estimated for households in Pimpla Soudagar, a village in the same region of Shirapur about two hundred km southeast on the Bombay Deccan. In 1915/16, the mean income household in Mann's sample had enough real income to buy about 2,370 kg of sorghum. A comparable estimate for the Shirapur sample was 2,320 kg. What has changed is household size. In Pimpla Soudagar in 1915/16, five members constituted an average household; in Shirapur from 1975 to 1983 mean household size was six individuals. Thus, this rough contrast suggests that effective food availability per capita has not improved.

In contrast, in Kalman the introduction and rapid diffusion of highly labor-intensive grape garden cultivation since 1981 would loom larger in explaining any improvement in real household income per person. By 1985, only three cultivator households in Shirapur had planted grapes, while about forty households in Kalman had prospered economically from irrigated grape gardens, ranging from one to ten acres.

In the Mahbubnagar villages, the correlates of moderately rising real income include greater exploitation of groundwater in Dokur and several contributing factors that are discussed at length in chapter 5 and have resulted in a tightening labor market in Aurepalle.

Table 4.2. Linear trends in real household income per person (in Rs in 1975 prices), by village and income quartile from 1975/76 to 1983/84

	Income Quartile			
Village	*Poorest*	*Poorer*	*Richer*	*Richest*
Aurepalle	20.0**[a]	18.7**	34.1**	4.4
	(4.50)[b]	(2.68)	(2.70)	(0.17)
Shirapur	33.7**	13.0	34.7**	-4.7
	(5.45)	(1.51)	(2.92)	(0.24)
Kanzara	38.1**	24.0**	20.4	35.5*
	(5.22)	(3.04)	(1.85)	(2.10)

[a]Estimates from a linear fixed effects model with household income by cropping year as the dependent variable and household and trend as independent variables.

[b]t values are in parentheses; * and ** denote statistical significance at the 0.05 and 0.01 levels, respectively.

Within - Village Comparisons

Estimates of relative trends in real income for groups within each village should not be as susceptible to life cycle considerations as absolute estimates of real income trends. We stratified the households into quartiles, based on relative income position in the initial three-year period from 1975/76 to 1977/78, and estimated trends in income for each quartile (table 4.2). The three-year base period should be less vulnerable than a one-year baseline to transitory influences that partially make relative income growth in the lowest decile a predetermined outcome. (Put another way, households that occupied the lowest decile in the base year because of bad luck are likely to improve on their economic performance in subsequent years.)

The poorest households have received as much or more income growth as the richest households in each village. In both Aurepalle and Shirapur, the richest households in the mid-1970s, that is, those in the fourth quartile, registered no significant change in per person income during the period of analysis. Meanwhile, real per capita income grew annually at about Rs 20 in 1975 prices for the poorest households in Aurepalle and about Rs 34 for comparable households in Shirapur. Only in Kanzara, where technical change in dryland agriculture was marked over the nine-year period, did household income expand for the larger cultivator households in the richest quartile.

These encouraging trends for the poorer quartiles were largely derived from a tightening village labor market. In Kanzara, a tightening labor market is a consequence of rising dryland productivity within the village. In Shirapur and to a somewhat lesser extent Aurepalle, the labor market has tightened in the absence of technical change. The explanations offered

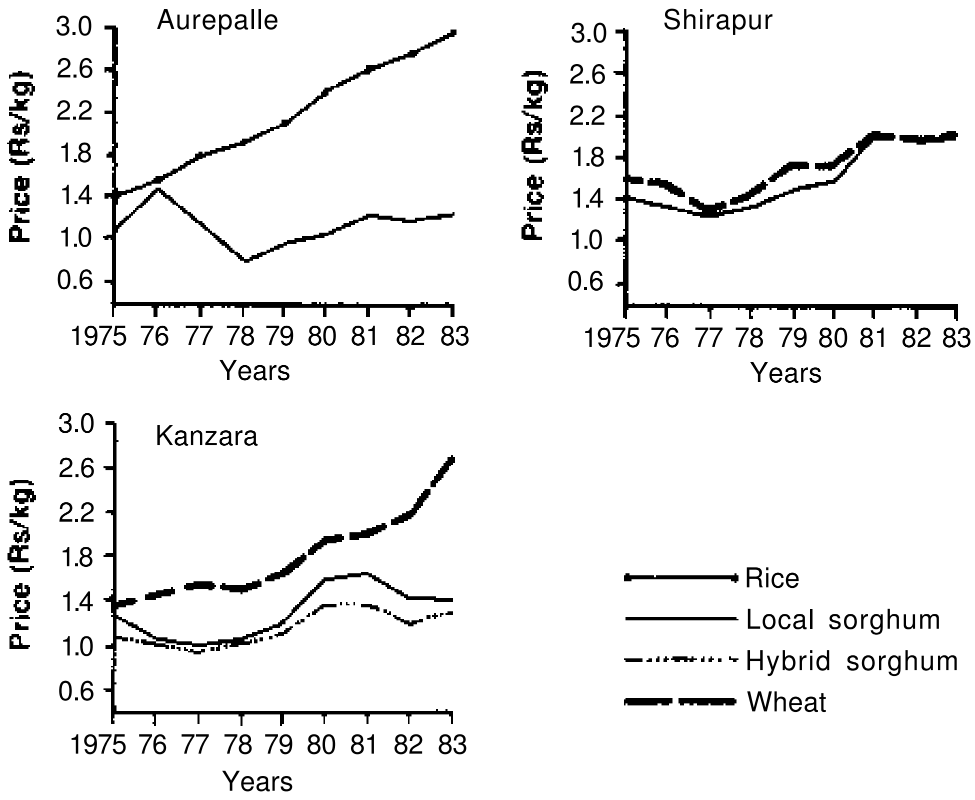


Figure 4.4 Consumer prices by cereal and village from 1975/76 to 1983/84

in chapter 5 for the labor market tightening are compelling, but they are as diverse as the study regions themselves.

Stable consumer food prices during the period of analysis should also receive much of the credit for whatever improvements have occurred in the poorer rural villagers' welfare. With the partial exceptions of paddy in Aurepalle and wheat in Kanzara, nominal prices of the food grains in each village exhibited limited inflation or variability during the period of analysis (figure 4.4). Food price inflation and price variability in the coarse cereals, mainly sorghum, were exceptionally mild. Likewise, stagnating producer harvest prices for cereals largely explain why the richer cultivators in the top quartile could not register significant real income gains during the period (figure 4.5). Upward movements in the price of cash crops, particularly castor in Aurepalle, mung bean and cotton in Kanzara, and safflower in Shirapur, to some extent offset the absence of growth in cereal grain prices. Rising fodder prices in the early 1980s also helped to compensate for flat nominal grain prices, but, in general, the period of analysis was marked by the sustained erosion in the profitability of cereals relative to other crops.

A trend of stagnating cereal prices and producer incomes is not unique to these dryland villages. A deterioration of farm profitability since the early 1970s and increasingly adverse sectorial terms of trade have been documented in some studies carried out at the national or state levels (Binswanger and Quizon 1986; Swaray and Gulati 1986).

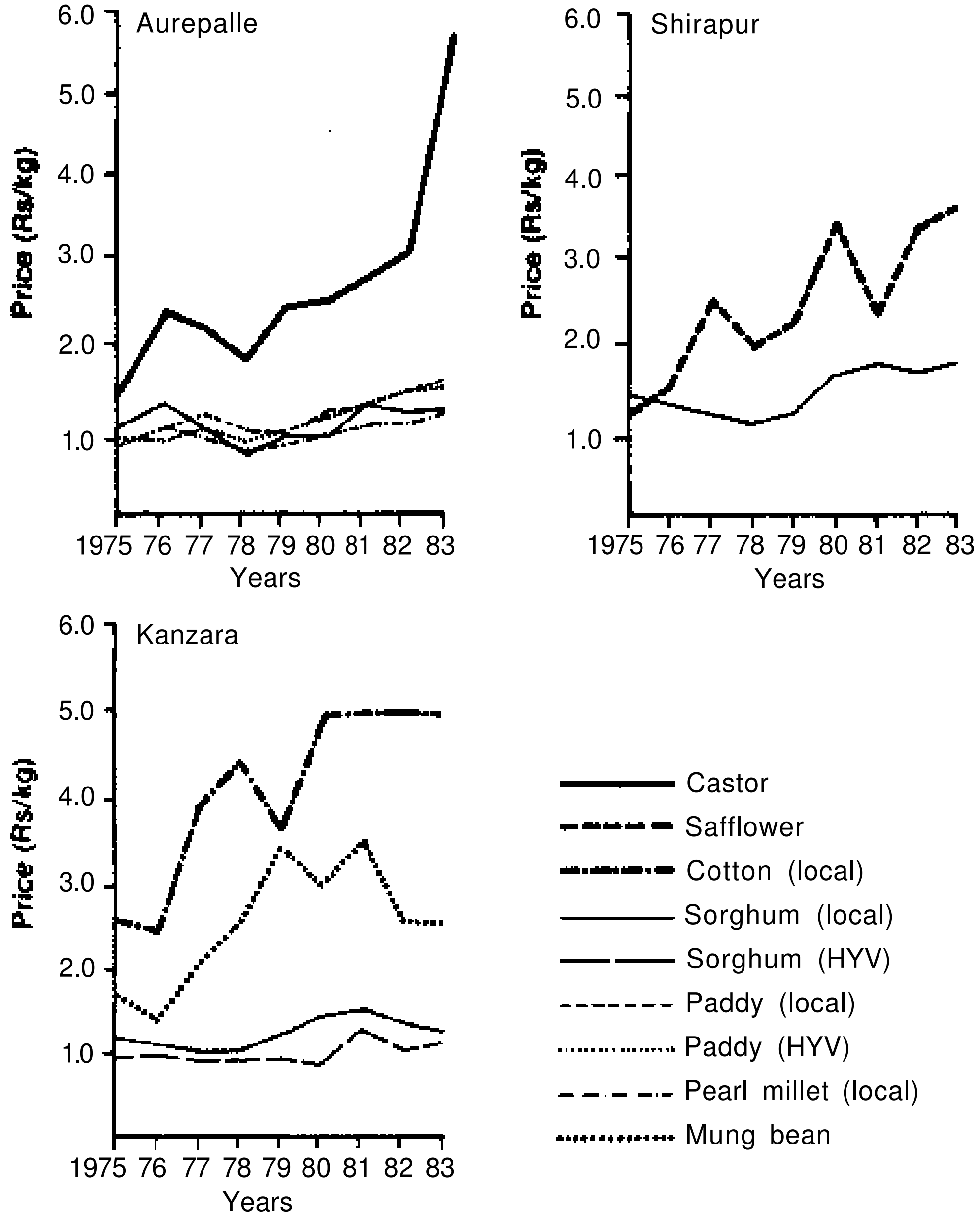


Figure 4.5 Producer harvest prices by commodity and village from 1975/76 to 1983/84

Within-village trends in real income per capita were paralleled by movements in real net wealth per capita. The two lowest asset quartiles from 1975/76 to 1977/78 experienced positive and statistically significant growth in net wealth, while the highest quartile either did not significantly enhance its asset-holding position (Aurepalle) or suffered a decline in net worth (Shirapur and Kanzara) (table 4.3). Land shedding and family subdivision were largely responsible for the decline in real net worth for several larger cultivator households occupying the two highest asset quartiles in Kanzara. In Aurepalle, special government programs oriented to improving the welfare of scheduled castes and tribes contributed to enhancing the asset position of a few sample households in the lower asset quartiles in the mid-1970s. The gap in real net wealth between landless and landed households also narrowed somewhat. Across the three villages, for households that were either landless or owned land in both

Table 4.3. Linear trends in real net wealth per person (in Rs in 1983 prices), by village and asset quartile from 1975/76 to 1983/84

	Asset Quartile			
Village	Poorest	Poorer	Richer	Richest
Aurepalle	190.2**[a]	304.7**	467.1**	76.0
	(7.35)[b]	(7.64)	(4.90)	(0.26)
Shirapur	111.9	324.0*	1,244.0**	-296.0*
	(1.56)	(2.40)	(4.22)	(2.13)
Kanzara	104.8**	78.6**	-206.1**	-469.0**
	(6.93)	(4.71)	(3.00)	(2.90)

[a]Estimates from a linear fixed effects model with household income by cropping year as the dependent variable and household and trend as independent variables.

[b]t values are in parentheses; * and ** denote statistical significance at the 0.05 and 0.01 levels, respectively.

periods, the ratio of net wealth of the landed to the landless was 11.9 from 1975/76 to 1977/78. By 1981/82 to 1983/84 that ratio had fallen to 8.5.

Changes in the Composition of Income and Wealth

The village composition of income and wealth changed slowly but perceptibly from 1975/76 to 1983/84. Income derived from nonagricultural self-employment (including toddy tapping in Aurepalle) loomed larger as an income source in the later years. Likewise, labor market earnings are now more important in the 1980s compared to the mid-1970s in Aurepalle and Shirapur. The share of net crop receipts in real per capita village income increased substantially in Kanzara. Livestock lost some ground to other income sources in the three villages.

Consumer durables and financial assets, starting from an extremely low base, now contribute more to real net wealth than they have in the three villages. Several sample households in each village invested in savings certificates and other forms of time deposits during the period of analysis. Respondent households now possess more radios, bicycles, and watches. Among productive assets, electric pumpsets have registered the most marked increase.

Absolute Poverty and Inequality

The analog to the favorable real income picture is the fall in poverty charted in panels a and b of figure 4.6. (Trends in absolute poverty were estimated with an income criterion, because we did not have detailed estimates of consumption expenditure for the nine-year period of analysis.) By either the head-count method in panel a or by the Sen index in panel b, absolute poverty has declined from 1975/76 to 1983/84 in

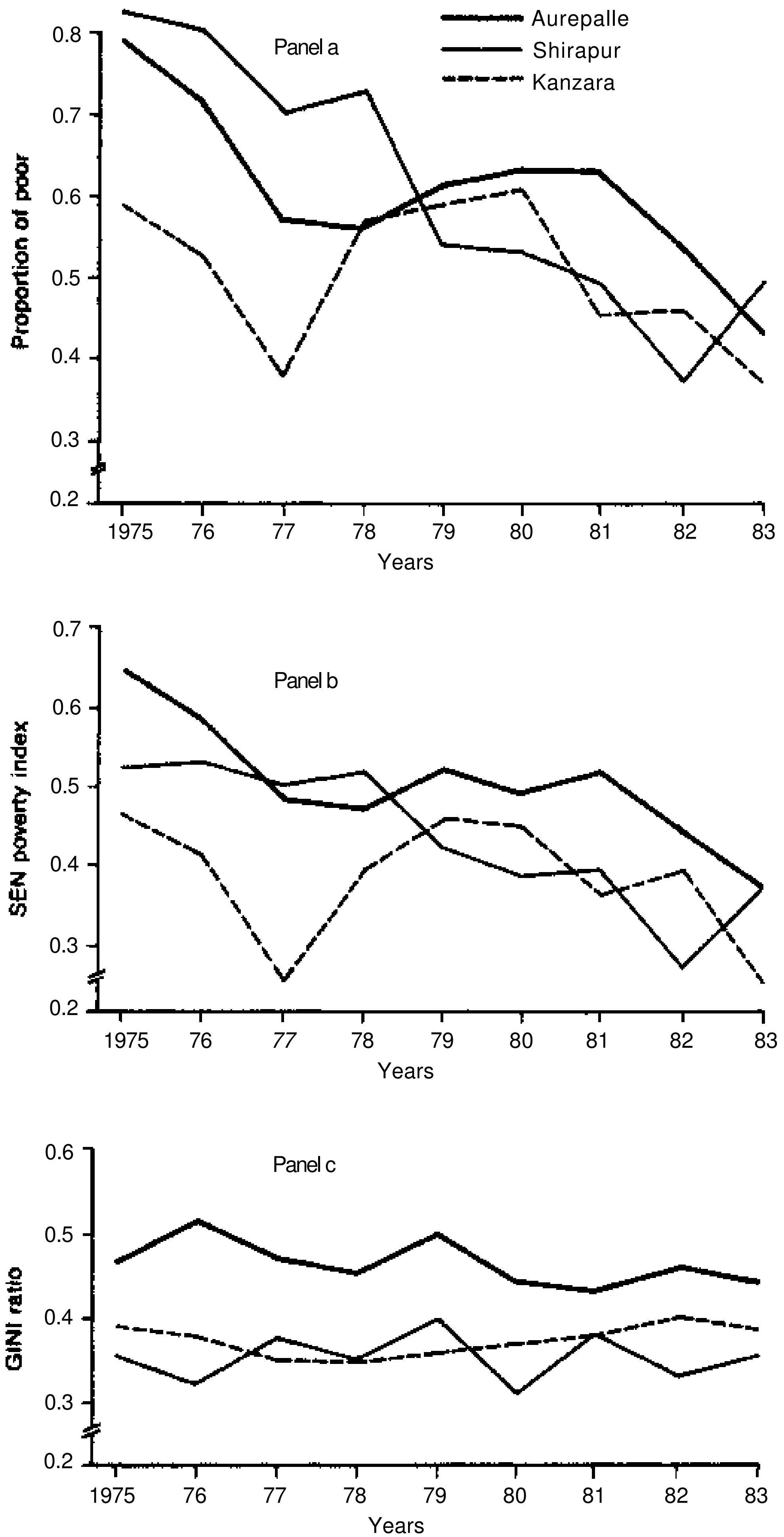


Figure 4.6 Poverty and equity indices by village from 1975/76 to 1983/84

Aurepalle and Shirapur. If we could reconstruct figure 4.6 with data on consumption expenditure, the incidence of absolute poverty would be markedly higher and the downward trend would not be as pronounced. In Kanzara, 1977/78 was an outstanding cropping year characterized by favorable rainfall and rising cash crop prices (figure 4.5). As a result, poverty indices plummeted in that year, masking a downward trend in poverty that appeared to manifest itself in 1980.

Income inequality did not change that much in the villages between 1975/76 and 1983/84 (panel c, figure 4.6). Similarly, inequality in real net wealth showed no trend in the Maharashtra villages, but the disparity in real wealth lessened in Aurepalle: the Gini concentration ratios declined gradually from 0.66 in the mid-1970s to 0.55 by 1983/84.

One of the salient features of the three panels in figure 4.6 is the visible narrowing of the gap in the incidence of poverty and to a lesser extent in income inequality among the three villages between the beginning and ending years (1975/76 and 1983/84) of analysis. A similar trend in the narrowing of the intervillage gap in real wages is reported in chapter 5.

Fluctuations

The village studies provide a rare opportunity to examine the incidence and implications of income and consumption variability in India's SAT. Empirical evidence at the household level on issues related to variability is slim in developed countries and more meager in developing countries. In particular, not much is known about the size of household income and consumption variability, income composition and variability, income covariance across households over time, income fluctuations and equity, and the nexus between income and consumption variability. Such knowledge is important because it sets the stage for chapter 8, where the consequences of alternative stabilization policies on household income variability are evaluated. Before turning to the empirical description of household income and consumption risk, we briefly discuss how fluctuations were measured in the next subsection.

Measuring Fluctuations in Income

The analysis again draws on data from the 104 "continuous" households that remained in the panel in Aurepalle, Shirapur, and Kanzara each year from 1975/76 to 1983/84. For those households, information on fluctuations in real per capita income is summarized by two measures: the coefficient of variation (CV) of deflated per person net household income and the likelihood that a household suffered a 50 percent or steeper shortfall from its median per person income in any one of the nine years. CVs are expressed in percent; they always refer to individual households and are never calculated across households.

Conceptually, fluctuations in income should be measured in much the same way that seasonality is quantified in a commodity price series. The data should first be cleansed of trend and cyclical effects. Before estimating CVs, we linearly detrended the deflated per capita net income data. For households which experienced significant ($p < .05$) income trends (about 40 percent of the sample), the detrended data were used to estimate income CVs; for the other households, the raw deflated per capita income data were used.

The only step we took to adjust the income data for life cycle effects was to separate dowry and marriage-related gifts from transfer income. We identified about eighty such transactions during the nine years in the three villages. The vast majority of those transactions related to dowry payments, which can be interpreted as social investment. Dowry and marriage-related gifts represented about 13 percent of mean household income in Aurepalle, 10 percent in Shirapur, and 4 percent in Kanzara from 1975/76 to 1983/84. The bulk of dowry and marriage-related expenses was incurred by the richer, large farm households in each village, particularly in Aurepalle.

Size of Household Income Variability: CVs and Shortfalls

The median CV of per person net household income across the 104 households in the three villages was about 30 percent (figure 4.7). Households with the most stable income profiles experienced CVs approaching 10 percent; those with the most volatile income streams had CVs reaching 80 percent. For the majority of the households in each village, CVs fell between 20 and 40 percent. What stands out in figure 4.7 is the tighter empirical distribution of CVs in Kanzara. Income variability in drought-prone Aurepalle and Shirapur was more acute than in rainfall-assured Kanzara from 1975/76 to 1983/84.

Within each village the level of income variability did not differ that much by farm-size class. In Aurepalle, small farm households had somewhat lower CVs than landless labor, medium farm, or large farm households. The concentration of toddy tappers, with a fairly assured income base, in the small farm group could be one reason for that result. Landless labor households in Aurepalle had more variable income streams, with CVs averaging 37 percent, than comparable households in Shirapur (29 percent) and Kanzara (25 percent). By itself that difference may not mean much, but it is suggestive that the MEGS may have protected some labor households from fluctuations in income in the latter two villages, particularly in Shirapur.

The estimated correlation coefficients between per capita income levels and household income CVs ran counter to the common belief that fluctuations in income are sharper for poorer households within a village; that is, income level and variability are often thought to be strongly and

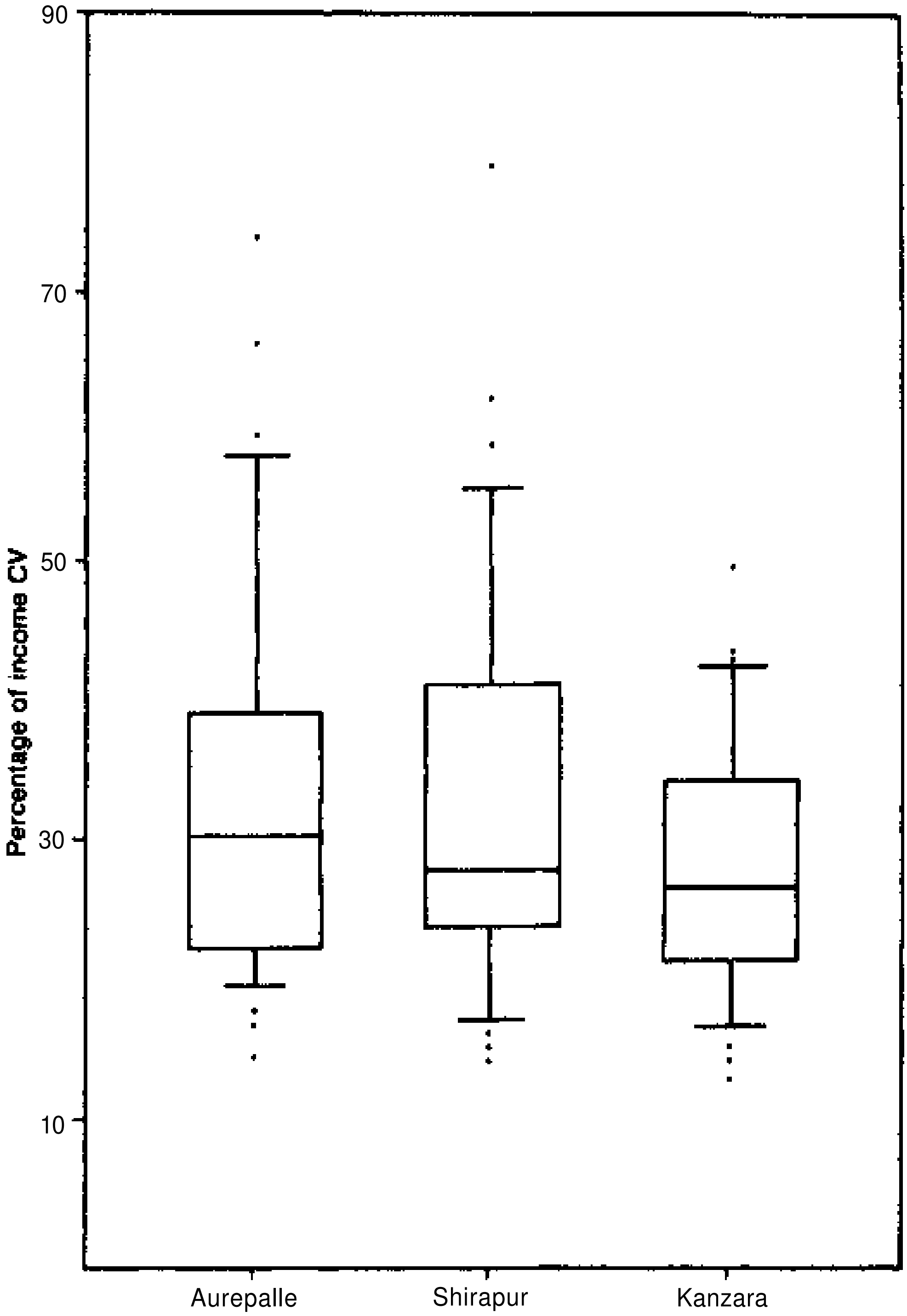


Figure 4.7 Empirical distribution of per capita income CVs from 1975/76 to 1983/84, by villages

inversely correlated. Only in the more assured ecologies like Kanzara, where the correlation coefficient was -0.29, would that popular perception appear to be weakly supported. In Aurepalle, the correlation coefficient was -0.10 and in Shirapur 0.08. Several cultivator households in the more fragile production environments of Aurepalle and Shirapur incurred sizable crop losses in some years that resulted in negative household income. Because the usually richer cultivator households can more easily experience negative income levels than poorer noncultivator households, income level and variability were not that inversely related in the study villages.

Table 4.4. Incidence of income shortfalls (in number of households), by village from 1975/76 to 1983/84

	Frequency of Shortfall[a]			
Village	*Once*	*Twice*	*Thrice*	*Total*
Aurepalle	8	3	2	13
Shirapur	8	4	1	13
Kanzara	5	1	0	6
Total	21	8	3	32

[a]Refers to the number of households that suffered an income shortfall below 50% of their median per person income in at least one of the nine cropping years.

The welfare loss implied by this level of income variability can be crudely measured by answering the question (discussed in detail in chapter 8), How much would a household be willing to pay in exchange for certain income (Newbery and Stiglitz 1981)? A CV of about 30 percent means that a representative risk-averse household would be willing to sacrifice about 5 percent of its mean income to insure perfect income stability. Five percent may not seem like much, but for the twelve households that had CVs exceeding 50 percent the losses were large, representing more than 12.5 percent of household income, as the amount households would be willing to pay rises exponentially with income volatility.

Another way to quantify fluctuations is to focus on downside consequences such as a steep drop in income in one or more years. Thirty-two of the 104 households suffered such a shortfall, where income in one year was less than 50 percent of the median year's income from 1975/76 to 1983/84 (table 4.4). As expected, shortfall households were more numerous in drought-prone Aurepalle and Shirapur than in rainfall-assured Kanzara.

Usually, several factors contributed to such shortfalls. Occasionally, one overriding event resulted in a sudden drop in income. Yield risk, mainly in castor production in Aurepalle, was primarily responsible for eight households incurring severe income shortfalls. Fluctuations in cropped area in paddy production in Aurepalle and post-rainy season sorghum production in Shirapur were important for five households. Marriage and family division, which changed the composition of labor market participants, led to sharply fluctuating per person income for nine households. Individual specific risks like accidents also took their toll. What emerges from this discussion is the realization that it would be difficult if not impossible to protect households from incurring income fluctuations of this size by designing interventions that focus on a single market or

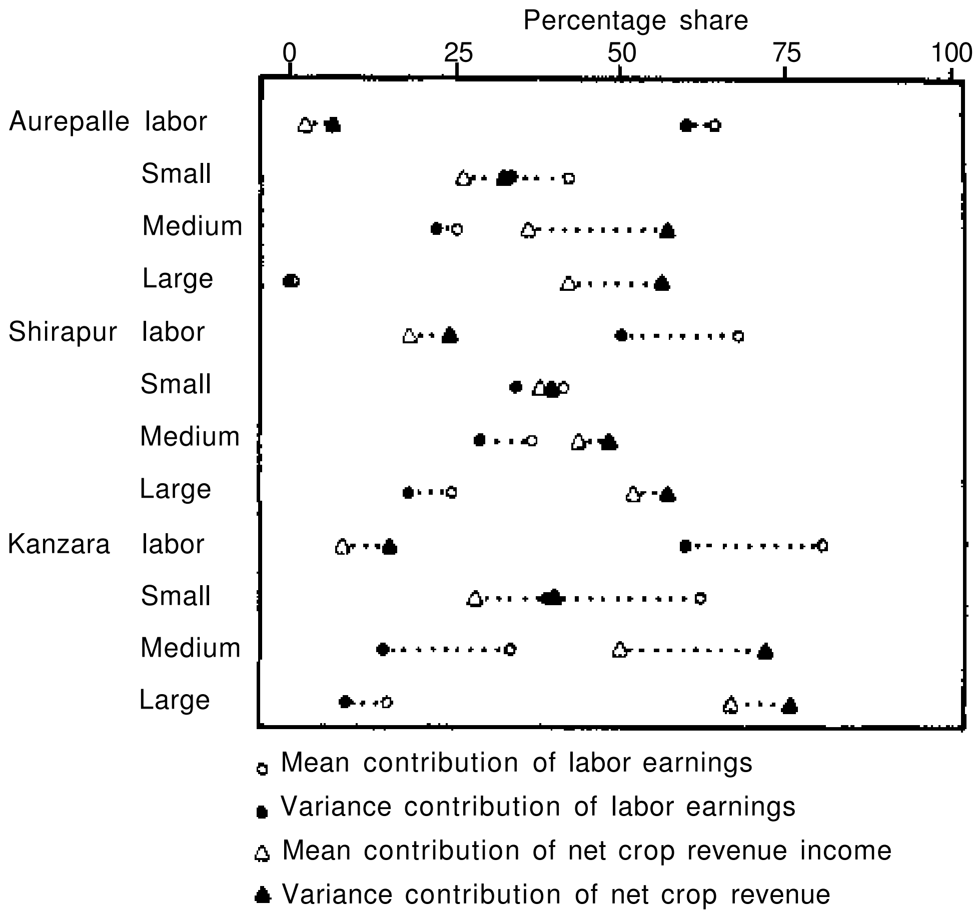


Figure 4.8 Average within household mean and variance shares (%) by income source to total household income per capita from 1975/76 to 1983/84, by village and farm-size group

Labor Market Earnings and Income Volatility

Several empirical findings pointed to the importance of labor market earnings in dampening household income variability. First, for eleven of the twelve village by farm size groups graphed in figure 4.8, labor income had a higher mean than variance share (the open circles lie to the right of the filled-in circles), suggesting that labor earnings had a stabilizing effect on household income. In contrast, for all twelve village by farm-size classes, crop revenue contributed proportionally more to household income variability than to mean household income (the open triangles are to the left of the filled-in triangles).

Second, correlating the importance of different income sources and CVs yielded only one significant association: The share of labor income was significantly and inversely associated (at -0.35) with household income variability in Shirapur. That relationship is again suggestive that the MEGS public works program has been effective in dampening income variability for participants in the casual labor market.

Third, and more important, households that relied more heavily on the labor market as a source of income were less susceptible ($p < .05$)

to abrupt shortfalls in income.'In testing several summary relationships in a probit model between income attributes and levels and the probability of incurring a shortfall, the only consistently significant estimated coefficient—aside from the village effect of living in more ecologically protected Kanzara—in all the specifications was on the share of labor earning in household income.

The absence of labor earnings to compensate for reductions in other income sources was most marked for the "repeat offenders" in table 4.4—the eleven households that suffered severe income shortfalls two or three times during the nine-year period of analysis. The majority of those households did not have an able-bodied, healthy member who could have participated in the labor market to make up for a sharp drop in the main source of income. Households with only one or two labor market participants were especially susceptible to income volatility. When prolonged sickness or personal injury occurred to one of the economically active workers, the other potential participant in the household sometimes had to withdraw from the labor market to care for the sick or injured member. Households headed by elderly women in Aurepalle were particularly vulnerable shortly after family division, when the bulk of erstwhile household assets were passed on to their sons.

Transfers and Income Smoothing

Remittances and gifts from relatives and friends could play a role in mitigating household income volatility. For example, recent research by Caldwell, Reddy and Caldwell (1986), discussed in chapter 3, suggested that transfers from relatives, located outside their dryland study villages in Karnataka, largely explained why households were able to maintain their consumption in the face of sharp income shortfalls occasioned by drought. In contrast, we find that the role of transfers in the study villages pales in comparison to the importance of consumption credit, discussed later in this section. The prevalence of negative correlation coefficients between transfer and all other household income in Shirapur and Kanzara in figure 4.9 suggests that transfers did play some part in smoothing income variability. In general, the value of net transfers rose in years when household income fell. Negative correlation coefficients outnumber positive by about 4:1 in each village. Nonetheless, the role of transfers was limited even in the Maharashtra villages. The absolute value of total transfers (both in and out) was only about 6 percent of annual household income in Aurepalle, 12 percent in Shirapur, and 6 percent in Kanzara. Shirapur was a net receiver of transfers, which represented about 2 percent of per capita household income from 1975/76 to 1983/84; Kanzara was also a net receiver and Aurepalle a net donor but on an even smaller scale than Shirapur. On average, gifts and remittances reduced the variability in cultivators' crop income (net of the opportunity cost of family-owned

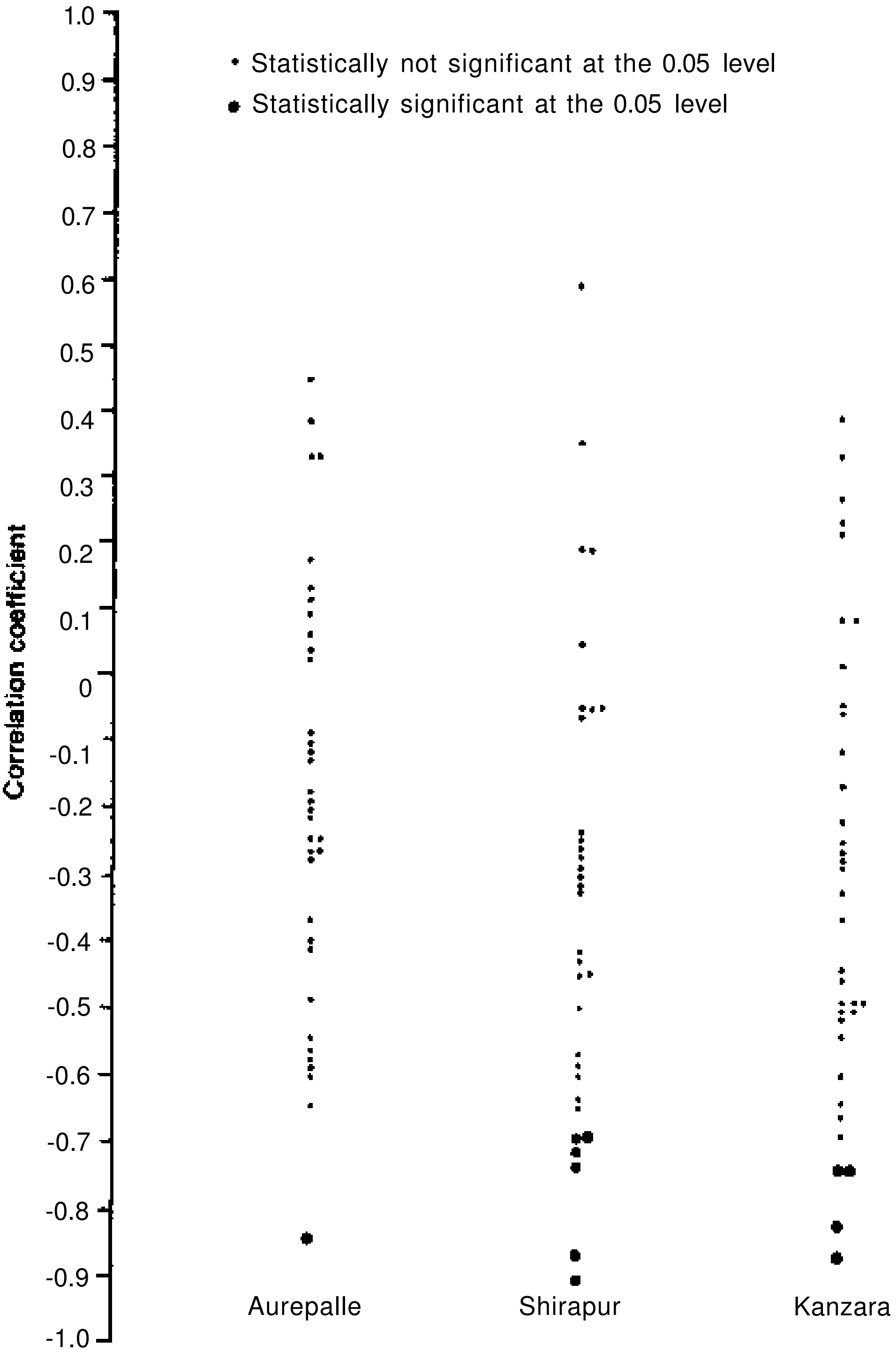


Figure 4.9 Household correlation coefficients between transfer and other household income from 1975/76 to 1983/84, by village

resources) by less than 1 percent (Rosenzweig 1986). Rosenzweig found that the transfer rate (i.e., the degree to which transfers compensated for crop profit shortfalls) depended on family structure. *Ceteris paribus,* households with more brothers residing outside, more migrants, and daughters-in law had higher transfer rates. In particular, " the point estimates suggest that a household with a 50-year-old head having 4 brothers, 2 married daughters, and one migrant would have a transfer rate of 2.5 per cent (the maximum rate in the sample is 5.3 per cent)" (1986: 15).

Income Covariances

Concern about the impact of risk on rural villagers' welfare in India's SAT rests largely on the presumption that production risks such as drought are highly covariate. Covariate risk potentially erodes the capacity of households to smooth income variability because households tend to rely on the same mechanisms at the same time. In this section, we analyze income covariance at several levels: (1) among villages across production regions in India's SAT, (2) between villages within production regions, (3) among major income sources within a village, and (4) among households within a village.

At the regional level, during the period of analysis from 1975/76 to 1983/84, detrended mean real net household income per capita was not that covariate among the sample villages in the three study regions. The across-village correlations were 0.35 for Aurepalle-Shirapur, 0.18 for Aurepalle-Kanzara, and -0.14 for Shirapur-Kanzara, respectively. As discussed in chapter 10, the absence of income covariance between major producing regions in India's SAT is not unexpected and has significance for technological policy.

Across paired villages within regions, income was much more covariate (Rosenzweig 1986). Based on retrospective survey data for Dokur, Kalman, and Kinkheda, mean real profits per hectare from crop production from 1975/76 to 1983/84 were positively associated at 0.32 for Aurepalle-Dokur, 0.43 for Shirapur-Kalman, and 0.84 for Kanzara-Kinkheda. Again, those results are not surprising, because Kinkheda is only 6 km from Kanzara, while Dokur is 75 km from Aurepalle.

The implications for risk adjustment of crop income moving in the same direction over time for villages in the same production region are not as trivial and transparent as they may seem. As described in chapter 3, a wife (at marriage or shortly thereafter) moves to her husband's village, and that is still the dominant form of permanent migration in these dryland rural communities. The husband's village is often not that distant. Thus, the effectiveness of transfers between in-laws to accommodate income risk is eroded by village proximity.

Spatial covariate risk does appear to influence the market for marriage (Rosenzweig and Stark 1987). In the study villages characterized by higher production risk, marriage partners came from more distant locales than in the more rainfall-assured villages. Still, the mean average distance between source and receiving villages across the household sample was only between 30 and 40 km.

Female rural-urban migrants should have less covariate income streams with their donor households in the study villages than in-laws, even those located in distant villages within the same district. Few if any households in the study villages make use of this potentially efficient means to income diversification. In contrast to Southeast Asia, migration of rural women in search of employment in urban areas is still rare in India (Skeldon 1986).

Within a geographic area as small as a village, we expect that mean per person net household income would fluctuate significantly from year to year and that income from the principal sources would be covariate. In particular, cropping year effects within the same village should be significant, which would be the most outward manifestation of covariate income risk within the village. Over the nine cropping years, agroclimatic events were sufficiently covariate within each village to produce significant intertemporal differences in mean income per person. In both Shirapur and Kanzara, average year effects for both crop and labor income moved in roughly the same direction, indicating that in years when crop income was high labor earnings were also greater. The cropping year effects on income within the village rose from several forces. Explanations focusing on a single underlying variable such as total annual rainfall did not do a good job of predicting the timing or size of these village effects.

At the household level, the degree to which income is covariate between households determines the scope for effective insurance mechanisms to develop within a given ecological environment such as a village (Binswanger 1986). A group of households with command over a heterogeneous resource base and with access to a wider array of opportunities would be less likely to have covariate incomes than another group comprised of households with a more homogeneous resource base and access to a narrower range of options. We would therefore expect that income would be more highly correlated among households within the same farm-size class than among those from differing farm-size classes.

That expectation appears to hold only for landless labor households in Kanzara (table 4.5). The relatively high income correlation coefficients among the landless households and among the landless and others in that village illustrate the heavy dependence of the landless on the casual agricultural labor market in Kanzara. Thus, on strictly income covariance criteria, the group with the lowest capacity to self-insure would be landless labor households in Kanzara. Fortunately, severe covariate risk seldom manifests itself in Kanzara.

Income Fluctuations and Equity

Income variability can accentuate measured income inequality, particularly in dryland regions where crop income in any given year can be low or even negative. For instance, calculating Gini concentration ratios for the Aurepalle sample in 1976/77 gave a result as high as 0.50, suggesting widespread inequality (figure 4.6, panel c). Income is inequitably distributed in Aurepalle, but an estimate based on mean income over the nine years was lower than any single year estimate. As evidenced by the ser-

Table 4.5. Median interhousehold correlations of household per person income, by village and fam-size class from 1975/76 to 1983/84

Village and Farm-size Class	Farm-size Class[a]			
	Landless	Small	Medium	Large
Aurepalle				
Landless	0.27			
Smalt	0.19	0.18		
Medium	0.22	0.10	0.15	
Large	0.12	0.10	0.18	0.07
Shirapur				
Landless	0.17			
Small	0.12	0.08		
Medium	0.27	0.11	0.25	
Large	0.23	0.12	0.19	0.13
Kanzara				
Landless	0.62			
Small	0.37	0.19		
Medium	0.28	0.20	0.13	
Large	0.44	0.10	0.23	0.09

[a]Based on 595, 528, and 630 interhousehold correlation coefficients in Aurepalle, Shirapur, and Kanzara, respectively.

rated lines connecting the Gini concentration ratios over time in panel c of figure 4.6 in Aurepalle and Shirapur, the tendency for single-year estimates to overstate inequality (Nugent and Walther 1982) was particularly marked in those drought-prone villages. In contrast, the smooth line for Kanzara suggests that a single-year estimate would be a fairly reliable indicator of relative inequality for that rainfall-assured village.

Consumption Variability

Reducing variability in consumption is the ultimate stability objective in economic welfare analysis (Newbery and Stiglitz 1981). How well consumption is stabilized depends not only on income variability but also on consumption and investment behavior, which is largely influenced by the level and variability of the prices of consumption goods, the performance of asset and financial markets, and the demand for and supply of intertemporal storage.

As discussed earlier, stable food prices imparted a great deal of stability to consumption. Consumption expenditure was substantially less volatile than household income. From 1976/77 to 1981/82, the mean CV of per person consumption expenditure, averaged across the 104 households in the three villages, was about 20 percent. As expected, nonfood consumption expenditure was considerably more variable than food consumption expenditure.

The intervillage differences between Aurepalle and Kanzara in income fluctuations spilled over into consumption variability. In particular, landless labor and small farm households in Shirapur and Kanzara seemed better able to cope with income variability than comparable households in Aurepalle, where expenditure on food was appreciably more variable.

Variability in Poverty and Identification of the Poor

To what extent does variability in income and consumption impinge on the incidence of poverty and the identification of the poor? To address that question, we tabulated the Dandekar-Rath head-count poverty measure, based on an income criterion, for the 104 continuous households in the three study villages from 1975/76 to 1983/84. The incidence of stochastic poverty was high, as about two-thirds of the households moved in or out of poverty at least one year during the nine-year period of analysis. Twenty-three households were persistently poor; their per person income was below the poverty line every year. Thirteen households had income that exceeded the poverty line each year. Stochastic or transient poverty accounted for about 60 percent of the household by year observations below the poverty line.

Using a poverty measure developed by Foster, Greer, and Thorbecke (1984), Ravallion (1987) attributed a poverty cost between 15 and 18 percent of mean income of the poor to income variability. Poverty reduction benefits for the 104-household sample for the same time period were larger for the stabilization of crop income than labor income. The 15 to 18 percent estimate is an upper bound to the realizable benefits from policies which perfectly stabilize income.

The relationship between mean real income per capita and years in poverty was nonlinear and characterized by one pronounced threshold effect (figure 4.10). Households with per capita income above the Dandekar-Rath poverty line every year were significantly richer than others. As years below the poverty line increased from one to nine, income fell at a decreasing rate. Thus, in these poor villages, one had to be genuinely well off to avoid falling below the poverty line in any one year. Households with zero years in poverty had more diversified income streams than others or had access to a regular source of income, such as a local government job. The difference in mean per person income between the nonpoor, defined as households that did not fall below the poverty line in the nine years, and those that fell below the poverty line only once was about the same size as the mean income gap between the latter, who once crossed over into poverty, and the poorest, with per capita income below the poverty line in all nine years. This nonlinear behavior suggests that identifying the nonpoor should be much easier than disentangling transient from endemic poverty. Household wealth per capita also did not vary systematically between the poorer groups, with per capita income below the poverty line from three to nine years.

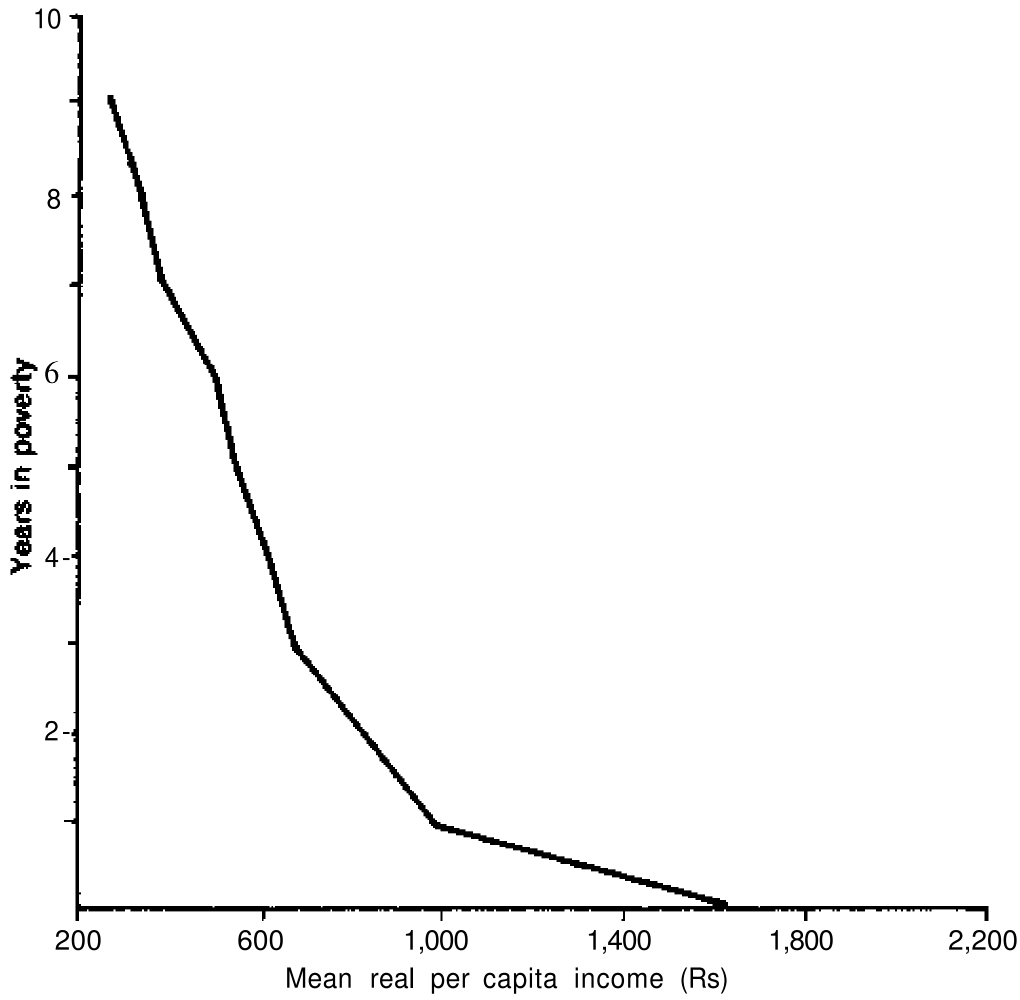


Figure 4.10 Mean real per capita income and years in poverty from 1975/76 to 1983/84 for the 104 continuous household samples in the three study villages

Charting the same relationship by village for each of the continuous households in the sample also shows how stochastic poverty can vary from village to village for a given level of income (figure 4.11). In rainfall-assured Kanzara, mean per capita real income is linearly related to and explains a substantial share of the variation in years in poverty. In contrast, in drought-prone Shirapur, predicting years in poverty from mean per capita real income is much more difficult.

Some of the correlates of endemic poverty are apparent in table 4.6, where the ten poverty states are aggregated into five groups—zero years in poverty, one to two years, three to six years, seven to eight years, and nine years below the poverty line. The nonpoor are more educated, do not participate as actively in the labor market, and own more land than the poor. Those who slip in and out of poverty in the second and third groups are primarily medium-size cultivator households. The ranks of the poor (in the last two groups) are disproportionately filled by the landless and the members of the Harijan community, who suffer from low caste status. Demographic considerations loom large in separating the "almost always poor" in group four from the "always poor" in group five. The "always poor" have higher dependency ratios and fewer eco-

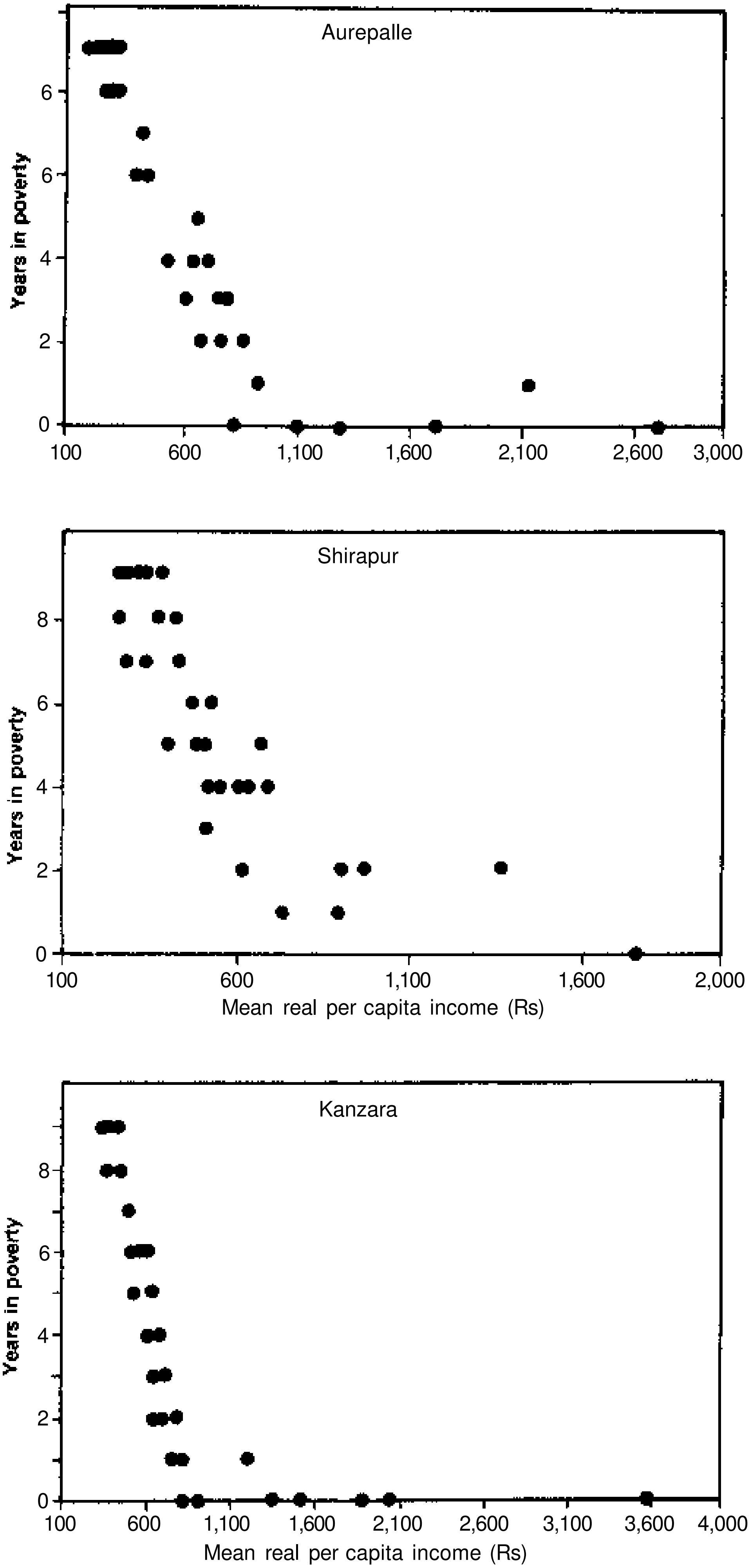


Figure 4.11 Mean real per capita income and years in poverty for each continuous household by village

Table 4.6. The correlates of stochastic and endemic poverty across the three study villages, from 1975/76-1983/84

	Group Description (Years in Poverty)				
	Nonpoor	*Stochastically Poor*			*Endemically Poor*
	0	*1-2*	*3-6*	*7-8*	*9*
Households by year observations (N)	117	180	297	135	207
Persona/ and demographic characteristics					
Age (years)	47.2	46.8	50.0	46.3	47.8
Household size (members)	6.6	5.9	6.4	5.5	6.9
Dependency ratio	0.41	0.31	0.35	0.39	0.51
Lowest caste status (%)	0	5	18	47	44
Schooling (years)	5.2	3.2	1.9	1.1	1.7
Resource endowments					
Landless (%)	0	2	16	29	38
Owned area (ha)	10.2	6.8	3.6	2.0	1.8
Irrigation (%)	15	13	8	3	3
Wage earners	0.5	1.3	2.2	2.6	2.3

nomically active workers than the "almost always" poor. The importance of such demographic characteristics associated with labor supply has been noted by Lipton (1983b) in describing the ultra-poor.

Switching to consumption variability and poverty risk, a somewhat different picture emerges. Only 10 of the 104 households were characterized by per person consumption expenditure greater than the poverty line in all six years from 1976/77 to 1981/82. Fortynine households, representing about half the sample, were mired in poverty every year. Those households accounted for more than 60 percent of the poverty by year observations. Thus, when evaluated from a consumption yardstick, the incidence of stochastic poverty was considerably less than when assessed from an income perspective.

Because consumption is less variable than income, measuring consumption expenditure in food shares in any one year should be a more reliable marker than income indicators in separating endemic from stochastic poverty. But as we saw in figure 4.2, households in the villages are very poor and food shares fall into a narrow band that makes identification of gradations of poverty a daunting task. Only one household in Aurepalle and one in Shirapur had a food share that was significantly ($p < .05$) different from the average household's food share in their respective villages (table 4.7). Nor was the ranking in relative food shares

Table 4.7. Relative variability of food expenditure shares by village, from 1976/77 to 1981/82

	Households Significantly[a]		*Spearman Rank Correlation Coefficients*	
Village	*Above Median Household*	*Below Median Household*	*Mean*[10]	*Number of Pairwise Comparisons Statistically Significant*
Aurepalle	0	1	0.11	3
Shirapur	0	1	0.15	1
Kanzara	7	5	0.42	14

[a]The number of households with estimated food shares significantly different (p < .05) from the median household in each village. The food share coefficients were estimated by regressing household food share by year observations on household and year dummy variables in a linear fixed effects model.

[b]Mean of the fifteen pairwise year-year comparisons of household food shares. For each year-year comparison, the number of observations was thirty-five households in Aurepalle, thirty-three in Shirapur, and thirty-six in Kanzara. With six years, fifteen pairwise comparisons are possible.

[c]At the 0.05 level of significance.

highly correlated from one year to the next in Aurepalle and Shirapur. In contrast, in Kanzara twelve of the thirty-six households had food shares significantly different from the median food-share household, and all but one of the fifteen paired comparisons of food-share rankings between years were significant at the .05 level. These results suggest that identifying and targeting programs for the poor based on food expenditure shares will not work in the impoverished, riskier production environments exemplified by Aurepalle and Shirapur.

Smoothing Consumption Variability

Households can smooth consumption variability arising from fluctuations in income in essentially three ways. They can change their net borrowing position in the financial market, divest or invest, or draw down or accumulate food stocks. To investigate which of those mechanisms was most heavily used, we analyzed the household consumption, income, and asset data from 1976/77 to 1981/82 for the twenty-eight "shortfall" households. (Twenty-eight of the thirty-two at-risk households in table 4.4 incurred an income shortfall between 1976/77 and 1981/82.) We examined how those households adjusted to heightened income volatility. Two of the twenty-eight severely curtailed their consumption in response to shortfalls in income as their consumption expenditure in the shortfall income year plummeted to less than half their median year's consumption expenditure from 1976/77 to 1981/82. The other twenty-six did adjust to the extent that consumption in the shortfall year did not fall below 50 percent of the median year's per capita consumption expenditure from 1976/77 to 1981/82.

To study systematically how those twenty-six income-variable households were able to achieve a modicum of consumption stability, we regressed annual changes in net credit position, asset holding, and stock inventories on farmer dummy variables capturing household-specific effects and on a zero or one shortfall variable indicating whether the household suffered an income shortfall during that particular year. We expected households to increase their borrowings, sell more liquid assets such as livestock, and draw down on stock inventories in a shortfall year.

Half the shortfall households came from Aurepalle, and they relied primarily on the rural financial market to smooth consumption. The estimated and statistically significant ($p < .05$) coefficient on the shortfall year variable indicated a substantial increase in net borrowing during the shortfall year. Eleven of the fourteen households were net borrowers during the year in which they incurred an abrupt shortfall in income. This result is not surprising given the active informal credit market in Aurepalle (chapter 7). On the other hand, borrowing did not significantly increase in the low income year for shortfall households in the Maharashtra villages, where the informal market is not nearly as well developed (chapter 7) and where employment on public work schemes is available for the economically active, who are able to do fairly arduous manual labor (chapter 8).

Turning to assets, livestock, especially buffalos and bullocks, was actively traded by households in all villages, particularly in Shirapur; however, we cannot show that mean livestock sales were significantly greater in shortfall years in any of the villages. Regression results on net annual balances of goat transactions, which figure in income, did not indicate an increased propensity to sell goats when the household faced a steep shortfall in income.

Storage of crops across years also played a limited role in adjusting to shortfalls in income in these villages. Only appreciable quantities of rice in Aurepalle are carried over across years, mainly by large farm households. Unlike in Africa's SAT, on-farm storage of cereals for more than one to two years is rare. Discussions with farmers suggest that on-farm storage was more important in risk adjustment before Independence (see also Dreze 1988). For example, farmers in Shirapur reported the existence in the past of large storage pits to carry over post-rainy season sorghum between years. Those structures are now only remembered.

Mobility

In each of the study villages, one can document a few cases of landless individuals or those with an inheritance of only a few acres rising steadily in economic status to become one of the wealthiest people in the village. At times, extreme upward mobility followed the pattern of rungs in a ladder, where the person started as a permanent servant, leased land as a tenant, bought land, purchased a dug well, and was en route to becoming a large farmer with one or more dug wells. It sometimes took two generations for pronounced upward mobility to manifest itself: The father started as a permanent servant, accumulated some land or wealth, and the son, building on that base, became one of the richest persons in the village.

While each village has one or more of these Horatio Alger stories to report, extreme downward mobility is more common. Several of the larger farm households in each village have disposed of most of their inherited land during their lifetime. Such land shedding is often accompanied by or results from alcoholism, gambling, or other types of disease or personal vice. Bad luck in the sex ratio of one's progeny with attendant magnified dowry commitments or in digging dry holes in the search for groundwater to irrigate one's crops has also contributed to the economic demise of some large cultivator households.

While the above general impressions, based on case studies documented by the resident investigators, indicate the presence of economic mobility in the villages, the degree of economic fluidity cannot be estimated with much precision. With the panel household data, nine years is too short a time period to analyze issues that pertain to income mobility, which ultimately can only be addressed with intergenerational data. Much that falls under the guise of mobility with intragenerational data has little to do with mobility per se but is occasioned by agroclimatic or life cycle events. Therefore, comparative inferences drawn on the data on income changes over time could be spurious if the sole cause of change in relative income position was assigned to mobility. With those qualifiers, we can say that mobility, loosely interpreted as the change in relative income position, was least in Aurepalle during the nine-year period of analysis. In Aurepalle, only two households moved by two or more income quartiles from the first to the third three-year period. In contrast, six households in Shirapur and five in Kanzara shifted two or more income quartiles between 1975/76 to 1977/78 and 1981/82 to 1983/84. Most of these thirteen households experienced such sharp movements in relative income position because of life cycle or agroclimatic events; only a minority could be attributed to true intergenerational income mobility. Statistically significant ($p < .05$) Spearman's rank correlation coefficients, measuring the degree of concordance of relative income position between the first and last three-year periods, of 0.83 for Aurepalle, 0.81 for Shirapur, and 0.74 for Kanzara also indicated that households in Aurepalle held somewhat more entrenched income positions.

A more comprehensive description of changes in the village income

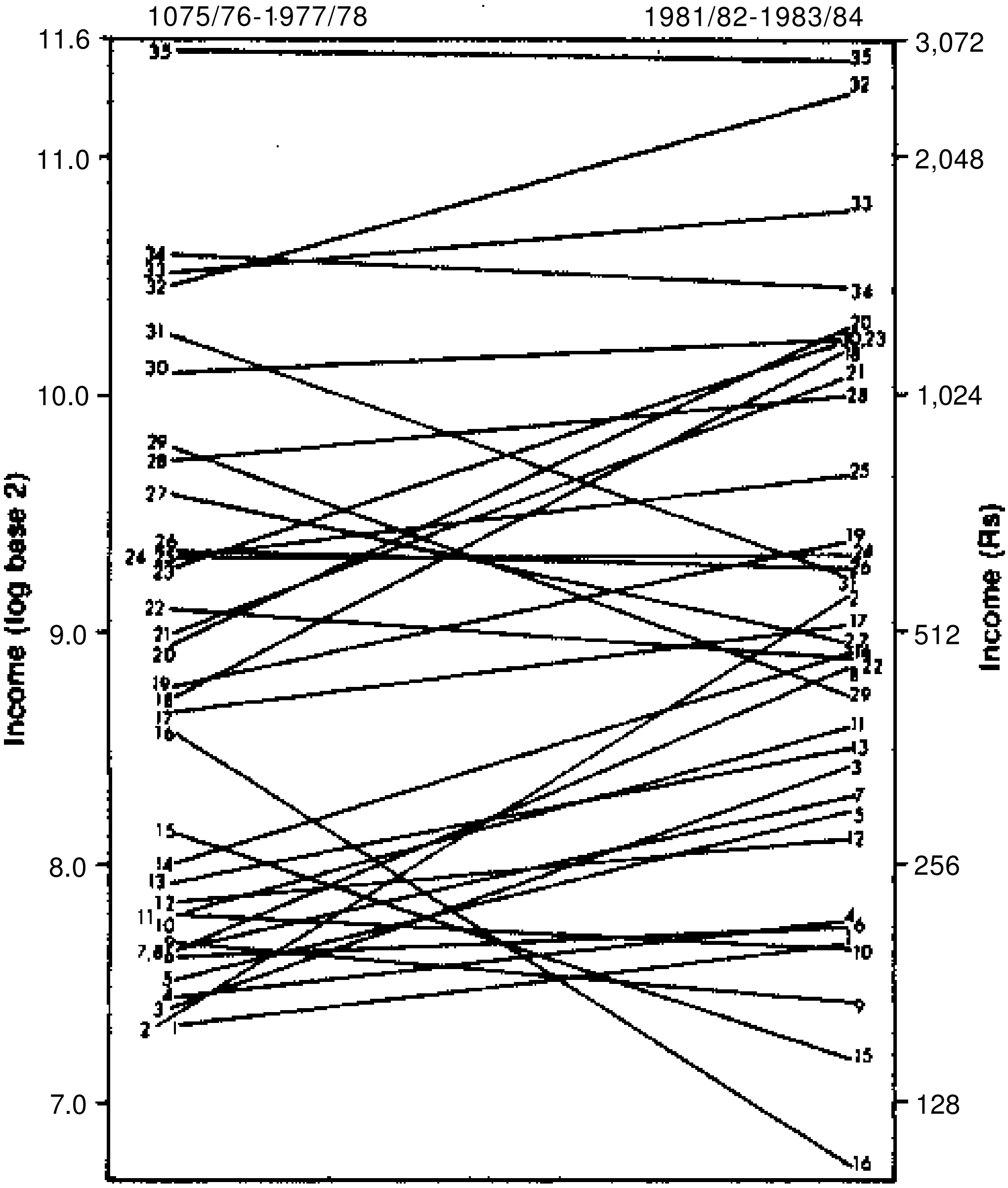


Figure 4.12 Change in real income between 1975/76-1977/78 and 1981/82-1983/84 by household in Aurepalle

profile is provided by the data arrayed in figure 4.12 for Aurepalle. The slopes of the lines connecting the mean household income levels received in the first and third three-year periods suggest a considerable reshuffling of households in relative income positions, even in Aurepalle. In the first three-year period, households fell into four fairly tightly clustered groups represented by household numbers one to fifteen, sixteen to twenty-nine, and thirty to thirty-four and thirty-five in figure 4.12. By the third three-year period, household income position was much more disperse, and several households had "crossed over" into another group.

Although the nine-year period may be too brief to render a judgment on the degree of income mobility in the study villages, with the help of retrospective survey data we can address the mobility-related question, To what extent do the characteristics of the respondent's parents and the resource endowments at inheritance (or at the time the respondent became head of the household) explain interhousehold variation in income within each of the pairs of villages in the three study regions? In other words, how much do truly exogenous influences account for the variation in household income? To answer that question, we regressed net household income per capita averaged across 1975/76 and 1976/77—the two years when detailed data on income were compiled for the six villages—on the exogenous variables that could have affected the respondent's income. Those variables included the education of the father, caste, if the respondent inherited land, the amount of inherited land, the quality of inherited land, the relative amount of irrigated land inherited, the number of bullocks inherited, the time of inheritance, and the location of the village within the regions (table 4.8).

The results of these regressions in table 4.9 are pretty much in line with expectations formed in earlier parts of this chapter. In Mahbubnager, caste was the most important variable in explaining the interhousehold variation in income. Switching from Reddi, the traditional farming high caste in Aurepalle and Dokur, to any other caste in those villages resulted in a steep shortfall, ranging from about Rs 500 to Rs 800. The amount or quality of land inherited, in and of itself, did not exert a statistically significant influence on household income. Caste affiliation did.

In Sholapur, the lowest caste households were significantly ($p < .10$) poorer than the highest caste Maratha households, but the income disparities were not nearly as large as those estimated in the Mahbubnagar region. The only other variable that mattered ($p < .05$) in determining income was the bullock endowment at inheritance. An additional bullock inherited increased income by about Rs 90 in 1976 prices.

In Akola, farmers who received more land at inheritance were able to capitalize on that endowment to their economic advantage. Land inheritance was a statistically significant ($p < .05$) determinant of per person income. No other exogenous variable significantly explained the interhousehold variation in per person income during that period.

These results largely reinforce our earlier perceptions of the villages and the study regions. When we think of Aurepalle, the role of caste and a skewed income distribution come to mind. Shirapur and Kalman conjure up images of the overriding importance of bullocks as a means to production, superimposed on a landscape of stagnant technological change. Kanzara and Kinkheda epitomize a rainfall-assured ecology where the potential for technical change confers measurable economic benefits to the owners of land.

These results are also quite robust. They do not change much when we extend the time series to nine years and reestimate the region-specific

Table 4.8. Variable description in analyzing the importance of inherited endowments on household income, by region

Variable (Measurement Unit)	Region					
	Mahbubnagar		Sholapur		Akola	
	Mean[a]	Range	Mean	Range	Mean	Range
Resource Endowments[b]						
Landless at inheritance (dummy)	0.20	0,1	0.18	0,1	0.36	0,1
Land inherited (acres)	8.09	0-125	10.7	0-37	9.36	0-93
Good soil (%)	25.8	0-100	49.4	0-100	49.2	0-100
Irrigated (%)	31.0	0-100	7.54	0-100	6.24	0-100
Bullocks *(N)*	0.75	0-9	0.68	0-4	0.46	0-6
Personal Characteristics						
Father's education (years)	0.32	0-5	1.30	0-7	2.03	0-10
Caste (dummy)[c]						
1	0.25	0,1	0.56	0,1	0.30	0,1
2	0.19	0,1	0.56	0,1	0.30	0,1
3	0.29	0,1	0.35	0,1	0.20	0,1
4	0.27	0,1	0.00	0,1	0.16	0,1
Other Determinants						
Caste 4	0.27	0,1	0.00	0,1	0.16	0,1
Time since inheritance (years)[d]	12.45	0-52	10.15	0-32	10.69	0-31
Village (dummy)[e]	0.52	0,1	0.50	0,1	0.51	0,1
Mean income (Rs per capita)[f]	679		484		625	
N		75		74		70

[a]Mean for the continuous variables; frequency proportion for the dummy variables.

[b]Refers to the endowment at inheritance or when the respondent became household head.

[c]Caste 1 is highest. Caste 4 lowest.

[d]From the time of earliest inheritance.

[e] Villages receiving a one in their respective regions are Dokur, Kalman, and Kinkheda. Those assigned a zero are Aurepalie, Shirapur, and Kanzara.

[f]Mean of 1975/76 and 1976/77.

equations with the less reliable per capita income data in the noncontinuous villages from 1977/78 and 1983/84. But they do change substantially when the data are pooled across the three regions and data from village studies in two other semi-arid tropical regions in Gujarat and Madhya Pradesh are included. In examining the intergenerational transmission of wealth with pooled data from the early 1980s in those ten study villages, Binswanger and Singh (1988) documented stronger effects of parental education and wealth on household income than what is implied in the reduced-form regional regressions in table 4.9.

Table 4.9. Regression estimates of the influence of inherited endowments on household income, by region

	Region					
	Mahbubnagar		Sholapur		Akola	
Variable	*Estimated Coefficient*	*Standard Error*	*Estimated Coefficient*	*Standard Error*	*Estimated Coefficient*	*Standard Error*
Resource Endowments						
Landless at inheritance	-27.5	164	-174	111	186	211
Land inherited	-3.28	6.07	-2.77	3.96	17.22*[a]	4.31
Good soil	-1.50	2.20	-0.35	0.93	0.79	1.93
Irrigated	-0.44	2.50	-0.80	1.74	0.90	3.46
Bullocks	61.9	82.2	88.1*	40.8	67.8	1.12
Personal Characteristics						
Father's education	99.9	69.7	-1.91	13.6	-3.16	26.7
Caste						
2	-526**	210	104	116	197	157
3	-637**	202	-145*	73.5	-8.18	189
4	-834**	223	—	—	-69.4	210
Other Determinants						
Time since inheritance	0.19	6.38	6.13	4.91	-10.2	8.80
Village	18.2	173	-68.7	74.0	-90.8	121
Constant	1,154		350		61.5	
R^2	0.35		0.11		0.27	
F value	4.54		1.86		3.30	

[a]** and * signify statistical significance at the 0.01 and 0.05 levels, respectively.

Conclusions

This chapter contained relatively few surprises. The microlevel evidence from the panel households in these poor dryland study villages largely supported recent findings on trends in income, consumption expenditure, and wealth from all-India surveys, particularly the initial results from the retrospective study of the NCAER. The period of analysis from 1975/76 to 1983/84 was a time of increasing prosperity, albeit from a very low base, for many of the panel households. The poorer households located lower on the income ladder in the mid-1970s experienced as much or more growth in real income per capita as the richer households. Real income growth was accompanied by some improvement in household net wealth as consumer durables and financial assets deepened. Casual empiricism also reinforces a story of economic and social progress in other dimensions of human welfare such as increased provision of basic services, greater diet diversity, stronger links between the village and the outside world, and enhanced liquidity.

A finding of no change in some aspects of household welfare was also consistent with results from retrospective, cross-sectional studies. Although many households moved up or down the village income profile over time, income inequality remained about the same in each of the study villages.

Agreement with the all-India evidence attests to the integration of these poor dryland study villages and regions in the national economy. Integration implies that one has to look outside the study regions to understand some of the forces shaping these trends. Increases in cereal productivity, largely outside the study regions, placed downward pressure on cereal prices, which in turn laid a solid foundation for real income growth for the poorer households who were net buyers of food. Cereal prices to consumers were remarkably stable during the period of analysis, and food price inflation was exceptionally mild. Conversely, stagnating producer prices for cereals in general and coarse grains in particular severely curtailed real income prospects for the larger cultivator households, especially those located in the rainfall-unassured regions, where technical change in dryland agriculture was limited.

Although several of these trends are favorable and clearly convey some good news, the vast majority of households in these dryland study villages are still very poor. Real income growth equivalent to U.S. $3 to $5 per capita in 1975 prices from a base of $65 per capita leaves a lot to be desired.

Off-farm earnings loom larger in household income in the mid-1980s than in the mid-1970s, but the lack of significant expansion in off-farm income opportunities over time deviates somewhat from the NCAER study's finding that nonagricultural self-employment was the main source of improvement in income for rural households from 1970/71 to 1981/82. Most likely, many of the sample villages of the NCAER study had experienced higher rates of agricultural growth, which in turn fueled the expansion of off-farm nonagricultural employment. We know that nonfarm employment is gradually expanding in the study regions, but the outlines of such growth are not sharp and pale in comparison to the rapidly growing off-farm opportunities in rural Southeast Asia, even in SAT regions such as Northeast Thailand (Shand 1986).

One manifestation of the slow growth in off-farm nonagricultural employment is the restricted role played by transfers and other remittances in dampening income variability. Transfers and remittances from family members outside the household can often be the most effective source of risk adjustment because donating members usually do not have income streams that are that covariate with those of receiving members. Slow growth in off-farm nonagricultural employment reduces the scope for tapping this efficient source of risk adjustment.

Whether the encouraging trends documented from 1975 to 1983 are only part of a repetitive cycle or represent a sustained improvement in rural livelihoods hinges largely on economic growth not only within but also outside these regions. The need to place economic growth (coupled with investments in basic health infrastructure) front and center in development policy was highlighted by the finding of conflict between absolute poverty, based on the head-count ratio, and income inequality, measured by the Gini concentration ratio. When income comparisons were made across the six study villages in 1975/76 and 1976/77, absolute poverty was the greatest in the three villages where income inequality was least. The size of the economic pie was so small that the only way for some households to rise above the poverty line was to have income more inequitably distributed.

Some unexpected results were uncovered in the analysis of income and consumption variability. We did not anticipate the strong positive role that participation in the labor market played in dampening fluctuations in income. Poor households with fewer economically active members or with ill or disabled workers were more susceptible to sharp shortfalls in income. Therefore, improving the health of potentially economically active individuals should lead to diminished income variability. This risk benefit should not be overlooked in assessing the desirability of investing in health care in dryland regions such as these, characterized by relatively high levels of household income variability.

Although a rigorous social cost-benefit analysis of direct government poverty alleviation programs was outside the scope of this chapter, observing such schemes in action in the study villages engendered considerable sympathy for the critics of subsidizing investment in productive assets, as practiced under the 1RDP, and for the advocates of rural public works programs such as the MEGS. Less than 10 percent of respondent households benefited from the IRDP during the period of analysis from 1975 to 1983. The objective of increasing longer lasting, productive self-employment was difficult to achieve because funds were diverted to other purposes (perhaps the salient example was loans for village enterprises which were subsequently used to buy land) and because the productive asset, especially livestock, was often sold before the full economic benefits were realized. Beneficiaries were also quick to exploit weaknesses in program design and administration.

The results in this chapter also show how hard it is to establish centralized guidelines for targeting beneficiaries for subsidized poverty alleviation programs, such as the IRDP, in poor dryland farming communities. In Aurepalle, membership in the Harijan community would be an effective marker of low economic status; in Kanzara, landlessness would likely be as good as any other criterion to identify endemic poverty in the village; and lastly, in Shirapur, one would be hard pressed to suggest an indicator that effectively sheds light on the shades of poverty in the village.

Recent research by Hazell and Singh (1988), based on ICRISAT village data from five study regions and on an income criterion to measure absolute poverty, shows that compared to competing criteria on household resource endowments and personal characteristics the size of landholding would do the best job in identifying households above and below the poverty line. About 90 percent of the poor owned less than 0.67 ha, but 33 percent of the nonpoor also owned less than 0.67 ha. Hence, the leakages from using that cut-off point to target poverty programs would be quite high.

In contrast, considerable circumstantial evidence was mustered to support the finding that the MEGS in Shirapur and Kanzara was congruent with the interest of the poor. Members in general and women in particular from the poorest households participated more than others (chapter 8). A work criterion and a not excessively high remunerative structure made for cost-effective self-targeting.

Summing up, much of the change that has taken place in these dryland farming villages since the start of the studies in 1975 has been for the better and has favored the poor. The problem is not of direction but of pace. Signals emerging from the village labor market—the subject of the next chapter—indicate that material change is, indeed, in the right directions.

5 Labor

Cultivators and agricultural laborers represent about two-thirds of the 180 million active workers residing in SAT India. Research and development strategies for the SAT should embrace these labor resources explicitly, as they are not only relatively abundant but resilient in the face of profound hardships.

When we started the village studies in 1975, relatively little was known about the functioning of rural labor markets in SAT India. Most previous microeconomic studies had concentrated on other parts of India, particularly East and more specifically West Bengal, addressed in the seminal village labor market research of Rudra, Bardhan, and their colleagues.

Since 1975, interpretative syntheses of existing research by Binswanger and Rosenzweig (1981) and Dreze and Mukherjee (1987) have shed considerable light on the outlines of labor relations, particularly contractual arrangements, in Indian villages. Rajaraman's (1982) work in an SAT region in Karnataka has also provided a valuable benchmark from which the findings on the functioning of labor markets in the study villages can be compared. Still, much of the labor market research pertaining to India's SAT is pitched at a more aggregate level, relying on cross-sectional information from the population census or from the NSS.

Until recently, the absence of in-depth empirical research led to the unquestioning acceptance of the view that rural labor markets in developing countries are highly imperfect. That view had dominated thinking in development economics since the 1950s (Binswanger and Rosenzweig 1981). Elements of alleged imperfection include rigid, institutional, and/or culturally determined wages, the prevalence of moral effects associated with patron-client relationships, occupational and geographic immobility, and labor market segmentation by sex. In particular, the stylized empirical facts of open unemployment and downward wage inflexibility were difficult to reconcile within a supply and demand framework. These facts laid the foundation for the construction of the macro labor surplus models tailored to the "special" labor market conditions in the developing countries (Lewis 1954; Ranis and Fei 1961). One of the main objectives of this chapter is to examine to what extent the empirical evidence from the study villages supports the conventional wisdom of widespread and deep-seated labor market imperfections.

We begin this chapter by describing in detail the important features of labor markets in the study villages. That description, based largely on contractual arrangements, is followed by a section on farm labor use. The degree to which farm size and labor use intensity are inversely correlated—a common finding in irrigated agriculture in Asia—receives considerable analytical attention. Labor market parameters and their seasonality are the subjects of the third section.

The time series nature of the village studies provides a unique opportunity to assess dynamics in these labor markets. Trends in real agricultural wages probably tell us as much about the economic well-being of the rural poor as any other measure of economic development; delineating and interpreting the reasons for and implications of those trends are treated at length in the fourth section. Next, we analyze the determinants of wages, participation, and days worked by participants. Estimates of labor supply response are generated in that analysis; those estimates provide the raw material for predicting the effects of technological change on household wages, employment, and income.

We conclude by commenting on the role played by the forces of supply and demand in shaping outcomes in village labor markets, on the context of the labor market dynamics observed in the villages between 1975 and 1985, and on the nexus between health and labor market consequences. Implications of the important issue of technical change and labor absorption in SAT agriculture are deferred to chapter 11.

Structure of the Village Labor Market

Based on contractual relations, the structure of the village labor market is presented schematically in figure 5.1. All villages have two basic labor markets, characterized as casual and long-term. The casual market consists of a daily component where contracts are negotiated for short periods, usually a single day or at most a week. Payment is made each day for an agreed number of hours. In the contract submarket, laborers are organized by an intermediary and are remunerated on a piece-rate basis for a specified job for farmers or government agencies. Daily earnings are generally higher from contract work compared to daily-rated jobs, but the former often involve longer hours and/or more strenuous work.

The long-term submarket consists of two segments: regular farm servants (RFSs), which is the exclusive domain of men, and domestic servants, comprised of women and boys. Employers of RFSs and domestic servants are invariably the wealthier, usually larger, farm households.

The description of these distinct but interrelated submarkets relies heavily on a study (Binswanger et al. 1984) that exposes their salient

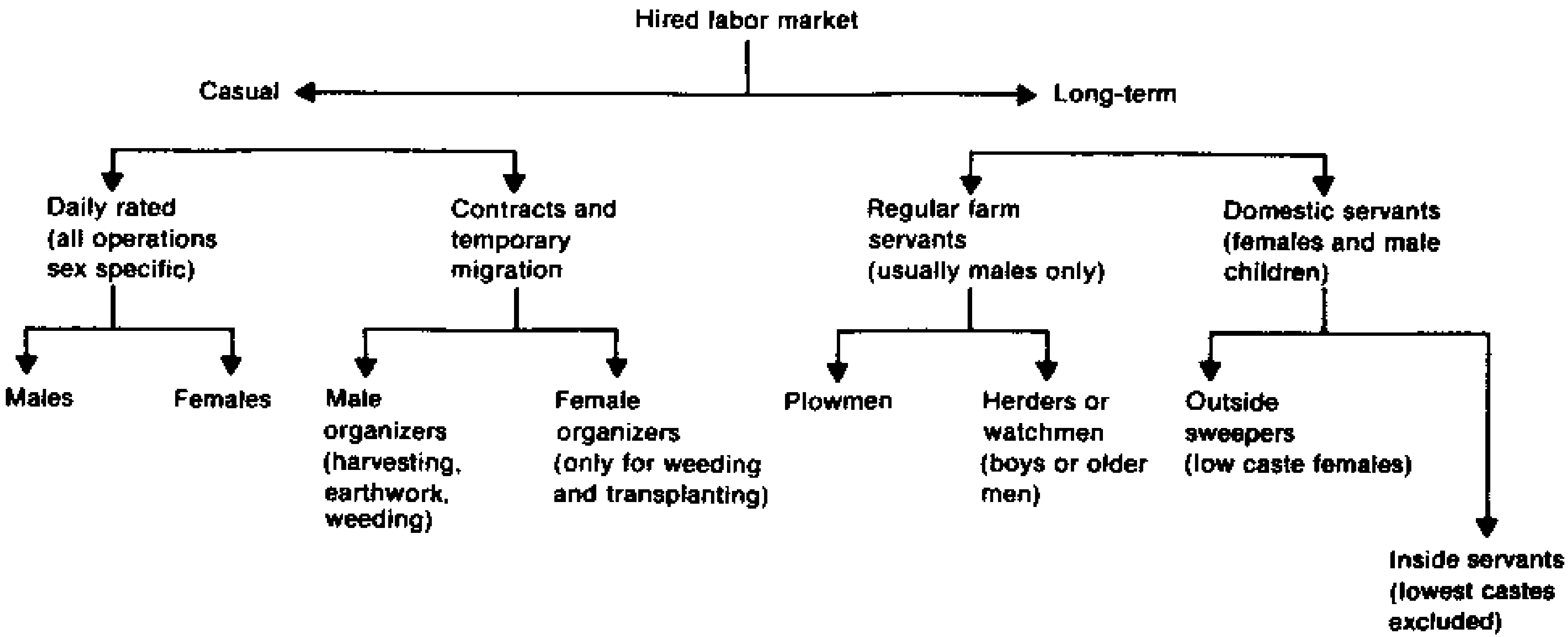


Figure 5.1 The features of the village labor markets

features at the midpoint of the village studies in 1979-80. That picture, taken by economists and anthropologists, is updated later in this chapter.

Daily-Rated Labor

The bulk of labor income is earned in the daily-rated labor market. The daily labor market is impersonal in nature, unlike the patron-client relationships which Hayami and Kikuchi (1981) described in the rice-growing regions of Southeast Asia. Similar to Rajaraman's (1982) findings in SAT villages in Karnataka, linkages with the markets for land and credit are also the exception rather than the rule in transactions involving daily-rated labor. That is, it is rare to find daily employment provided or required by lenders or landlords in return for loans or tenancy arrangements in the study villages.

In the evenings, employers, RFSs, or the wives of the RFSs search out candidates for work on the following day. In Dokur, search often occurs in the morning of the day of work, when the responsibility of looking for labor often falls on the wives of large farmers. In Sholapur, employers look for more efficient and reliable workers first and offer premiums. Workers who have to approach prospective employers generally accept discounted wages.

Employers are usually indifferent about the caste or socioeconomic status of the prospective daily employee, and caste does not play a direct role in workers' screening of prospective employers. Employees are willing to work for almost all employers, and they regularly change their employer throughout the course of the year. It is not unusual for the same laborer to be engaged by more than twenty employers annually.

With the exception of harvesting and threshing, agricultural daily-rated tasks are generally sex-specific. Ideological support for segmentation is strong. A taboo prevents women from touching the plow and (as in some other societies) men who do domestic chores are ridiculed. The segmentation between men's and women's tasks is ruled by dharma, or duty, related to the biological role of women in bearing children and the strength of men (Maclachlan 1983). Low wages for women are commonly attributed by both men and women to women's lack of physical strength and stamina. (One need only see the loads carried by them and the discipline of paddy transplanting to realize that the large observed wage differentials cannot be entirely explained in this way.)

Daily-hired labor is paid in cash in the Maharashtra villages. In Dokur, daily-rated labor receives cash for all tasks except harvesting and threshing, while in Aurepalle daily wages are in kind, mostly in paddy, sorghum, or castor. Workers engaged in harvesting and postharvesting operations are mostly remunerated on a piece-rate basis, while those carrying out preharvesting operations are paid daily wages.

Contractual Employment

The other component of the casual labor market can be divided into two categories: contract agricultural work and off-farm employment. Both generally involve periods and payment conditions of more than a single day and piece-rate remuneration.

Farm Contracts The incidence of contracting varies from village to village and depends on the availability of off-farm employment opportunities and on the intensity and timeliness of the demand for women's labor in sex-specific operations like weeding, transplanting, and harvesting of paddy. All the villages have groups of men who contract out their labor for well digging and deepening, and in the Mahbubnager villages groups of women are recruited by women organizers for time-bound tasks related to paddy production. Women are paid by the job; that is, a specified task for a stipulated area. The organizer works with the other members of the group and receives the same share of wages. In the Akola villages, a pseudo-form of contracting occurs where the organizer supervises the performance of the gang members, who are remunerated with a daily wage. The organizer receives twice the daily wage for his or her supervisory responsibilities.

Off-Farm Contracts Turning to off-farm work, gangs of laborers in Kanzara are organized by a *mukkadam* to work on government projects outside the village. Piece rates are paid and subsidized food grains can be purchased under Food for Work programs. Small consumption loans are granted by village shopkeepers to contract workers on certification by the *mukkadam* that they are employed on an organized scheme. In Shirapur, groups working on government contract employment are much smaller than in Akola and less formally arranged. They are generally organized by males, as is the case elsewhere for contract off-farm work.

Temporary migration for periods of five to eight months to work on large government projects is common in Dokur and provides an alternative to RFSs. Subcontractors recruit labor by advancing amounts from Rs 200 to Rs 1,000 (in 1979/80) and form gangs of up to seventy laborers at a time. Projects are often hundreds of kilometers distant. The demand for loans is an important motive for participation. This alternative employment opportunity, together with extensive irrigation, has meant labor relations in Dokur are more favorable for labor than in Aurepalle.

The Regular Farm Servant

RFSs fulfill the large farmer's need for permanent hired help. They mainly tend livestock and plow and cultivate fields.

Access to credit has gradually replaced survival insurance in times of scarcity as the primary motivation for laborers' entering into RFS contracts. Daily-rated workers are unable to obtain loans from employers in return for a commitment to be available to work for them in peak periods. Without collateral, loans can only be secured from employers by entering into an RFS contract for three to twelve months. RFS contracts are almost exclusively with men, and families rarely have more than one of their members involved in such an arrangement at any one time. When a second family member works as an RFS, that contract is with another employer to broaden the family's credit base. Contracts are verbal and before about 1980 were rarely broken. In recent years, more RFSs have sought to abrogate their contracts as the labor markets have tightened. In the 1970s when disputes occurred the village *sarpanch* (headman) or elders would be called in to adjudicate, mostly always in favor of the employer. More recently, RFSs have found it easier to renegotiate contracts against the background of the illegality of bonded labor contracts.

The few women on regular contracts are employed on domestic tasks in wealthy households. The virtual exclusion of women from the RFS market implies they have limited opportunities to secure loans.

The RFS contracts in Dokur and in the two Sholapur villages involve a combination of cash and kind wages (table 5.1). In Aurepalle, RFSs are paid in kind, while in the rainfall-assured Akola villages RFSs are remunerated with cash. Parts of the contracts are generally paid as lump-sum advances and the balance in monthly installments.

A steady demand for labor throughout the year because of the dominance of long-duration cotton leads to RFS contracts from three to five months in the Akola villages. These often start as early as September and October to cover the lean season and substitute for consumption loans. In all other villages, RFS contracts were exclusively on an annual basis. Where loan advances were involved in Aurepalle and Dokur, RFSs were required to renew their contracts annually until the debt was repaid, although such arrangements again were verbal. Repayment often took five to six years.

By 1979/80, the incidence of RFS contracts was declining in the Sholapur villages, probably because of the presence of nearby government public works projects. The in-kind remuneration of an annual ration of 330 kg of sorghum had not changed since 1940. In this drought-prone district, workers seem to prefer a minimum amount of food grains in their contracts to ensure survival. The cash portion had risen from Rs 3.30 per month in 1940 to Rs 41 to Rs 63 per month by 1979, barely sufficient to match inflation. RFSs in Aurepalle were successful in negotiating a 25 percent increase in their in-kind wages in 1977 and a lowering of interest rates by the same percentage. This was the result of a one-day strike, probably encouraged by government support for improved conditions for scheduled and lower castes and bonded laborers.

Table 5.1. Monthly salary arrangements for regular farm servants (RFSs) compared to wage labor incomes

Region/ Village	*Range of Kind Payments (Rs)*	*Range of Cash Payments (Rs)*	*Cash Equivalent of Total Wages (Rs)*	*Interest on Loans Given to RFS (%)*	*Ryan-Ghodake Monthly Wage Equivalent (Rs) 1975/76*[a,b]
Mahbubnagar					
Aurepalle	44.5 kg paddy/month (Rs .86/kg) + one pair of sandals/year + pinch of tobacco/day	nil	43	18	53
Dokur	1 blanket every two years at Rs 100	70-115	73-121	18	46-76
Sholapur					
Shirapur	27.5 kg of sorghum/ month (at Rs 1.40/kg)	41-62	*77-98*	nil	55-70
Kalman	Food	75-105	75-105	nil	53-75
Akola					
Kanzara	nil	120-150	120[c]-150	May take form of salary reduction	96-120
Kinkheda	nil	120-150	120[c]-150	nil	96-120

[a] Account has not been taken of the additional hours worked by RFSs to achieve these wages; adjusted to 1975/76 prices.

[b]Calculated on the assumption that a permanent servant is willing to work for wages three hundred days/year, but subject to the village average unemployment probability. *Source:* Ryan and Ghodake (1980:table 3).

[c]Note that in the Akola villages the contracts *are* for three to five months only. In the Mahbubnagar and Sholapur villages they are for twelve months. *Source:* adapted from Binswanger et al. (1984:table 8.4).

Apart from this instance, in-kind wages remained constant between 1962 and 1977.

Clearly, RFSs in Aurepalle were worse off than daily laborers in 1979/80. The shortfall in RFS wages in Aurepalle can be attributed to oligopsony rent extracted by employers. Personal characteristics did not influence the wages RFSs received in Aurepalle. The dominant caste among the RFSs is a Harijan community, the Madigas. Employers seemingly exploit the low status of Madigas and their demand for loans for marriage of their children. Marriage is a social investment and hence important for validation relative to their caste group. The scarcity of nearby alternative employment opportunities further contributed to the strong bargaining position enjoyed by large farmers in Aurepalle in the 1970s.

The monthly wages of RFSs are considerably higher than the expected monthly earnings of daily-rated laborers in the other villages (table 5.1).

However, RFSs work much longer hours than workers in the daily labor market and perform a variety of tasks. Daily-rated laborers average seven to eight hours per day, while the RFSs spend about 25 percent longer in Akola, 40 percent in Sholapur, and 60 percent in Mahbubnagar. When the monthly wages of RFSs are discounted for these additional hours, only in Akola do we find that RFS wages exceed those of daily laborers. In Dokur and Sholapur, they are about the same, and in Aurepalle RFS wages were less than those of daily laborers. One might expect to find such a differential in Akola because the RFS contracts are short-term—three to five months.

As Lipton (1983b) notes, the efficiency theory of wages predicts higher total wages (cash plus in-kind) for long-term labor contracts (where the employer can capture the supposed productivity benefits of improved worker nutrition), than for daily-rated contracts, which would not normally include meals for the same reason. Only in Akola, where RFS payments substantially exceeded those of daily-rated labor, was there evidence in support of this hypothesis derived from the efficiency wage thesis.

Farm Labor Use

In this section, we confine ourselves to labor engaged in crop-related activities. We exclude labor used for domestic work, building, repairs, transport, fuel gathering, food processing, regular jobs, animal husbandry, marketing, handicrafts, and other activities. Collectively, those non-crop activities represent about 50 percent of the total labor time of men and women in the villages. Our presentation draws liberally on Ghodake, Ryan, and Sarin (1981), Ryan, Ghodake, and Sarin (1980), and Ghodake and Ryan (1981).

Interregional and Village Variation

We observed substantial variation among the six villages in total (hired plus family) labor use per hectare of cultivated land in the late 1970s and early 1980s. Dokur was the prominent outlier with about three times more labor use (1,375 hours) per hectare of gross cropped area than the other villages. Greater use of irrigation in Dokur, where more than half of net cultivated land is irrigated from tanks and wells, is the explanation, demonstrating the employment-creating potential of the existing tank and well irrigation systems in the Alfisols of South India. Improved technologies for the drylands in villages like Dokur will have to compete with these irrigation systems for labor use at strategic times in the crop-growing season.

The two villages in Akola used about 50 percent more labor per hectare than the two Sholapur villages even though the proportion of irrigated area was higher in the Sholapur villages. Less labor is used per hectare in Sholapur than in Akola largely because post-rainy season crops require much less labor for weeding and interculturing than do rainy season crops on black soils. Cotton, grown extensively in Akola, also demands much more labor than the food grains, which dominate the cropping systems in Sholapur.

Another striking regional difference in labor use among the villages was the high CV of 25 percent in mean annual labor use per hectare in both the rainfall-unassured Sholapur villages. Much of that variability manifests itself in large fluctuations in the demand for harvesting labor. As we saw in the last chapter, workers in the Sholapur villages were fairly successful in compensating for those agroclimatically induced fluctuations in labor demand. In contrast, a low CV of 10 percent for Kinkheda shows how stable agricultural labor demand can be in dryland agriculture in more assured production environments.

Composition of Farm Labor

Farm households rely heavily on hired labor to cultivate their land. In the Mahbubnagar and Akola villages, hired labor provides the lion's share (60 to 80 percent) of total labor use in crop production. Men and women contribute almost equally to total labor use, with children supplying negligible amounts of labor.

Hired labor looms proportionally larger in women's labor use than in men's. Of the total female labor used in the Mahbubnagar and Akola villages, 80 to 90 percent was hired. In the Sholapur villages, the hired component was smaller, about 70 percent of total women's hours worked in crop production. This comparatively lower figure was primarily because of the absence of hand weeding, traditionally a women-intensive operation, in post-rainy season crops. In contrast, the activities of paddy transplanting and weeding in Mahbubnagar and cotton picking in Akola create a high demand for hired female labor.

Summing up, men contribute substantially more to total family crop labor than do women, while women dominate the hired labor market. Thus, if new technology options could increase the overall demand for hired labor, their proportional impact will be larger on women's wage employment, provided such technical change does not decrease labor demand in operations which are predominantly carried out by women.

Women generally work 10 to 30 percent more hours per day than men, the latter averaging seven to eight hours. This difference reflects the dominant role of women in domestic work, food and fuel gathering/ processing, and handicrafts, which are undertaken in addition to their participation in paid and unpaid agricultural activities. The length of the adult working day varies only 10 to 15 percent within the year, but over the years duration of the working day for daily-rated laborers receiving a daily wage appears to be shortening. In the mid-1970s, most daily-rated laborers worked seven to eight hours; by the mid-1980s six to seven hours seemed to be the norm. A shorter work day for daily wage labor appears to be one manifestation of a tightening labor market, discussed later in this chapter.

Farm Size and the Intensity of Crop Labor Use

The size of farm is often inversely related to the use of total labor (family plus hired) per unit of land (Bardhan 1973; Bharadwaj 1974; Booth and Sundrum 1984; Norman 1967; Rajaraman 1985; Srivastava 1966). Five explanations, some summary and other causal, are generally given: (1) higher cropping intensities on small farms, (2) more labor-intensive crops on small farms, (3) greater labor use per hectare within cropping systems on small farms, (4) more use of family labor attributed to higher family labor endowments per hectare with a lower opportunity cost on small farms, and (5) better soil quality on small farms, which enhances labor productivity.

The initial tabulations of total crop labor use by farm size conveyed a village-specific picture. In most years, small farms in Aurepalle used significantly less total labor per hectare of operated land than did large farms. In Kalman and in the Akola villages, small and large farm households were characterized by about the same level of labor intensity, while in Shirapur and Dokur differences in labor use intensity were significant about half the years, when small farms used more total labor per hectare than large farms.

These initial results are reinforced by the simple correlation and regression coefficients between labor use and operated area (table 5.2). A significantly positive relationship is obtained in Aurepalle, a significantly negative one in Shirapur, with the other villages not exhibiting a noticeable relationship.

The temptation is to infer that the nexus between total labor use intensity and farm size is tenuous in dryland agriculture in India's SAT; however, several other variables related to the household's resource endowment influence labor use intensity. When we allow for their effects in a multivariate regression analysis, the relationship between farm size per se and total labor use intensity becomes more evident (table 5.3). Variables considered in addition to farm size are extent of irrigation, draft availability, and the size of the family labor force. We also controlled for soil quality variation and year-to-year variability.

The large increase in explanatory power which occurs with a more adequate specification of the determinants of crop labor intensity suggests that farm size per se is by no means the primary factor explaining variations in this important input in these SAT villages. However, after allowing for the effects of other determinants, a significant and inverse

Table 5.2. Simple regressions and correlations between crop labor use per hectare and farm size, from 1975 to 1983 by village[a]

		Regression Analysis				
Region/ Village	*Period*	*Coefficient on Farm Size*	*Farm Size Elasticity*	*Significant Year Dummies (N)*	$\bar{R}^2$	Simple Correlation Coefficient
Mahbubnagar						
Aurepalle	1975/83	18.54**[b] (7.13)	0.25**	0/8	0.16	0.41*
Dokur	1975/79	-6.95 (-1.66)	-0.05	2/4	0.14	-0.11
Sholapur						
Shirapur	1975/83	-13.98** (-4.36)	-0.31**	5/8	0.09	-0.29*
Kalman	1975/79	-1.85 (-1.61)	-0.16	1/4	0.13	-0.14
Akola						
Kanzara	1975/83	3.75 (0.11)	0.11	3/8	0.12	-0.04
Kinkheda	1975/79	-0.45 (-0.62)	-0.02	1/4	0.02	-0.05

[a] Labor use is expressed as man-equivalent hours per hectare of gross cropped land and farm size as operated land (ha).
[b] t values are in parentheses; * and ** indicate statistical significance at the 0.05 and 0.01 levels, respectively.

relationship between farm size and labor intensity is obtained in four of the six study villages. That relationship is most pronounced in the two Sholapur villages, where the elasticity is between -0.2 and -0.3.

Contrary to the doubts of Hayami and Kikuchi (1981), the extent of irrigation plays a dominant role in determining the demand for labor in all six villages, especially in Mahbubnagar and Sholapur, where a 10 percent increase in the proportion of land irrigated leads to a 3 to 6 percent rise in labor use per gross cropped hectare. In the Akola villages, the effect of irrigation on labor demand per hectare was less marked, with elasticities around 0.06. The high labor requirements for cotton, the dominant rainfed crop in Akola, no doubt explains the small size of the irrigation coefficient. Also, irrigated crops like sugarcane in the Sholapur villages and paddy in the Mahbubnagar villages absorb more labor than the irrigated cropping systems of the Akola villages.

Similar interregional variation in the effect of irrigation on labor use intensity was also observed in study villages in Gujarat and Madhya Pradesh in the early 1980s (ICRISAT 1987: 273-275). Rainfall in the Gujarat villages averages about 600 mm and is erratic; in the Madhya Pradesh villages rainfall averages about 1,300 mm and is assured. The

Table 5.3. Estimated labor use intensity elasticities of household resource endowments, by village[a]

Region/ Village	Household Resource Endowment: Farm Size (Operated Area in ha)	Irrigation (%)	Family Workers (N)	Bullocks (N)	$\bar{R}^2$	Observations (N)
Mahbubnagar						
Aurepaile[b]	-0.03	0.39**[d]	-0.11*	0.14**	0.78	289
Dokur[c]	-0.12**	0.57**	0.09	0.002	0.48	141
Sholapur						
Shirapur[b]	-0.21**	0.32**	0.16	0.01	0.54	274
Kalman[c]	-0.31**	0.30**	-0.03	0.18**	0.66	145
Akola						
Kanzara[b]	-0.16**	0.05**	-0.06	0.12**	0.35	291
Kinkheda[c]	-0.04	0.06**	0.03	0.001	0.24	138

[a]Expresses the proportional change in total labor use intensity per hectare of gross cropped area in response to a change in the household's resource endowment. The elasticities are estimated at the arithmetic means of the dependent and independent variables.

[b] Refers to ten cropping years, 1975/76-1984/85.

[c] Refers to five cropping years, 1975/76-1979/80.

[d]* and ** indicate statistical significance at the 0.05 and 0.01 levels, respectively.

estimated response in labor demand to a change in the level of irrigation was much higher in the Gujarat than in the Madhya Pradesh villages.

Irrigation also probably accounts for much of the discrepancy in the estimated farm-size labor use intensity elasticities in tables 5.2 and 5.3. As the simple correlation between the percentage of irrigation and farm size is positive (0.41) in Aurepalle, we expect that therein lies the explanation for the direct relation between size and labor intensity in this village. An inverse relationship between irrigation and size in Shirapur (—0.18) could reinforce the inverse size/labor intensity relationship shown in table 5.2. Similarly, in Kanzara the lack of a size/labor intensity relationship in table 5.2 could stem from the positive correlation (0.32) between irrigation and farm size.

The positive coefficients on bullocks in all six villages are also consistent with the observation in chapter 3 that the bullock hire markets may not be that well developed. Apparently, cropping systems with high draft power requirements are also more intensive in their demand for labor as they act as complementary inputs. Still, bullock availability is not as important as access to irrigation and farm size in conditioning the intensity of crop labor use in most of the villages.

The mixed signs and insignificant coefficients on family work force support the hypothesis that the daily-rated labor markets in these villages work fairly well and are reasonably competitive. Most cultivator households are both buyers and sellers of labor.

The trend of secularly declining farm size documented in chapter 6 can be expected to lead to more labor absorption in these villages, especially in the drought-prone Vertisol districts like Sholapur. Similarly, of the three study regions, the scope for effective land reform to increase labor employment in agriculture would be greatest in Sholapur, particularly if such institutional change was accompanied by investments in irrigation. In the other two regions, agrarian reform would not add appreciably to labor use intensity.

Farm Size and the Composition and Seasonality of Crop Labor Use

In each region, operated farm size and the proportion of family labor used are inversely related. Many members, particularly women and children, of wealthier families drop out of the crop work force. Family labor availability per hectare is also inversely correlated with farm size, contributing to the use of relatively more family labor on small farms. That finding is common in the literature of both Asia and Africa (Rudra and Biswas 1973; Norman 1974).

While small farms hire proportionately less labor than do large farms, the extent of labor hiring by them is by no means insignificant, reaching 58 percent of the total labor use in Akola. That observation is not unique to India's SAT, as small farms hire significant amounts of labor in other regions of India (Rudra and Mukhopadyay 1976). The relationship between hired female labor use and farm size is also similar in all villages: The female/male ratio in the hired labor force rises with increased farm size.

The fortnightly CV of total labor use per hectare within the cropping year is higher on small than on large farms. The variability of per hectare labor use is negatively related to the number of different crops and/or crop mixtures grown on farms. An increase in the number of crops helps in evening out labor demands. Small farmers grew significantly fewer crops than did large farmers in all the study villages.

Trends in Labor Composition and Use Intensity

The share of hired labor in total hours worked was reasonably stable in the study villages until 1980, when it declined sharply (figure 5.2). That fall was contemporaneous with the upturn in real wages during the 1980s reported later in the chapter. Women's share in total labor use did not change appreciably from 1975 to 1985.

Labor use intensity has also changed in some of the villages, significantly increasing for both men and women in Kanzara and declining in Aurepalle (table 5.4). Growth in labor use in Kanzara has been particulary strong, with an annual growth rate of about 5 percent for women and 3 percent for men. Much of that growth undoubtedly stems from shifts to more labor-intensive cropping patterns, particularly from the

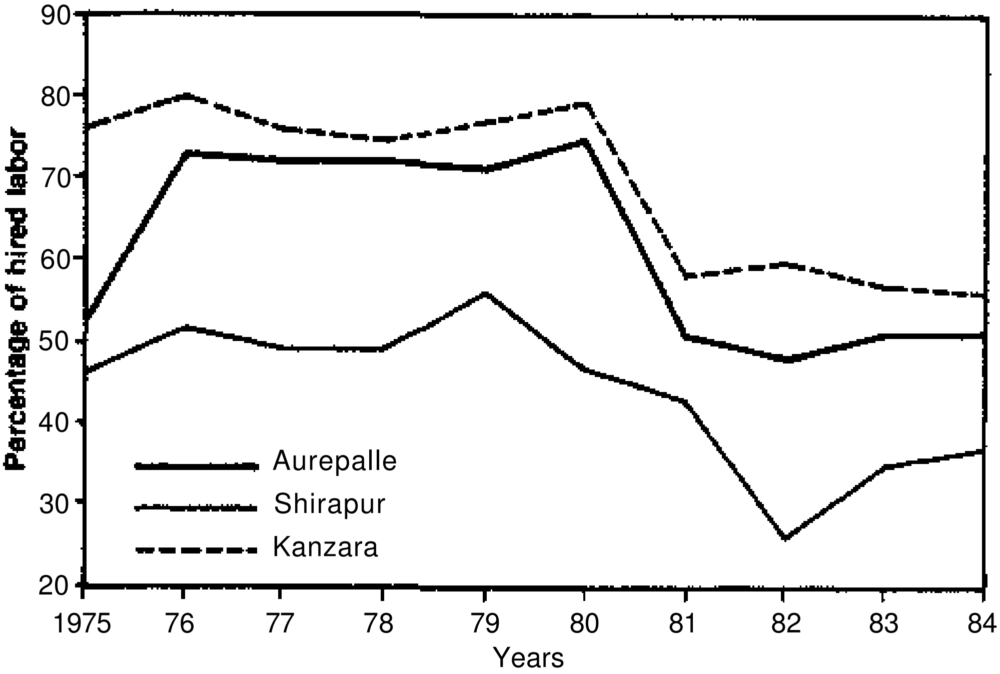


Figure 5.2 Hired labor share in total crop labor use from 1975/76 to 1984/85

substitution of mung bean, intensive in its demand for women's labor for weeding and harvesting, for local sorghum in upland cotton intercropping systems.

The significantly negative trend in table 5.4 for Aurepalle could be the result of two effects. Between 1983 and 1985, annual rainfall was below average. In addition, the supply of labor to the village market has

Table 5.4. Annual trends in crop labor use in three villages, from 1975 to 1983

	Male			*Female*		
Region/ Village	*Trend Coefficient[a] (Hrs/ha)*	*Mean Use[b] (Hrs/ha)*	*CV*	*Trend Coefficient (Hrs/ha)*	*Mean Use (Hrs/ha)*	*CV (%)*
Mahbubnagar						
Aurepalle	-9.22**[d] (-2.78)	192	73	-7.82 (-1.94)	204	83
Sholapur						
Shirapur	-5.29 (-1.35)	176	90	-7.65 (-1.50)	174	119
Akola						
Kanzara	6.99** (2.92)	218	46	14.76** (4.53)	286	49

[a]Coefficient in a regression of labor use per hectare of gross cropped land on a time trend in years.
[b] Expressed in hours per hectare of gross cropped land.
[c]Coefficient of variation around the detrended mean.
[d]t values are in parentheses; ** indicates statistical significance at the 0.01 level.

decreased with attendant increases in real wages, as described later in this chapter. In a tightening labor market, one would expect *ceteris paribus* a substitution of family for hired labor and a fall in labor use, which is what was observed.

Labor Market Parameters and Their Seasonality

In rural areas, problems of seasonal unemployment can be acute (Rudra and Biswas 1973). By examining the timing of the various peaks and slacks in seasonal labor use throughout the year, one can identify strategic periods when apparent underuse of labor exists. Such knowledge could conceivably be capitalized upon in evolving new technology options. Research on improved soil and water management techniques, which entail creation of capital by such operations as land shaping and smoothing, bunding, and excavating reservoirs to store runoff or promote groundwater recharge, figure prominently in dryland agricultural development. Making use of labor for these tasks at times when its opportunity costs are lowest can substantially improve the benefit/cost calculus of such technology options in addition to augmenting incomes of hired laborers. New cropping systems requiring changes in the timing of labor-intensive operations such as sowing, weeding, harvesting, and threshing may also need to allow for existing seasonal labor distributions if they are to be adopted.

Some examples of the likely impact of prospective technologies on labor use patterns in village contexts are discussed in chapter 10. Here we focus on labor market participation, employment probabilities, wages, and labor opportunity costs and their seasonality. Our discussion is based primarily on a detailed within-year study carried out in 1975/76 for the six villages (Ryan, Ghodake, and Sarin 1980; Ryan and Ghodake 1984).

Participation Rates

Average *labor force* participation rates were measured as the proportion of time spent in agricultural and animal husbandry activities on one's own farm, in labor market work, and in seeking employment. Mean estimates across the six villages in 1975/76 were 0.42 for men and 0.40 for women. These compare with average *labor market* participation rates, which exclude own-farm work, of 0.30 for men and 0.37 for women. These estimates seem low and suggest that there is a considerable amount of activity going on besides farm and labor market work in these villages. Our estimates of labor market participation are close to those of 0.24 to 0.46 for women and 0.16 to 0.40 for men estimated by Rajaraman (1982) in three dryland villages in Karnataka. But her figures for labor force participation were considerably higher: 0.92 to 0.94 for women and 0.65 to 0.82 for men.

Women participated in the daily labor market substantially more than men in the Mahbubnagar villages and in Kinkheda. Dokur registered the highest female market participation (0.61) in 1975/76. Even women from large farm households in Dokur worked in the daily labor market, highlighting the influence of paddy irrigation on the demand for female labor. Women's participation was lowest in the Sholapur villages and men's least in the Mahbubnagar villages. These results support Maclachlan's (1983) thesis that women's participation in agricultural work increases as population density rises.

Seasonal variation in participation as measured by CVs was marked. Dokur had the lowest seasonal variation in participation, no doubt because of extensive irrigation, which ensures more continuous labor demand and fewer discouraged workers.

Probabilities of Employment

The probability of employment (PME) in the daily hired labor market (represented by the left branch in figure 5.1) was calculated as the number of days people were successful in obtaining wage employment as a proportion of the days in the period they tried. The probability of involuntary unemployment in the market (PMU = 1 - PME) is not equivalent to the usual measures of unemployment derived from stock concepts that generally include farm-employed or self-employed people in the labor force and are based on data from one-time census or sample surveys (Krishna 1973; Bardhan 1977). PME is a flow concept which can be used to adjust wage rates to indicate opportunity costs of leisure and farm or household work in the context of the new household economics.

The overall average probability of involuntary market unemployment (PMU) for men during 1975/76 was 0.19, while for women the incidence of unemployment was 0.23. The average PMUs for men were 0.12 and 0.39 during peak and slack periods, respectively, while for women the corresponding figures were 0.11 and 0.50. These seasonal ranges are much higher than in the Karnataka villages of Rajaraman (1982). Her estimated seasonal spread ranged from 0.00 to 0.15 for men and 0.01 to 0.19 for women. Our estimates indicate that during peak periods the probabilities of involuntary unemployment for men and women become almost equal; during slack periods the difference increases, affecting female labor employment more adversely.

For comparison with stock measures of unemployment in India, we also calculated probabilities of involuntary unemployment (PU) with person-days of own-farm work included in both the numerator and denominator. First, the probability of labor employment (PE) was estimated; PU = 1 - PE.

Because of the relatively small amount of time devoted to own-farm work in most of these villages, the unemployment rates (PU) did not fall

Table 5.5. Rural unemployment rates from other studies using person-day criteria

		Coverage		Unemployment Rates (%)	
Author (Year)	Data Source	Geographic Area	Time Period	Male	Female
Visaria (1980)	National Sample Survey (NSS)	All-India	1972/73	6.8	7.8
		Maharashtra	1972/73	8.2	12.8
		Maharashtra (Casual laborers only)	1972/73	17.4	21.1
Lipton (1983b)	NSS	Andhra Pradesh	1972/73	8.1	16.3
		Maharashtra	1972/73	7.7	11.7
		All-India	1972/73	6.7	9.9
	NSS	Andhra Pradesh	1977/78	8.7	14.3
		Maharashtra	1977/78	6.2	9.2
		All-India	1977/78	7.6	9.5
Rajaraman (1982)	Village survey data	Karnataka	1979	2.2-6.5	3.3-11.6
Bardhan (1984)	NSS	West Bengal (Casual labor seasonal ranges)	1972/73	8.0-24.0	19.0-44.0

a great deal when we included farm work in the numerator and denominator of PME. The exceptions were men in the Mahbubnagar villages and women in Shirapur, where own-farm work is relatively more significant. On average across the six villages, the PU in 1975/76 was 0.14 for men and 0.21 for women.

In years that were comparable with other studies, which have also used a person-day criterion for measuring unemployment, the incidence of unemployment in the study villages was always greater (table 5.5). On most occasions, the estimated unemployment rates were more than double those found in other studies. Clearly, these SAT villages in general had inferior employment opportunities to the average Indian village and also to the average village in their respective states in the mid-1970s.

The average unemployment estimates showed considerable intervillage variation by gender. In the Sholapur villages and in Kanzara, men had a significantly better chance of obtaining daily market wage employment than women in 1975/76. In Aurepalle, employment prospects for the two sexes were not significantly different. On the other hand, in Dokur and Kinkheda women had significantly better prospects in the daily-rated village labor market than men did.

In Shirapur, not only were women's average probabilities of employment low, but their fluctuation throughout the season was particularly high, with a CV of 37 percent, whereas for males it was much less (12 percent). In Kalman, average employment probabilities for both men and women were substantially better at 0.92 and 0.77, respectively, than in nearby Shirapur. Seasonal variations in Kalman were also less. These intervillage differences in labor market parameters reflect geographic immobility.

The most buoyant daily labor markets are in the two cotton-growing Akola villages. In Kanzara, both men and women succeeded about eight times in ten in finding a job, while in Kinkheda they succeeded nine times in ten. Seasonal fluctuations were not substantial except for Kanzara women, whose CV was 30 percent.

In general in 1975/76, men from labor households had a better chance of being successful in finding daily wage employment relative to their counterparts in the cultivator households. That observation did not hold for women in landless labor households. They experienced proportionately more unemployment than women from farm households. Furthermore, regression analysis showed no significant relationship between farm assets and men's probabilities of involuntary market unemployment, but the incidence of women's involuntary unemployment was significantly and inversely related to wealth in the form of farm assets. Women generally are no better and are often worse off then men with regard to daily labor market employment opportunities, but in addition women from the poorest households, namely the labor group, are often the most disadvantaged.

Wages

Daily wage rates of women over the nine years from 1975 to 1983 have been 57 percent those of men in Aurepalle, Shirapur, and Kanzara. That average wage relative is much lower than the 80 percent figure for thirteen states in India in 1960/61 derived by Rosenzweig (1978) and cited as a common ratio by Lipton (1983b). It seems that SAT environments are less conducive to female labor demand than are the better-endowed Indian regions and/or women are excluded from more of the tasks which offer higher wages.

Judging by the generally low and/or nonsignificant correlations of fortnightly wage rates of males and females during 1975/76 (Ryan and Ghodake 1980), there appears to be considerable segmentation in the male and female labor markets in five of the six villages. Men and women participate in the daily labor market at roughly similar times (correlation coefficients of 0.21 to 0.56), particularly in Aurepalle and in the Sholapur villages. They also experience similar movements (correlation coefficients of 0.59 to 0.95) in their chances of obtaining a job throughout the year (Ryan and Ghodake 1980). In theory, then, one would expect seasonal wage rates of men and women to also move together if women were able to shift in and out of similar tasks to those done by men as their respective wage rates begin to diverge. The extent to which this does not occur in four of the six villages—the simple correlation coefficients ranged between -0.24 to 0.76—is a further indication of the degree of apparent segregation of male and female labor markets. Only in Dokur and Kinkheda were men's and women's intraseasonal wages strongly correlated. We do not know why men's and women's fortnightly wage rates were much more highly correlated in Dokur and Kinkheda than in the other villages. (And as we shall soon see, these within-year findings are at variance with the between-year results.)

Only two operations, harvesting and threshing, are usually performed by both sexes. Women concentrate on five tasks: nursery bed raising, transplanting, planting, weeding, and thinning. Men focus on nine major operations, four of them involving bullock power. In Karnataka, Rajaraman (1982) found that only men had exclusive tasks, six in all. These were plowing, dung transport, well digging, bund making, sugarcane tying, and pesticide application. All other work was done by both sexes, although women dominated operations such as transplanting paddy and hand weeding. Apparently, the incidence of task segmentation varies spatially in India's SAT. Labor markets in Rajaraman's Karnataka study villages clearly exhibited less sex differentiation than in our study villages.

Opportunity Costs

In many instances, one is able to obtain data on seasonal rural market wage rates, but there is no way of knowing how well these identify seasonal opportunity costs, which are at the heart of questions related to labor supply analysis and the value of household production and time. Opportunity cost is defined as the expected wage foregone by a prospective labor market participant when that person works on his or her farm or in his or her household or chooses leisure. It is measured as OC, where $OC_t = W_t \times PME_t$ and W_t = market wage rates in period t. We recognize that OC may not be a good measure of the value of time for farmers who do not participate in the labor market. For them, OC is less than their "reservation wage." This selectivity bias is more important for large farm families whose market participation is generally less than that by small farm families.

The analysis of seasonal opportunity costs using fortnightly data for 1975/76 showed that their CVs were in general higher than those for both daily wages and probabilities of employment. Thus, considerable scope exists for designing technologies which capitalize on periods when labor opportunity costs are low. The periods of the year when opportunity costs are at their highest and lowest vary considerably from region to region, village to village, and year to year. Peak periods are generally associated with such operations as harvesting, threshing, preparatory tillage, transplanting, sowing, and weeding.

Earlier, we reported that the difference in the opportunity cost of labor was one explanation for disparities in labor use intensities between large and small farms. Such differences in opportunity costs are at the core of Sen's (1966) hypothesis of labor market dualism, that the imputed price of labor to small farmers is lower than the actual price of labor to large fanners. To test that hypothesis, we estimated paired t-tests between the fortnightly wage rates of the labor category (by sex) in 1975/76 and the fortnightly opportunity costs of labor from the small-, medium-, and large-sized farms (Ryan and Ghodake 1984). The hypothesis contends that as large farmers are excess demanders of labor their labor cost is the full agricultural wage. Small farmers are excess suppliers of labor and their relevant labor "price" is their opportunity wage.

In the three villages where wages of men from labor households (who we assume would potentially work on large farms) were significantly greater than small farm opportunity labor costs, family male labor use per hectare was significantly greater on small farms than on large farms, as the dualism hypothesis predicts. The evidence for labor market dualism was not as mixed for women. In the six villages, women's mean wages from labor households significantly exceeded the average opportunity cost of female labor in small farm households. Higher involuntary unemployment probabilities for women (particularly those in the drought-prone regions) create larger divergences between their wage rates and opportunity costs. These gaps in turn lead to the more substantial differences we observed between family female labor use per hectare on small and large farms.

A paradox remains, however, for large farm households with some labor market participation. In three of six villages, the fortnightly wage rates of men from landless labor households were significantly higher than the market opportunity labor costs of men from large farm households. For women, that relationship was true for five of the six villages. Hence, those large farms whose members enter the labor market are also faced with higher wage rates for the labor they hire than the opportunity costs of their own family labor. It thus seems clear that the dualistic hypothesis is an oversimplification of the way the labor markets function in these villages.

Dynamics of Wages and Unemployment

The prevailing view based on a large amount of empirical evidence is one of real wage stagnation for agricultural laborers in India in general (Bhattacharya and Roy 1976) and for India's SAT in particular (Rajaraman 1982; Parthasarathy 1987). Because trends in real wages and unemployment are so important in conditioning economic welfare, we devote considerable attention to their documentation and understanding in this subsection. We focus on the two markets within which most of the agricultural work gets done in the villages: the markets for daily rated labor (including contract agricultural labor) and for regular farm servants.

Wages in the Daily-rated Labor Market

From a longer historical perspective, the evidence from the study villages would seem to endorse the consensus view of stagnating real wages. We return to Mann's (1917) study village, Pimpla Soudagar, 250 km northwest of Shirapur with the same mean and CV of rainfall as Shirapur but not as much post-rainy season cropping. In 1915/16, female wages in Pimpla Soudagar were half those of males, which is roughly the same sex-wage differential that exists today. We calculate that, in sorghum equivalents, wages in Pimpla Soudagar ranged from 2.72 to 4.08 kg per day for men and 1.36 to 2.04 kg per day for women. For the nine-year period 1975 to 1983, male wages in Shirapur averaged 3.63 kg of sorghum equivalents and female wages 1.79 kg. Thus between the starting and ending points of this sixty-year period real wages have probably not changed a great deal in this region.

But during the period of analysis from 1975 to 1984, we noticed significant upward movement in nominal wages, not only in Shirapur but also in the other villages. Wages were calculated from labor use data from the plot cultivation schedule described in chapter 2. Annual mean wages were calculated for each operation and then weighted by total hours worked by operation to derive an estimate of a village mean wage by sex. Each annual village by sex wage estimate was based on about six hundred observations.

The nominal wage rises were quite steep, with women's almost quadrupling and men's almost tripling in Aurepalle and Shirapur in the ten-year period and both almost doubling in Kanzara (figure 5.3). When we deflate the nominal wages in figure 5.3 by the village-specific consumer price indices described in chapter 4, each "continuous" village—contrary to the subsistence and efficiency theories of wage determination—experienced some growth in real wages over the study period. Both men's and women's real wages have risen by about 60 percent in Aurepalle from 1975-1978 to 1981-1984. In Shirapur men's real wages rose during the same period by 41 percent and women's by 58 percent. Real wages in Kanzara rose much less—11 percent for men and 19 percent for women—so that by the end of the period gender-specific wage rates in the three villages were relatively closer together than at the start (figure 5.3).

The rise in real wages for both men and women in Aurepalle and Shirapur is statistically significant, but for both genders in Kanzara we cannot reject the hypothesis of real wage stagnation (table 5.6). Ironically, real wages for daily-rated labor have increased most in those villages

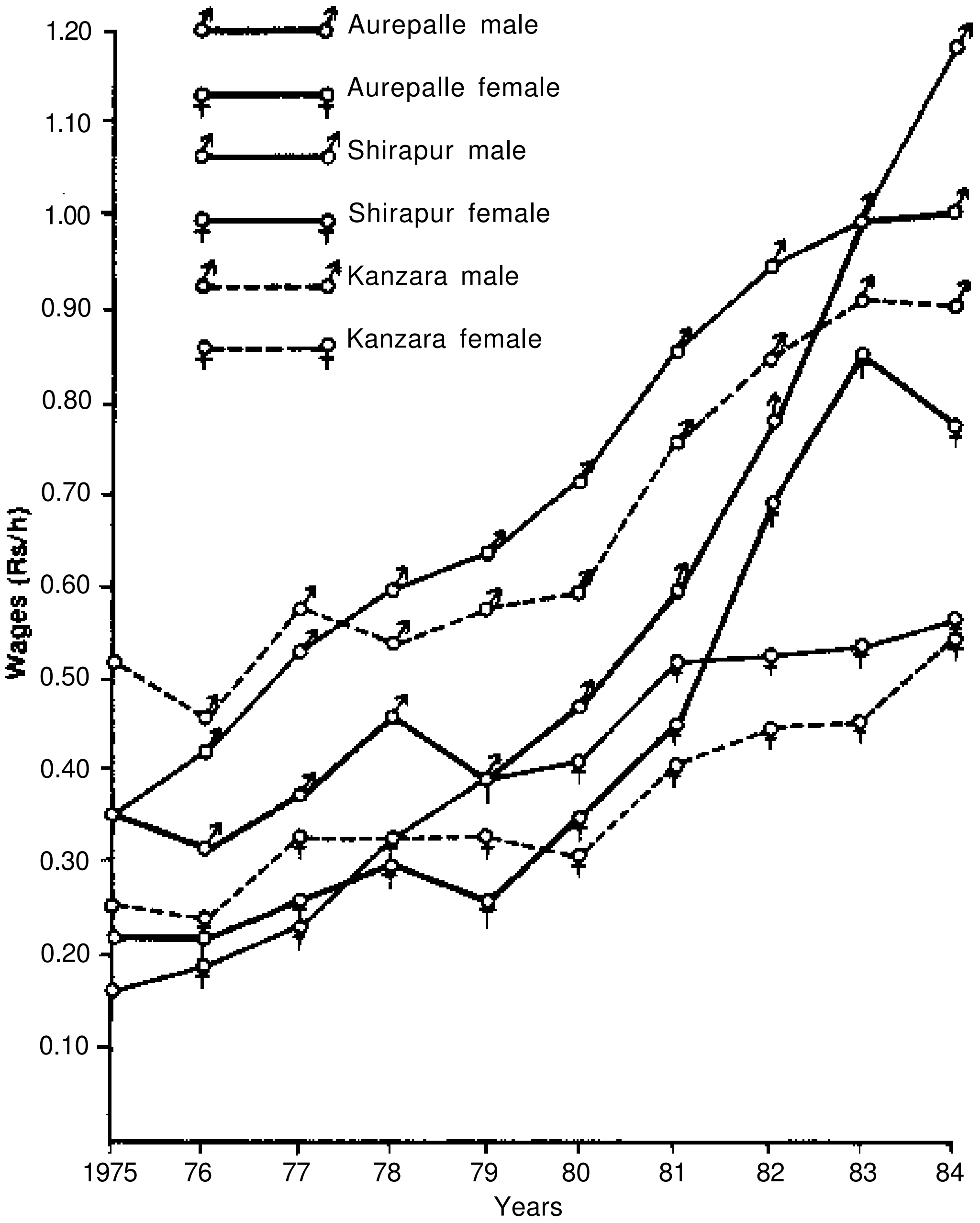


Figure 5.3 Nominal wages by village and sex from 1975/76 to 1983/84

Table 5.6. Linear trend in real wages, by sex and village from 1975/76 to 1983/84

	Region/Village/Sex					
	Mahbubnagar (Aurepalle)		*Sholapur (Shirapur)*		*Akoia (Kanzara)*	
Regression Estimates	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Intercept	0.21	0.10	0.37	0.12	0.47	0.26
Annual trend (Rs/hr)[a]	0.04*[b] (2.51)[c]	0.04** (3.11)	0.04** (6.96)	0.04** (5.50)	0.01 (0.82)	0.003 (0.50)
$\bar{R}^2$	0.40	0.52	0.86	0.79	0.01	0.002

[a]Real wages are expressed in 1975/76 prices.

[b]* and** indicate statistical significance at the 0.05 and 0.01 levels, respectively.

[c]t values are in parentheses.

where the demand for agricultural labor has not increased and risen least in the only village where we have firm evidence (table 5.4) that labor use intensity is increasing over time.

One explanation for these divergent trends in real wages between Aurepalle and Shirapur on the one hand and Kanzara on the other centers on immigration into the village. Few if any landless labor households have permanently immigrated into Aurepalle and Shirapur since 1975, while about twenty such households have moved to Kanzara from nearby areas during the same period. With increasing demand for agricultural labor, the Kanzara labor market has tightened over time, but as we shall soon see tightening has been manifested in better employment prospects and not in higher real wages.

Why real wages have risen in Shirapur is fairly clear. Off-farm labor demand, driven by the Employment Guarantee Scheme and other government-financed local irrigation projects, has sharply increased since the mid-1970s. Increased demand for off-farm labor has undoubtedly translated into upward pressure in the daily-rated casual labor market, particularly for women.

In Aurepalle, explanations for the surge in real wages since 1980 are more complex. Little if any of the rising trend in real wages in Aurepalle can be attributed to changes in on-farm demand. Between 1983 and 1987 Aurepalle and other villages in Mahbubnagar district were in the grip of a prolonged drought, which has decreased the demand for annual crop labor. That decrease has been partially offset by an increase in labor demand from well digging and deepening in response to falling water tables caused by the drought. Overall, the village demand for agricultural labor has not increased to any appreciable extent in Aurepalle and hence cannot explain the recent upward trend in real wages in the village.

Villagers are quick to point to several supply "shifters" that have been responsible for a tightening daily-rated labor market in Aurepalle. Such forces have resulted in significantly decreased participation in the daily-rated labor market. In the mid-1970s, participation was broad-based, as men and women from landless labor, small, and medium farm households from several castes hired out their labor in return for in-kind wages. Now, participation comes mainly from landless labor households, especially those belonging to two Harijan communities, Madigas and Malas. Declining participation is attributed to the following factors:

1. Many erstwhile landless labor households have received small amounts of village land, some of which was not cultivated previously, and (as we shall document later in this chapter) asset ownership is strongly and inversely related to labor market participation,
2. As noted in chapter 3, tapping toddy (palm) trees has become more profitable over time. Members of the Gowda caste, the community

that traditionally practices this profession, are allocating more effort to toddy tapping and have also purchased more land, which further reduces their labor market participation.

3. A few landless labor and small farm households who used to participate in the daily labor market have now become tenants. This new form of tenancy involving joint cultivation of irrigated land is discussed in chapter 6.
4. The toddy tapper story also applies to shepherds. With rising goat and sheep prices, they are increasingly specializing in small ruminant production and spending less time working in the village labor market. Like toddy tappers, they have also bought land in the village.
5. Government welfare schemes designed to stimulate business enterprises among lower caste or "weaker section" households have further reduced incentives to participate in the village labor market. Some of the beneficiaries are engaged in vegetable selling, shopkeeping, and tailoring.
6. Last, and perhaps most important, temporary migration in response to off-farm opportunities, mainly rickshaw pulling and construction work in Hyderabad, has increased considerably since 1983.

Collectively, those six forces have led to a gradual but sustained decline in labor supplied to the village market and a reduction in crop labor use intensity documented earlier. Additionally, more knowledge about and exposure to earning opportunities prevailing outside the village have improved laborers' bargaining position in negotiating wages with large farmers. Laborers feel that wages are higher if negotiated on a contract basis rather than individually for daily-rated work. Contract agricultural work for women's tasks in paddy production is increasing in Aurepalle. Laborers increasingly prefer to work in gangs organized by an intermediary rather than work separately and directly for a large farm employer on daily-rated tasks.

Although we have not systematically collected labor market data in Dokur, Kalman, and Kinkheda since 1978, the story emerging on real wages in those three villages seems to be the same as in Aurepalle, Shirapur, and Kanzara. Again, real wages appear to be rising in the three villages, but we do not know the statistical significance of that trend. The reasons for the upward trend also vary from village to village. In Dokur, stimulated by a heavy investment in well irrigation, real wages probably increased steadily in the late 1970s and early 1980s. More recently, in the mid-1980s, real wages have leveled off and fallen because of drought in Mahbubnagar district. That drought has hurt Dokur much more than Aurepalle. Between 1984 and 1986, rainfall was not sufficient to generate enough runoff to fill the large village tank in Dokur, halving the village's irrigated paddy area.

In Kalman, investment in small irrigated grape vineyards (mentioned in chapter 3) in the early 1980s and greater off-farm labor demand have contributed to upward pressure on wages in the village labor market. The picture on wage trends in Kinkheda is similar to that in Kanzara. Labor intensification within dryland cropping systems and shifting to more labor-intensive cropping systems have increased village labor demand. Somewhat greater access to irrigation has also spurred labor demand; however, we saw earlier that the irrigated cropping patterns in the Mahbubnagar and Sholapur villages are more intensive users of labor than the irrigated cropping systems in the Akola villages. Similar to Kanzara, we doubt that the positive trend in wage levels in the daily-rated market is statistically significant.

Several other aspects of wage dynamics in the study villages deserve to be reported. First, nominal wage trends over time across different operations were highly correlated. Remuneration for harvesting and post-harvest processing often rose most rapidly among tasks in years when marked increases in nominal wages occurred.

Second, the differential in men's and women's wages narrowed significantly over time in Aurepalle and Shirapur, the two villages where real wages for both sexes were rising. With regard to wage parity, women have gained the most in Shirapur, where the equal pay provisions of the state's Employment Guarantee Scheme have undoubtedly indirectly influenced what has happened in the village agricultural labor market.

Third, deviations in real wages from the linear trend estimates in table 5.6 were strongly correlated between the sexes over time at 0.97 in Aurepalle and 0.79 in Kanzara—the two villages where the agricultural labor market is not influenced by locally available public works projects. These remarkably high correlations indicate that, while the village labor market is clearly segmented by sex, the year-to-year fluctuations in wages in those segments are conditioned by the same forces.

In Shirapur, the correlation between men's and women's wage deviations was much lower, at 0.19. The lack of synchrony in the movement of detrended wages between the sexes in Shirapur could be attributed to interyear disparities in off-farm employment opportunities facing male and female laborers. For example, in some years, men were much more in demand for off-farm jobs like carting sand than in other years. Such fluctuations in sex-specific, locally available, off-farm employment opportunities could have reduced the degree to which men's and women's wage deviations were associated.

Last, the within-year variation of agricultural wage rates increased over the period for both sexes in the three villages, especially for women in Aurepalle and men and women in Shirapur. One possible explanation for this trend could be an increase in the use of contract or piece-rate compensation for various operations, with individual variations in productivity being reflected more explicitly in wages. That explanation would apply most to the increasing within-year variation in women's wages in Aurepalle. In Shirapur, seasonality in the increasingly locally available nonfarm employment opportunities near the village probably has accentuated within-year agricultural wage rate dispersion.

Unemployment in the Daily-Rated Labor Market

Estimated market unemployment rates fluctuated much more than real wages during the period of analysis (figure 5.4). Still, the mean village unemployment estimates by sex show a moderate but statistically significant ($P < .10$) declining trend for both men and women in Aurepalle and Kanzara. For those villages, that trend supports the inference of a tightening market for men's and women's agricultural labor.

Several outliers in figure 5.4 require more explanation. For both men and women in Aurepalle, the probability of involuntary market unemployment was highest in 1978/79, an exceedingly wet year which limited access to fields and constrained timeliness in the performance of operations. For instance, in that year we recorded no observations for interculturing, which usually accounts for about 15 percent of total men's crop labor use. Likewise, 1976/77 was a harsh drought year which markedly decreased the demand for agricultural labor in Shirapur.

Unlike village-to-village differences in wages, intervillage disparities in unemployment rates did not change much between 1975 and 1985. Kanzara began the study with the most buoyant labor market and also ended that way because of a substantial decline in unemployment rates, particularly for women, for whom the incidence of unemployment was halved. Recently, unemployment in Kanzara has fallen well below 10 percent. The labor market in Shirapur started as the "thinnest," with the highest unemployment rates, and remained so at the end of the period. Its drought-prone nature, limited irrigation, stagnant technology, and reliance on post-rainy season crops following a rainy season fallow all conspire to limit labor demand. The advent of the effective operation of the MEGS and the related upswing in locally available employment opportunities in canal irrigation construction most likely contributed to the sharp fall in the unemployment rate for both men and women in the late 1970s. Nonetheless, we have no plausible explanations for the sudden rise in unemployment between 1980/81 and 1982/83. An individual examination of employment histories of labor market participants in Shirapur from 1979/80 to 1983/84 also did not shed much light on why the incidence of unemployment was high from 1980/81 to 1982/83 and low in 1979/80 and 1983/84. Days worked off-farm during that period did not decline compared to the earlier period from 1977/78 to 1979/80, when much lower rates of involuntary unemployment were observed.

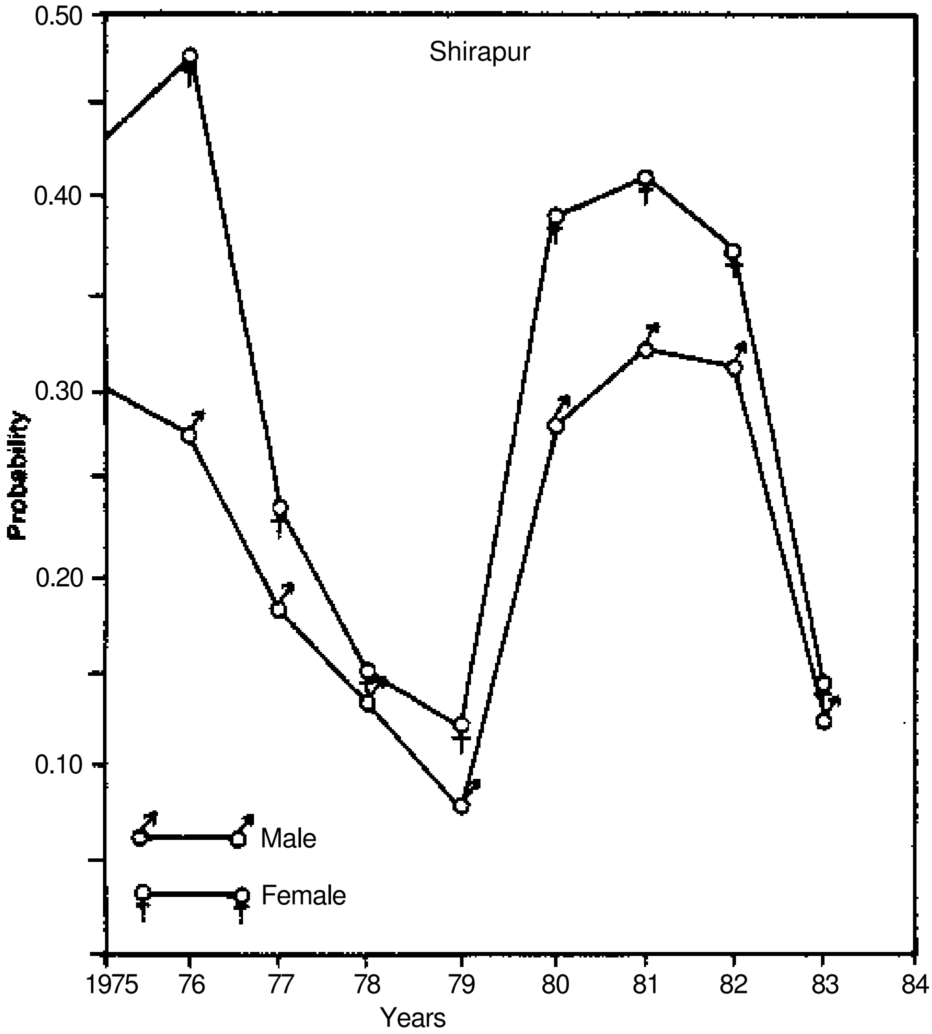
Like wage deviations, deviations from linearly detrended unemployment rates were positively and highly correlated between the sexes within each village from 1975/76 to 1983/84. Estimated correlation coefficients were 0.58 in Aurepalle, 0.96 in Shirapur, and 0.90 in Kanzara. These values are much larger than we expected; they further reinforce the view that climatic variability in India's SAT affects the men's and women's segments of the labor market in roughly the same manner with regard to wage and employment consequences.

Remuneration in the Market for RFSs

Since the 1979 survey on contractural relations in the village labor markets (Binswanger et al. 1984), the market for RFSs has also undergone substantial change. From the laborer's perspective, that change has been for the better. The market for RFSs has tightened in all the villages. Farmers increasingly complain that they are no longer able to hire good quality permanent help.

The poorest paid RFSs still reside in Aurepalle, but even in Aurepalle compensation to RFSs has increased in real terms. The mean monthly payment in paddy has risen by about 20 percent from 45 kg (table 5.1) in 1979 to 55 kg in 1985. Compensation to RFSs has also steadily increased in the Maharashtra villages. In Shirapur, RFSs still received 330 kg of sorghum per annum, but the cash component of their contract had doubled from Rs 75 in 1979/80 to Rs 150 by 1985/86. In Kalman, the cash component has also doubled over those six years, from Rs 100 to Rs 200. In the Akola villages, the mean monthly salary rose from about Rs 110 in 1979/80 to Rs 190 in 1985/86 in Kanzara; comparable figures for Kinkheda were Rs 130 to Rs 210. A large share of those gains was eroded by rising consumer prices, but the relatively flat village consumer price indices (rising gradually from a base of 100 in 1975/76 to a level between 150 and 160 in the early 1980s) suggest that compensation to RFSs has more than kept pace with inflation.

Tightening in the market for RFSs can have widespread consequences for the village markets for land, credit, and draft power. What has happened recently in Shirapur is illustrative. Pressure on the market for RFSs has meant that a tenancy arrangement called angwata has come back into vogue. Large farmers find it preferable to sharecrop their land rather than employ RFSs as plowmen. The landowner supplies and maintains the bullocks; the tenant bears input costs, mainly labor; and output is divided three-quarters to the landowner and one-quarter to the sharecropper. For irrigated crops, the tenant receives a one-third share because out-of-pocket expenses on purchased inputs are greater. Although the tenants accept greater risk and probably less compensation than if they are employed as RFSs, laborers prefer this arrangement because they can be their own boss. In the poorer dryland villages like Shirapur, few farmers can now afford more than one RFS.


Shirapur
Probability
0.50
0.40
0.30
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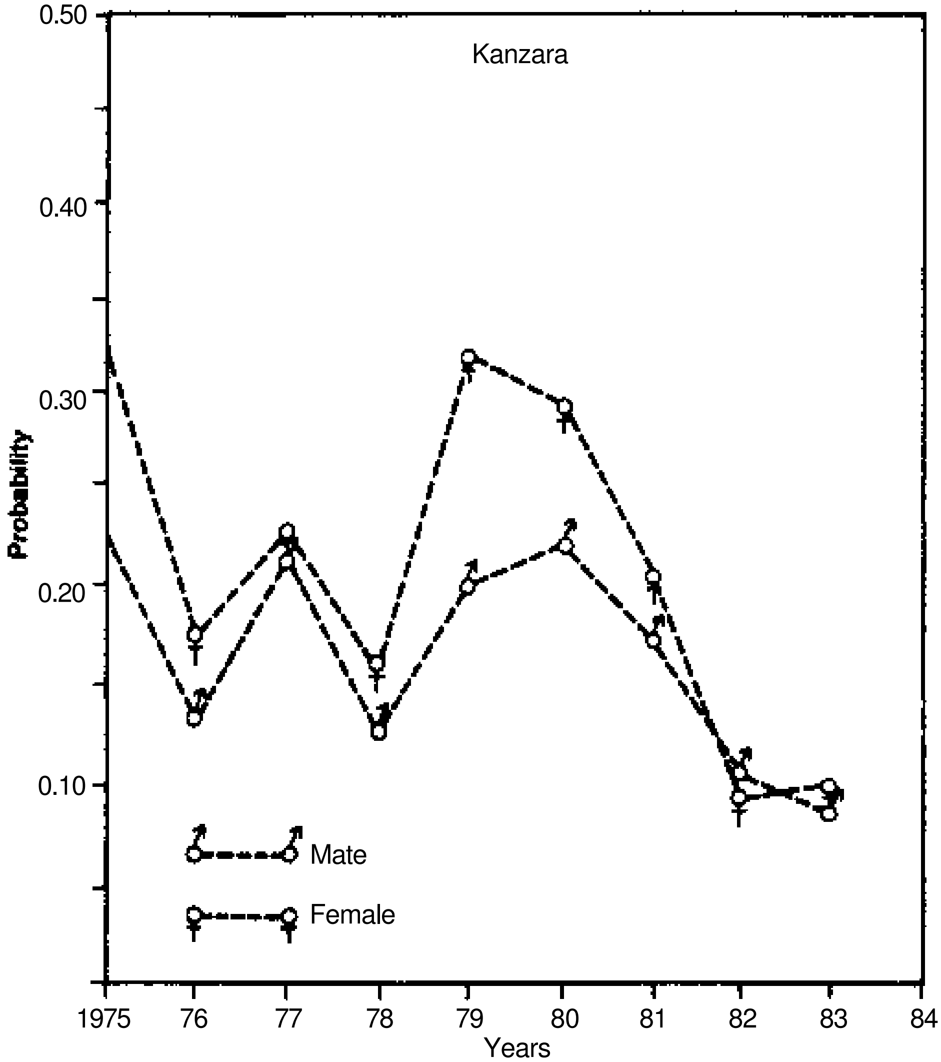
0.10
Male
Female
1975
76
77
78
79
80
81
82
83
84
Years


Kanzara
Probability
0.50
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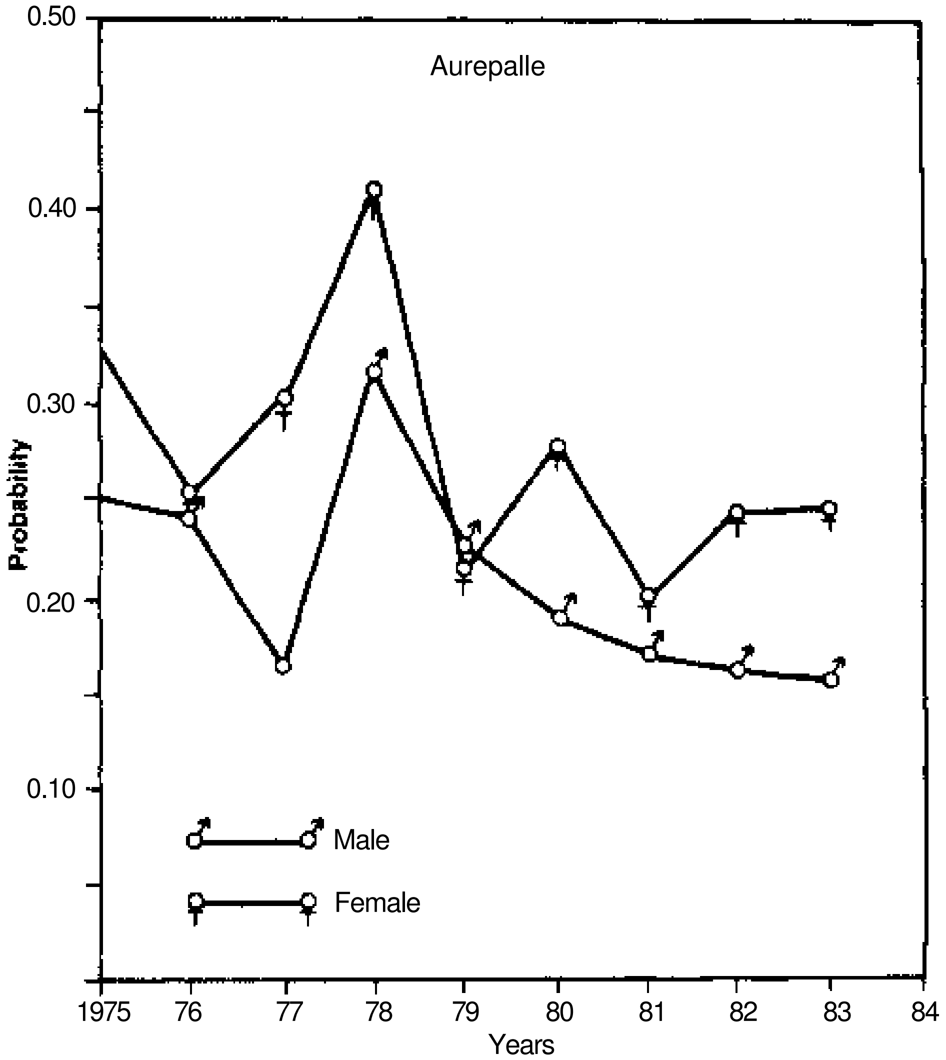


Figure 5.4 (*opposite and above*) Involuntary market unemployment probabilities by village and sex from 1975/76 to 1983/84

Increasingly, entrants into the RFS market in the villages are laborers who cannot do hard manual labor, particularly piece-rate work, or individuals who need a loan and who do not have collateral other than their labor. The loan component in the remuneration of RFSs has loomed larger in recent years. For example, in the Akola villages from 1980/81 to 1982/83, seventy RFS contracts were negotiated by respondent household members, and of these 51 percent included advances averaging Rs 313. The same households from 1983/84 to 1985/86 negotiated only fifty-nine RFS contracts, 73 percent of them involving advances averaging Rs 520.

Rather than work eight to twelve hours a day as an RFS, workers increasingly prefer to participate in the casual labor market, which grants them more freedom in participation, wage, and employment decisions. The incidence and consequences of unemployment are not that severe to make the fixed-term contracts of RFS work attractive. Declining unemployment documented earlier for some villages like Aurepalle and Kanzara raises the opportunity cost of not working in the daily-rated labor market.

Labor Supply Responses

To assess the consequences of technological change on employment and wages requires knowledge of the parameters of the labor market. Unfortunately, empirical studies which estimate labor supply and demand relationships in developing countries are rare. The only published economic research that we are aware of on labor supply for India is work by Rosenzweig (1977, 1978) and Bardhan (1979). Using household survey data for rural India, Rosenzweig (1977) estimated supply elasticities of 2.0 and 0.7 for women from landed and landless households, respectively. For men from both landed and landless households, he found a backward-bending supply curve with an elasticity of - 0.16. Bardhan's (1979) supply elasticity for all adults from landless and small farm families in rural West Bengal was 0.29 and for adult men from the same households 0.20.

In this section, we analyze labor supply responses to changes in wages in the daily-rated labor market. The section is based on Ryan and Wallace (1986), who used data from 1975 to 1978 to estimate labor supply in the six study villages. Their approach features human capital considerations in estimating labor supply. The determinants of wages, of the decision to participate, and of the extent of participation are explained before labor supply elasticities are estimated and applied.

Determinants of Wages

The wages offered to individuals in the daily hired labor markets in these villages are postulated to be endogenous, contrary to the wage determination assumptions in macro labor surplus models (Lewis 1954; Ranis and Fei 1961) that are popular in the economic-development literature. Empirical support for a variable wage model comes from the aforementioned studies of Rosenzweig (1977, 1978).

Ryan and Wallace (1986) used a Mincer (1974) wage function to determine the relative importance of demand and human capital variables on the formation of men's and women's wages in the daily-hired labor market in the six villages from 1975 to 1978. (Extensive F-testing indicated that pooling data across seasons and villages within gender categories was acceptable.)

The variables are described in table 5.7, and the regression estimates are presented in table 5.8. The independent variables come from two sources: human capital attributes and demand influences. Human capital attributes include education, experience, nutritional/health status, and degree of disability. Demand influences consist of seasonality and village by year interactions, which were included to measure effects of factors such as rainfall and its distribution, pest and disease incidence, cropping patterns, off-farm employment opportunities, and product prices on the derived demand for agricultural labor. Such village by year interactions

Table 5.7. Description of variables in the Mincer offer wage equation, the probit analysis of probability of participation, and the analysis of the extent of labor supply and their statistics

	Mean		Standard Deviation	
Description	*Male*	*Female*	*Male*	*Female*
Explanatory Variables:				
Actual weight as proportion of age-sex standard	0.80	0.83	0.12	0.15
Caste dummy = 1 if belongs to highest caste group, 0 otherwise (caste group 1)[a]	0.39	0.38		
Caste dummy = 1 if belongs to second highest group, 0 otherwise (caste group 2)	0.25	0.23		
Caste dummy = 1 if belongs to third highest caste group, 0 otherwise (caste group 3)	0.22	0.22		
Caste dummy = 1 if belongs to lowest caste group, 0 otherwise (caste group 4)	0.14	0.16		
Dummy = 1 if disabled, 0 otherwise	0.03	0.17	—	—
Years of completed schooling as of early 1979	3.67	1.16	4.09	2.58
Age minus years of education minus 8 = experience	21.9	26.6	16.8	15.9
Square of experience	761	961	875	1,016
Dummy = 1 if illiterate, 0 otherwise	0.44	0.78	—	—
Season dummy: peak = 1, slack = 0	0.51	0.52	—	—
Value of operated land + improvements + livestock + implements (Rs. '000) (farm assets)	26.7	26.9	35.1	34.3
Daily nonearnings net income per household (Rs)	1.70	1.67	3.20	2.71
Dependent variables:				
Natural logarithm of average daily wages during period	1.22	0.64	0.27	0.24
Participation dummy: in probit = 1 if a participant in a period, 0 otherwise	0.37	0.56	–	—
Participation rate of participants: Proportion of period worked or searched for an off-farm job	0.54	0.58	0.30	0.28

[a]Dummy variable dropped in regressions to avoid singularity in the [X'X] matrix.

could also capture the effect of itinerant agricultural labor coming into the villages for work. Caste was also included to test the hypothesis of wage discrimination within these rural daily labor markets.

In general, the equations for men and women in table 5.8 show that human capital variables such as education, experience, and nutritional well-being are important considerations that explain variations in daily wages paid to men. However, individual human capital attributes were not as important as demand factors, such as the type of season and village characteristics, in explaining wages of women. These results differ considerably from Rosenzweig's. In his study, wages were not found to be importantly affected by human capital attributes embodied in individual participants in the nonsalaried, private-sector occupations characterizing rural labor markets in India. Human capital effects were strongly outweighed by geographical demand factors, especially for females, suggesting that labor is not very geographically mobile in rural India.

There would appear to be a higher immediate payoff in these Indian villages to investments in improving men's nutrition as measured by weight-for-age than to investments in enhancing their education, if they remain occupationally immobile. The elasticity of wages with respect to years of education of males is only 0.02; the weight-for-age elasticity is 0.32. Only if increased education of males leads to a change in the type of labor market in which they seek employment would it be likely that more education would have a higher return than improved nutrition.

The low returns to education in the daily labor market of 0.8 percent for men and 1.2 percent for women are not surprising. They are the same order of magnitude found by Rosenzweig (1977) in northern India. Only when educated people move to salaried positions and self-employment would one expect to discern higher returns to their education. Women's average education was 1.3 years, while men's was 3.6 years. The fact that we observe upward secular trends in schooling described in chapter 3 for both males and females in these villages suggests both genders perceive there are returns to education, although not in the casual daily labor market.

Introducing improved agricultural technology options, which place a premium on education to reap their potential rewards, could provide a means of enhancing the rates of return to education. For instance, one recommended technique in integrated pest management that has been statistically linked to education in one region of India's SAT is the adoption of economic thresholds on when to spray to control pest infestation (Mueller, Kshirsagar, and Pawar 1986). But returns to more timely spraying accrue to management unless workers can significantly influence such decisions.

If the returns in higher wages to the improved nutrition of men are as high as suggested by the results of this study and are virtually non-

Table 5.8. Wage functions for adults in the six study villages, 1975 to 1978[a]

Variables	*Male*	*Female*
Intercept	0.69**[b]	0.29**
	(8.23)	(5.45)
Weight-for-age	0.40**	0.05
	(5.33)	(1.41)
If Caste 2	0.03	-0.008
	(0.83)	(-0.38)
If Caste 3	-0.003	0.007
	(-0.10)	(0.32)
If Caste 4	-0.05	0.02
	(-1.44)	(0.72)
If unable to do hard field work	-0.12	-0.09**
	(-0.64)	(-3.09)
Education in years	0.83×10^{-2}	1.17×10^{-2}
	(1.68)	(1.93)
Years of experience	1.00×10^{-2}**	0.14×10^{-2}
	(4.95)	(0.97)
Years of experience^2	-1.75×10^{-4}**	-0.26×10^{-4}**
	(-4.72)	(-1.35)
If illiterate	-0.04	0.05
	(-1.60)	(1.68)
If "peak" season	0.03	0.08**
	(1.82)	(6.04)
Inverse Mill's ratio[c]	0.03	0.11**
	(0.82)	(3.93)
R^2	0.38	0.51
N	762	1,024
SSE	33.24	30.35
F ratio	16.41	38.61

[a]Wages are expressed as the natural logarithm of Rs/day. In addition to the variables shown in the table, variables representing (village x agricultural year) dummies were included. Eleven of the sixteen were significant at the 5% level in the male equation and thirteen in the female. These coefficients are not included in the table due to space limitations.

[b]t values are in parentheses. * and ** indicate statistical significance at the 0.05 and 0.01 levels, respectively.

[c] Refers to a variable to correct for the possibility of sample selectivity bias inherent in the fact that the wage equations can only be estimated using data from market participants. For nonparticipants there are no observations on offer wages. See Heckman (1974).

existent for women, this may provide a partial rationalization for men receiving first priority in the intrahousehold allocation of food. The frequent failure of special nutrition programs aimed at the nutritionally vulnerable groups, such as preschool children and pregnant and lactating women, may be a result of the diversion of the added food supplies to male household members in order to generate increased wage income. If this is true, it implies that targeted nutrition programs may not succeed in the short term unless adult males are also included.

The wage premium to men with greater weight-for-age is also consistent with the evidence cited by Maclachlan (1983) of the importance of male strength in village agriculture in South India. He cites medical data which show isometric muscle strength and aerobic work capacity of women is 60 to 75 percent that of men of the same age. Such differences lead to the clear gender segmentation of tasks, which is accepted by all members of the village, with men responsible for the more physically demanding tasks such as digging with a hand hoe/crowbar and plowing with bullocks.

We have calculated that the additional wages which would be needed to be earned by a man sturdy enough to undertake heavy work requiring consumption of 3,900 kcal per day, versus the sedentary requirement of 2,400 kcal, would have to be about Rs 0.53 per day (in 1977 prices) to purchase sufficient sorghum to provide the extra calories. Using the weight-for-age coefficient in table 5.8, that man would need to attain a weight-for-age about four standard deviations higher than average (1.22 versus 0.80 in table 5.7) to earn enough just to pay for the added energy required for the more arduous tasks. These weight-for-age premiums for men could hardly be considered discriminatory if it is accepted that men require additional food purchases to meet higher energy demands of the tasks with wage premiums.

In the three Karnataka villages studied by Rajaraman (1982), full-day contracts involving provision of two cooked meals, one in the morning and one in the evening, were almost always only awarded to men. Additionally, such contracts were for the six exclusively male tasks which require considerable strength. Apparently, employers in these Karnataka villages also recognize there are productivity effects from enhancing the nutritional status of men for certain tasks but not of women. That recognition is expressed differently from the ICRISAT study villages in Andhra Pradesh and Maharashtra, where we never observed daily wage payments in the form of cooked meals.

Using weight-for-height as the measure of short-run or transitory health status, Deolalikar (1986b) also found that in the same villages the market wage premium for enhanced health of workers was about the same as farm family members' marginal value product estimated from a production function approach. His estimated elasticities of the effect weight-for-height of family workers has on farm productivity was very high, ranging from 2.0 to 4.2. (More transitory nutritional measures, such as caloric status, or more permanent anthropometric measures, such as height-for-age, reflecting cumulative health status, were not significantly associated with men's or women's wages [Deolalikar 1986b; Ryan and Wallace 1985].) From these results, there seems to be some evidence in these villages of a relationship between nutritional status and worker productivity that is reflected in men's wages and in farm production.

The mechanisms through which this relationship operates are still not clear. Wage uniformity for a given operation, season, and sex is the rule rather than the exception, so better anthropometric status does not directly translate into higher daily wages unless remuneration for tasks is on a piece-rate basis. Apparently, men with superior anthropometric status select themselves or are selected for the more strenuous, higher wage tasks, while men with lower weight-for-age proportionately are overrepresented in the lower wage, less arduous activities. Survey information from Shirapur and Kanzara on who participates in the Employment Guarantee Scheme can be offered as corroborating evidence for that explanation. Some village laborers, who are often involuntarily unemployed, do not participate in the EGS because they are not physically able to do hard piece-rate work demanded in those projects.

Demand influences were more powerful than human capital considerations in explaining the variation in women's wages. Seasonality had a greater effect on women's wages than on men's wages, but its size was not large, probably owing to the degree of aggregation (several months) involved in creating the seasonal wage variables. As Ryan, Ghodaker, and Sarin (1980) point out, wage peaks are short-lived, often lasting less than a fortnight.

The village by agricultural year interactions explained a substantial portion of the variation in wages (footnote a, table 5.8). The average absolute size of these coefficients for women (0.29) was almost twice that of men (0.15). Variables comprising demand, including these village by year dummies, exert a more significant effect on female than on male wages, again suggesting the relative geographical immobility of women's labor.

Based on the village dummy variables, Kalman had the lowest wage rates during 1975 to 1978 (labor intensive grape gardens were introduced later), *ceteris paribus* the individual characteristics of participants. Kalman is in a drought-prone area with diverse soils, and is somewhat remote from major towns and markets, and it has poor road access and a limited extent of government employment projects. In Shirapur, women's wages were 20 percent higher and men's 11 percent than in Kalman. In contrast to Kalman, Shirapur had extensive and sustained government works projects nearby. Shirapur is also endowed with better soils and is more proximate to town markets. While there may be some expectation of wage differentials between villages like Shirapur and Kalman, which although in the same district are some 30 km apart, Rajaraman (1982) found that in three contiguous study villages in Karnataka wage rates differed even on the same day.

Finally, the castes to which workers belong did not have much bearing on the wages they received. We hence infer that wage discrimination in the daily-rated labor market is not significant.

Determinants of Labor Market Participation

The decision to participate in the hired daily-rated labor market, as determined from a probit analysis (table 5.9), is primarily influenced by nutritional status, health, wealth, nonearnings income, education, and caste (Ryan and Wallace 1986). Many of the determinants are the same as in the preceding discussion on the determinants of wage variation.

Women who are adequately nourished (100 percent of the weight-for-age standard) have a probability of participation (POP) as calculated from the probit, which is 0.05 higher than those who have average levels of nutrition (84 percent of standard). For men, nutritional status has little effect on their POP, both statistically and numerically. We know from the wage function that this weight-for-age index had no effect on the wages of women, but it had a marked impact on men. Hence, the present result seems contradictory. In theory, we would have expected this variable to have had either a small negative influence or none on the POP for women, but a substantial positive effect for men. Apparently, better health status for women reduces their reservation wage and hence increases their POP, even with no change in the offer wage. For men, an increase in weight-for-age raises reservation wages and largely offsets the effect of the index on participation via offer wages.

Having a disability which prevents hard physical activity virtually precludes male participation in the labor market (i.e., almost a 100 percent reduction). For females, the decrement in POP is of the same order of magnitude as for men but represents only a 50 percent reduction in their overall POP. In other words, a disabled woman still has a POP of 0.34 if she is average in other respects.

Lipton (1983b) hypothesizes that overall participation rates in India are reduced 5 to 6 percent due to illness. Our results indicate that disabilities have a more substantial effect on decisions to participate than Lipton suggests. The analysis in the next subsection of the extent of participation showed that men with physical disabilities who do participate will do so for only 11 percent of the time compared to 56 percent for able-bodied participant males—a reduction of forty-five percentage points. On the other hand, physically disabled females who participate only reduce their participation from 58 percentage points to 55 percent, a reduction of 3 percentage points compared to able-bodied females.

Education has a weak negative influence on the POP of both men and women. Even though education was shown to marginally increase wage offers, it is clearly not sufficient to compensate for the value of education either in other occupations or in farm/household production.

The elasticity of the probability of participation with respect to the value of farm assets was -0.61 for men and -0.37 for women. These elasticities are the major explanation for the relatively low probabilities of participation for men from large and relatively affluent farm households

Table 5.9. Determinants of the probability of participation by adults in the daily hired labor market in six villages, 1975 to 1978, using a probit function

	Males		*Females*	
Variables Affecting Participation	*Initial Probability**	*Changes in Probability*[b]	*Initial Probability*	*Changes in Probability*
Continuous				
Weight-for-age index	0.30	-0.06	0.57	0.34**
Education in years	0.30	-0.01**	0.57	-0.03*
Years of experience[c]	0.32	-0.00*	0.56	-0.00
Value of household farm assets (Rs '000)	0.30	-0.07**	0.57	-0.08**
Nonearnings income per household (Rs/day)[d]	0.30	-0.01**	0.57	-0.01**
Discrete				
If Caste 2	0.25	0.15**	0.51	0.05
If Caste 3	0.25	0.08	0.51	0.06
If Caste 4	0.25	0.13*	0.51	0.23**
If unable to do hard field work	0.31	-0.27**	0.62	-0.28**
If illiterate	0.27	0.07	0.60	-0.04
If "peak" season	0.29	0.02	0.55	0.04

[a] Probability at mean level of variables other than when considering the dummies of interest, which are set to zero. The (village x year) dummies have not been included here.

[b]When continuous variables are increased by one unit (i.e., partial derivative of the probit probability) and dummies are set to a value of one after the initial probability has been estimated with the dummies of interest set to zero instead of at their mean levels in the data.

[c]This had both linear and quadratic terms in the probit. Before calculating the partial derivative of the probability function the mean of the linear term was used in the quadratic term.

[d] Excludes farm income and wages.

[e]* and ** signify that the coefficient in the probit used to derive the change in probability was significant at the 0.05 and 0.01 levels, respectively.

rather than their caste status per se. Indeed, those men from the second to highest caste group had a significantly higher participation probability than any other caste group. Caste plays a more dominant role for women; the lowest caste women participate much more than others.

As we shall see in the next chapter, average farm size had halved between 1950 and 1982 for the panel households owning land in 1950. The asset elasticities derived above suggest that labor market participation by landowning families, who experienced such declines, may have increased by up to 31 percent for men and 19 percent for women as a result of the secular reduction in farm size. This calculation assumes the rupee value of land assets changed in the same proportion as farm size and that other influences on participation remained the same. Of course, there would be an offsetting effect for those such as the landless who acquired land during the same period. The net result is unclear, although the village wage trends suggest these other influences have more than offset the farm-size effect and led to increases in village real wages.

Nonearnings income of the household, derived from sources other than the farm or from wage market earnings, significantly reduced the POP of adults. Expressed in elasticity form, the effect on men (-0.08) is double that on women (-0.04). In both cases, this presumably transitory income effect is overwhelmed by the size of the more permanent income effect of farm assets.

Men in the Mahbubnagar villages where irrigated rice is an important crop have a significantly lower POP than those in the Maharashtra villages. Men in Shirapur have a significantly higher POP than those in other villages. Recall that Sholapur is a drought-prone region with little irrigation and a cropping pattern involving a rainy season fallow followed by post-rainy season crops of sorghum, chick-pea, and safflower. The demand for crop labor per hectare under such a system is much less than in the other four villages. Resort to the daily labor market is necessary for the sustenance of many cultivator households and is reflected in the higher POP.

For women, the tabular comparisons in Ryan and Ghodake (1984) essentially held up in the probit analysis. Women from Dokur had the highest POP, undoubtedly induced by greater access to employment conferred by the comparatively large area under irrigation.

Determinants of the Extent of Labor Market Participation

Having analyzed the determinants of wages and labor market participation, the Mincer econometric recipe for estimating labor supply calls for one more ingredient: an understanding of what contributes to the variation in days worked (the participation rate) among labor market participants (Ryan and Wallace 1986). Using a logistic regression analysis, Ryan and Wallace found that increased earnings from sources other than wages and farm work significantly reduce the participation rate of men who worked in the daily-rated labor market in these villages (table 5.10). Nevertheless, the elasticity of this effect was quite low at -0.04. Thus, for men, leisure is a normal good with an income elasticity of demand of 0.04, whereas for women the income elasticity is essentially 0. More educated men worked significantly fewer days in the market (an elasticity around -0.10), thereby reinforcing the effect of education on reducing participation. More educated women did not have fewer days of market work, although education had a much greater effect on reducing their POP than for men. Women from the second to the highest and from the lowest caste groups worked significantly more days in the labor market than others. Caste had no influence on men's days worked.

The village dummy contrasts indicated that male and female market participants in Aurepalle consistently worked more days per season than

Table 5.10. Determinants of labor supply in six villages[a]

Variables	*Males*	*Females*
Intercept		-0.61
	(-1.96)[b]	(0.97)
Farm assets	-1.84×10^{-6}	-2.12×10^{-5}**
	(-2.30)	(-3.25)
Natural log of daily wages	3.29**	2.56*
(predicted)	(3.03)	(2.03)
If Caste 2	-0.14	0.47**
	(-0.56)	(267)
If Caste 3	-0.34	0.10
	(-1.37)	(0.63)
If Caste 4	0.29	0.42*
	(102)	(2.20)
If unable to do hard field work	-1.32	-0.39
	(-1.17)	(-1.37)
Education in years	-0.08**	0.03
	(-3.39)	(0.75)
Daily noneamings income per	-0.05*	0.02
household	(-2.32)	(1.02)
Inverse Mill's ratio (lamda)	-0.32	-1.24
	(-0.61)	(-0.51)
$\bar{R}^2$	0.11	0.17
N	739	1,013
SSE	2,586	2,209
F ratio	3.46	8.23

[a]In addition to the variables shown in the table, variables representing (village x agricultural year) dummies were included. Four of the sixteen were significant at the 5% level for males and eight of the sixteen for females.

[b]t values are in parentheses. * and ** indicate statistical significance at the 0.05 and 0.01 levels, respectively.

those from any of the other villages, in spite of their POP being the lowest of all villages. Apparently, participants in the labor market in Aurepalle are more specialized than elsewhere. As discussed in the section on real wage dynamics, that specialization appears to be increasing over time and is a consequence of the marked reduction in participation rates of several communities, including toddy tappers and shepherds.

Labor Supply Estimates

The short-run elasticities of labor supply with respect to real daily wages in these six villages were estimated by Ryan and Wallace (1986) as 1.52 for men and 1.08 for women. The male elasticity is higher than Rosenzweig's (1977) estimate but the female elasticity is comparable. Both are larger than Bardhan's (1979) estimates.

Adjusting the previously derived supply elasticity for male labor for the effect of income on days worked leads to an income-compensated elasticity of male labor supply of 1.48; for women the income-compensation effect was even less than for men. Thus, contrary to Rosenzweig (1977), little support is provided for the notion of a backward-bending supply curve of labor for either men or women.

These labor supply estimates lead to the inference that with shifts in labor demand, women's wages will be more volatile than men's but that their market employment will fluctuate less. This inference is borne out by the average intrayear CV of 67 percent for women's wages during the period 1975 to 1978 compared to 39 percent for men. The CV for participation was 48 percent for women and 56 percent for men.

Labor Supply and Technical Change

Much of the agricultural research being conducted in the semi-arid tropics of India aims at developing land-saving/labor-using technology choices, reflecting the region's relative factor endowments. This approach is expected to lead to cost-effective technology options which will, at the same time, help alleviate unemployment and enhance the wages and incomes of rural poor, who rely largely on wage earnings for their livelihood. Some prospective technologies for the rainfall-assured, Vertisol (black-soil) regions of semi-arid tropical India show promise of increasing labor requirements per hectare between 40 to 260 percent (Ryan, Ghodake, and Sarin 1980; Ryan, Virmani, and Swindale 1982; Ghodake and Kshirsagar 1983). Using the derived supply elasticities of 1.52 for men and 1.08 for women, the effects of a 50 percent increase in effective labor demand from such technological change on a representative household are to increase wage rates of males by 33 percent and those of females by 46 percent (table 5.11). Annual household market labor earnings rise by about 160 percent from Rs 1,700 to Rs 4,400. Total household income would increase by 63 percent from Rs 4,300 to Rs 7,000 per year, assuming income from other sources (crops, livestock, etc.) does not change. These results suggest that for a typical family of eight people with four regular labor market participants in these Indian villages, the elasticity of household labor earnings with respect to this labor demand shift is 3.2. The equivalent elasticity of total household net income is 1.3. The magnitude of these parameters illustrates the potential that programs aimed at creating employment can have on the welfare of low-income households, especially those that rely on wage earnings for their livelihood.

Of course, these effects could be short-lived. They would be mitigated to an extent by migration of labor from other regions to capitalize on any wage premiums. If these higher wages held up over a longer time horizon, the incentives for selective mechanization would sharpen during those periods and for those operations where labor bottlenecks are most severe. Additionally, prospective dryland technology options in a high potential production environment are unique in one important aspect: They add three months to the crowing season and hence are less con-

Table 5.11. Scenario analysis of effect of increased labor demand on labor market participation, wages, labor, and household incomes for a representative household

Variables	*Existing Situation 1975-78*	*After 50% Increase in Effective Labor Demand*
Average family size	8.37	8.37
Labor market participants *(N)*		
Men	2	2
Women	2	2
Participation rates		
Men	0.54 (0.44)[a]	0.81
Women	0.58 (0.45)	*0.87*
Wage rates (Rs/day)		
Men	3.39	4.50
Women	1.90	2.78
Household labor income[b]		
Men	1,089	2,661
Women	624	1,766
Total	1,713	4,427
Total household net income (Rs/year)	4,300	7,014

[a] Figures in parentheses are the participation rates adjusted for the probabilities of market employment of 0.81 for men and 0.77 for women, respectively. It is assumed there is no resultant unemployment after the increased labor demand.

[b] The source for the household income data is chapter 4.

strained by an inelastic aggregate supply, which limits the scope for labor absorption from investments in the agricultural sector (Binswanger and Quizon 1986). We return to analysis of these technological options in chapter 10 and comment on where they fit into the prospects for labor absorption in dryland agriculture in India's SAT in chapter 11.

Conclusions

Returning to the major theme posed at the outset of this chapter, the labor markets in the six study villages are reasonably competitive and responsive to the forces of supply and demand. Rising real wages in Aurepalle is perhaps the most salient example of that response. Several econometric models (Bardhan 1984; Evenson and Binswanger 1984; Rosenzweig 1984) based on a supply and demand framework predict that reductions in labor supplied will significantly increase agricultural wages-just what happened in Aurepalle in the early 1980s.

Rising real wages derived from tightening in the labor market for daily-rated workers and RFSs in Aurepalle and Shirapur are also inconsistent with the notion of an institutionally fixed rigid wage assumed by macro labor surplus models. Because most cultivator households sold their own labor as well as bought others' labor, these labor markets were not characterized by extreme dualism, with large farmers the exclusive buyers of labor and all others the sole sellers.

By and large, nominal wages for specific operations were downwardly inflexible over years within a village. We did, however, observe one instance (in Dokur in response to a steep shortfall in demand for labor caused by a drought in the mid-1980s) when nominal women's wages for some operations fell suddenly from their previous year's level. Differences in piece rates paid in harvesting sorghum in Kanzara between 1985/86 and 1986/87 was another such case. In October 1985, in response to a newly initiated public works project which sharply increased the demand for wage labor, the piece rate for sorghum harvesting shot up to 96 kg per acre. When that demand subsided in 1986 the piece rate returned to its earlier level of 64 to 72 kg per acre. Also, we noted some occasions when wage rates changed several times within the same village on the same day. Again, in Kanzara we observed four different wage offers within the same day for the harvest of mung bean. Unseasonally heavy rainfall in August 1983 greatly accentuated the need for a timely harvest. During one day in the peak harvesting week, drums in the village sounded four times, signaling consecutive raises in the piece rates offered by different employers from Rs .20 to .30 to .35 to .40 per kg of pod harvested.

Labor market tightening was not accompanied by pronounced changes in contractual relations. We were able to document only two cases where contractual terms had markedly changed. The importance of short-term contract work—the right branch of the casual labor market in figure 5.1—in hiring groups of women for agricultural operations is gradually increasing in some of the villages like Aurepalle. A tightening labor market has undoubtedly improved laborers' bargaining position, which probably accounts for the moderate increase in short-term contract work relative to daily-rated employment in Aurepalle. Remuneration in food is also declining in importance in RFS contracts in Kalman. Presumably, the survival motive does not loom as large in such contracts as it once did.

The tightening labor market has also had some repercussions in other village factor markets. In Shirapur, the supply of tenancies has increased because large farmers have found it more profitable to sharecrop out their land than to cultivate land with RFSs. Although they are exposed to more risk, prospective RFSs prefer being sharecroppers because this arrangement grants them more autonomy in decision making and freedom from their erstwhile employers.

By the mid-1980s, all the village labor markets were free of effective oligopsonistic power. That is not to say that large farmers did not try to fix wages. They did, but they were only successful in Aurepalle in the market for RFSs. As the labor market has tightened in that village, the bargaining strength of RFSs has increased and they have been able to negotiate on at least two occasions since 1975 a significant increase in monthly in-kind payments, which is their main form of remuneration.

Still, the village labor markets deviate substantially from a perfectly competitive norm. They are insular and strongly segmented by gender. Geographic and occupational (sectoral) immobility restrict women laborers' potential contribution to household welfare. Also, and although patron-client relationships are for the most part absent, we have documented the presence of moral effects. Again, in Dokur during the drought in the mid-1980s, large households readily provided consumption loans and gifts in kind to landless labor households to maintain the village work force (Bidinger, Nag, and Babu 1986a). They also in some cases opened up harvesting to anyone who needed work in the village. As many as ninety workers on one occasion showed up to harvest a small irrigated plot of groundnut (B. Nag, personal communication). Part of the large farmers' benevolence is probably derived from the rapid expansion in private well irrigation in the late 1970s and early 1980s. Increased investment in dug wells stimulated the demand for agricultural labor. Farmers realized that they needed a stable village work force to make those investments attractive, as laborers have the alternative of temporary migration for off-farm contract work (Bidinger, Nag, and Babu 1986a).

It is probably too early to tell whether the rising wages documented in this chapter are part of a longer-term upward trend or only a large blimp in a historical picture of real wage stagnancy. At least we can say that real wages have not declined from 1975 to 1985 in the study villages.

Some recent research also supports the story of labor market tightening. For instance, resurveys of villages in SAT North Arcot district in Tamil Nadu have shown a rise in real wages between 1973/74 and 1982 to 1984 (Harriss 1986; Ramasamy et al. 1986). In a recent and comprehensive survey of trends in rural poverty, Parthasarathy (1987) reported mixed results on movements in real agricultural wages from 1975 to 1986. Based on data from *Agricultural Situation in India* on wages paid to men for sowing and harvesting, real wages to agricultural labor were rising in some states and stagnant in others.

Looking into the future, an upward trend in real wages may be difficult to sustain in some of the villages. For example, in the vicinity of Shirapur, the scope for incremental and economically desirable public works projects, while not exhausted, is becoming more limited. Also, in Dokur the foundation for the expansion in labor demand has been based on the increased exploitation of a renewable, but captive, resource: groundwater.

The dynamics of the village labor market bring home several other important messages. First, technical change in these dryland agricultural villages is not a sine qua non for rising real wage rates to obtain. In rainfall-unassured villages like Shirapur and Aurepalle, changes in off-farm employment opportunities will likely play a larger role in conditioning wage levels and contractual relations than opportunities for agricultural employment within the village. In this sense, the essential linkage between a research and development strategy focused on the agricultural sector and one which stresses employment creation in India would seem more relevant to assured SAT regions such as Akola than to rainfall-unassured regions such as Mahbubnagar and Sholapur.

Second, a slow to moderate rising food price index contributed to the positive real wage trends in the villages. During the study period, policies of food grain self-sufficiency, domestic absorption, and public sector procurement favored consumers (Binswanger and Quizon 1986) and set the stage for increases in nominal wages to express themselves in increments in real wages.

Third, although the economics of public-sector employment programs or subsidies are debatable, such interventions can effectively contract labor supply in village labor markets. We attributed much of the improvement in the real wages in Aurepalle to government programs to redistribute village land and to assist village entrepreneurs. Both actions resulted in reduced daily labor market participation in the village. Such changes in labor supply frequently go unnoticed, but they are potentially important in conditioning wage consequences in the daily-rated labor market.

The empirical results also highlight the importance of health status in being associated with (if not contributing to) higher wages for men and greater labor market participation for women. While the mechanisms and direction of causality underlying the link between health status and those labor market parameters are not clear, corroborating evidence points to another source of benefits from improving health status. *Ceteris paribus,* cultivator households, whose members weighed more for a given height, had higher farm labor productivity than those comprised of individuals with less weight-for-height. Because the individual s health and nutritional status are not associated with household income (in chapter 9), it seems unlikely that these benefits flow from household income to health status to farm labor productivity. Taken together, these findings broadly support the argument that investing in health is not only an end in itself but will also be accompanied by measurable economic benefits felt in village labor markets.

6 Land

Much of the prevailing wisdom about the land market in South Asia stems from perceptions about and experiences in irrigated agriculture, particularly in the Indo-Gangetic Plain spanning northwestern and northeastern India. Views about the "frozen," uncompetitive nature of the land market, economic polarization, distress sales as a means to accumulate land, increasing landlessness, landlords' exploitation of tenants, and extreme fragmentation of holdings are common (Myrdal 1968; Ladejinsky 1965).

Such thinking probably was the consensus view immediately following Independence, when agrarian relations in several parts of India were essentially feudal. For example, Ladejinsky (1952: 192), in typically vivid prose, cited one extreme case in West Bengal where as many as seventeen different rights to the same piece of land were claimed and where multiple intermediaries (or rent collectors) between tenants and landlords were a fact of life.

The importance of agrarian reform did not go unnoticed by Indian economists. Writings on agrarian structure and reform occupied more pages of the *Indian Journal of Agricultural Economics* in the late 1940s and early 1950s than those on any other topic.

The response by the central and state governments was to promulgate legislation designed to abolish intermediaries, secure title and occupancy rights for tenants, control rents paid by tenants, limit holding size, and consolidate holdings. The track record of agrarian legislation varied geographically and by legislative intent. In some states and regions, the legislation was effectively administered and the end result matched intent; in others, the legislation existed only on paper; and for yet a third set of regions and legislative regulations, mainly tenancy acts, what happened departed markedly from what was intended (Ladejinsky 1965).

During the last twenty years, issues related to the land market have receded in importance on the agricultural policy agenda. Still, the earlier authoritative assertions persist. Compared to land markets in Southeast Asia, those in South Asia often look more imperfect and hence more susceptible to reinforcing and even accentuating political and economic inequality within a village, locality, or region (Hayami 1981).

The main aim of this chapter is to determine how well the perceived stylized facts, some of which were cited at the outset of this chapter, fit the study villages in India's semi-arid tropics. We shall soon see that the fit is sometimes a most imperfect one. Agrarian legislation, whether predicated on correct or incorrect facts, has played an indirect and often important role in conditioning how the land market has evolved in the dryland study regions. That evolution is the subject of the next section on trends in the land market and is followed by sections on farm size and productivity, tenancy, and land fragmentation. The chapter ends with a brief summary of the match between the conventional wisdom and the empirical evidence.

The Shaping of the Land Market

Trends in the distribution of landed wealth are hotly debated in the Indian literature on agrarian reform. Some observers such as Raj (1976) find evidence to support the view of increasing economic polarization where wealthier landowners accumulate property at the expense of smaller and more marginal farm households. Others represented by Vyas (1979) arrive at the opposite conclusion: The distribution of landownership is becoming more equitable over time, with small to medium farm households as relative gainers and large farm households as net losers. Vyas even went so far as to refer to intertemporal changes in the ownership distribution of land as a "remarkable shuffle" (1979: 13).

Both of these divergent views rest on differing interpretations of rounds of the NSS. Because the operational definitions of tenancy and ownership vary somewhat from round to round and because the distinction between arable and nonarable land is blurred across the rounds, comparative analysis of the NSS data can give misleading and even spurious inferences on trends in the distribution of landownership (Cain 1983). The dynamics of landownership are so complex that it is questionable whether their outlines can ever be adequately discerned solely from NSSs. What is needed to complement national data are intensive microeconomic inquiries that rely either on longitudinal studies or retrospective surveys (Cain 1983; Vyas 1979).

The picture that emerges from the retrospective data on the land market in the study villages is generally consistent with three trends in the distribution of landownership: (1) decreasing relative landlessness (in the sense of land gainers outnumbering land losers), (2) broadening equality, and (3) declining farm size. The data overwhelmingly support Vyas's interpretation of the NSS information. Before documenting those trends, we briefly describe the retrospective survey data and the focus of the analysis in the next subsection.

Retrospective Data

In 1984, the 240 respondent households in the six villages were canvassed with a retrospective questionnaire designed to provide historical information on family assets. The starting point for recalling such information was the inheritance of the respondent's father. Across the 234 canvassed heads of household—three had emigrated from the "discontinued" villages of Dokur, Kalman, and Kinkheda since 1978, two had temporarily migrated, and one had died—the median date of the father's inheritance was 1933. Information on land market transactions was collected from the date of the father's inheritance until 1982/83. The interviews were long and tedious, but respondents, except for older widows, experienced no difficulties in remembering land transactions. (For households headed by women, information was collected on the inheritance of the husband's father.)

The analysis is patterned after Attwood's (1979) classic case study of changes in landholding between 1920 and 1970 in a large, irrigated, sugarcane-growing village on the Bombay Deccan. Cain (1981) has carried out a similar exercise for Aurepalle, Shirapur, and Kanzara, focusing on the influence of risk and insurance on agrarian change and fertility. Cain's benchmarks were the date of the respondent's inheritance and 1980. We used 1950 as a benchmark for comparison because most of the institutional reforms, primarily tenancy acts and land ceiling regulations, could have begun to have been felt in the early 1950s, shortly after Independence.

To adjust for land quality, wet land was multiplied by 4.0 to convert it to dryland equivalents. A multiplier of 4.0 approximately reflects differences in land value and in economic returns between well-irrigated land and dryland.

Incidence of Landlessness

The retrospective data are consistent with a declining trend in relative landlessness in the majority of the study villages (table 6.1). Across the six villages, land gainers, who were landless in 1950 and owned more than 0.5 acre in 1982, outnumbered land losers, who owned land in 1950 and possessed less than 0.5 acre in 1982, by a ratio of 5 : 1. Of the 202 sample households owning land in 1982/83, sixty were landless at their parents' inheritance. About two-thirds of the landless households in 1950 had acquired some land by 1982. Only eight of the presently landless households owe their landlessness to the loss of land.

Declining relative landlessness is most noticeable in the Akola villages: only thirty-seven households owned land when the parent of the respondent inherited, sixty-three owned land in 1982/83. The incidence of landlessness has changed least in Shirapur, where the tenancy market is very

Table 6.1. Changes in the composition of landownership and landlessness from 1950 to 1982, for the sample households in six study villages

Landownership in 1982	*Landownership in 1950*	*Description*[a]	*Sample Households (N)*	*% Village Population*[b]
Owned land	Owned land	Land keeper	148	58
	Landless	Land gainer	46	20
	Immigrant since 1950		8	4
Landless	Owned land	Land loser	8	4
	Landless	Landless stayer	23	13
	Immigrant since 1950		1	1

[a]Taken from Attwood (1979).

[b] Adjusted for the different sampling fractions between cultivators and landless labor households by village in table 2.1. The percentages represent the simple averages across the six villages.

active and where dryland cultivation is often not more economically rewarding than working on nearby government works projects or even in the casual village labor market. The ownership distribution of land was also more equitable in Shirapur than in the other villages in 1950.

Immigration into the villages since 1950 has not contributed significantly to landlessness. Only in the Akola villages has immigration played a minor role. The unimportance of immigration in explaining landlessness is yet another reflection of the lack of economic growth in these dryland study villages.

We also feel that emigration by land losers has not substantially affected trends in landlessness since 1950. If emigration by land losers was marked, the estimates of landlessness would be severely biased downward. These comparisons are characterized by selectivity bias because emigrants who resided in the village during the retrospective period of analysis are not in the sample. Of the original 240 household sample, fourteen heads of household emigrated from the study villages between 1975 and 1984 when the retrospective questionnaire was canvassed. (Eleven of the fourteen were from the continuous villages and were subsequently replaced in the panel.) Six belonged to the landless labor stratum, and eight were cultivators mainly from the medium farm-size group. Five of the eight cultivator households have kept their land in the village and lease it, mainly to relatives. None of the eight landed leavers could be called land losers in the traditional sense that loss of land precipitated emigration. Hence, the case for large selectivity bias in omitting landless emigrants from the sample is not supported by the recent village evidence on emigration.

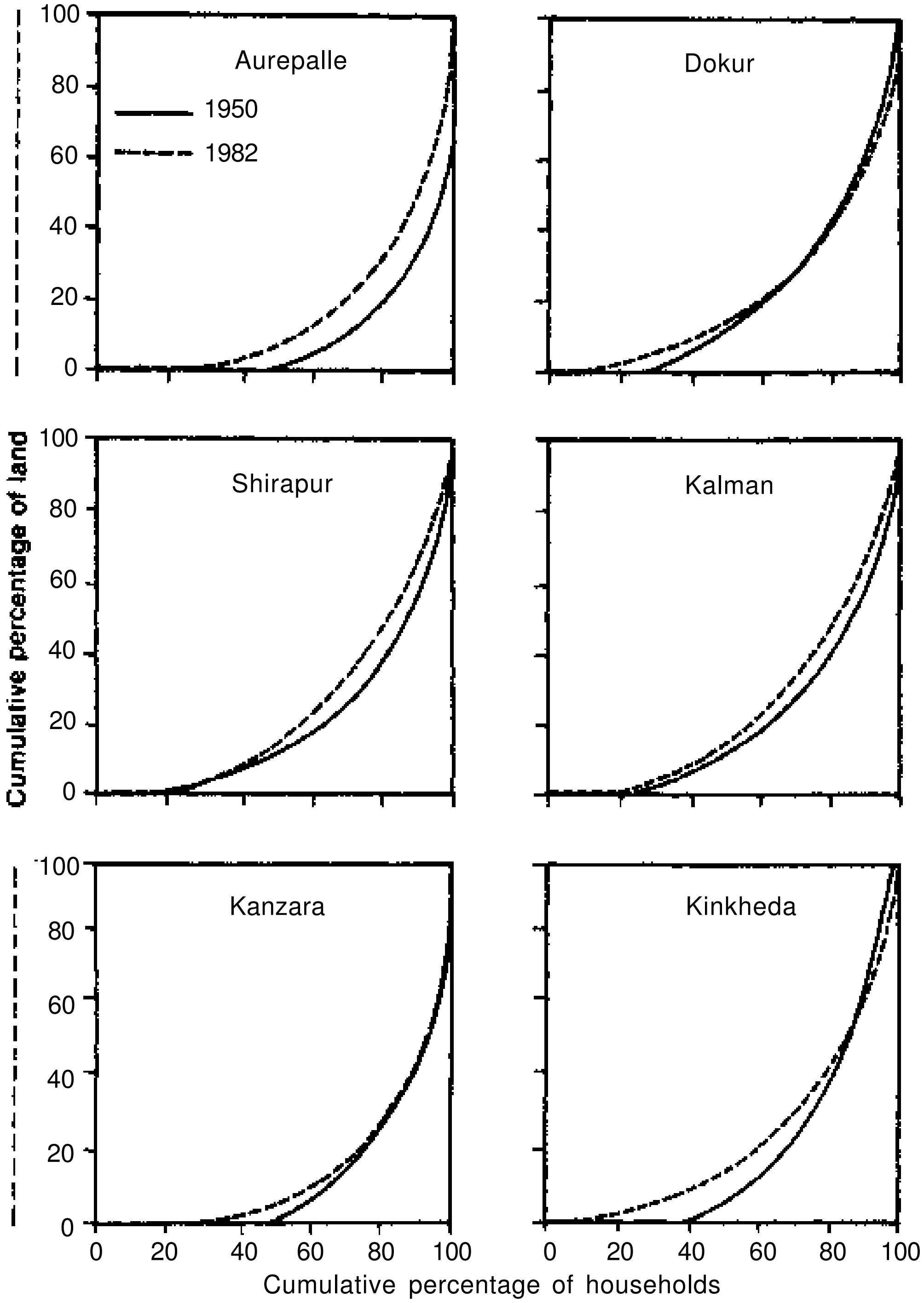


Figure 6.1 The distribution of owned land by village in 1950 and 1982

The Concentration of Landholding

The concentration of landholding has not increased appreciably in any of the villages since 1950 (figure 6.1). Polarization has not occurred. The tendency toward equality in landownership was greatest in Aurepalle, where the distribution of landholding was the most skewed among the six villages in 1950. In Shirapur, Kalman, and Kanzara, the snapshots of the landownership distribution in 1982 show less inequality than the picture taken in 1950, but the movement toward equality was not as pronounced as in Aurepalle. In Dokur and Kinkheda, unambiguous conclusions about changes in equality of landownership cannot be drawn because the Lorenz curves cross. Nonetheless, the change is the same in both villages: greater equality in landholding among the 80 percent of the population owning 40 percent of the land and less equality among the top two deciles. As we shall soon see, the households in the top two deciles in 1950 are not necessarily those in 1982, as a substantial reshuffling in landownership has occurred.

More people owning land is one consideration underlying the trend toward broadening equality in landownership. The shedding of land by the larger landowning households in 1950 is another. Downward mobility by the larger landowners is evident in figure 6.2. For the landowners in 1950, about 2.5 times as many observations fell below the diagonal, the line demarcating equal landholding in 1950 and 1982, as above it. By the same token, upward mobility in landownership was not rare: about one household in four in the landed sample had more land in 1982 than in 1950. Epitomizing these trends, twenty-six of the thirty households (across the six villages) that were among the five largest landowners at their father's inheritance (in each village) had less land in 1982 than their father inherited. Several families, starting from a relatively small base at inheritance, have also acquired a sizable amount of land.

The presence of relative mobility is also communicated by estimated Spearman rank correlation coefficients (for the landed sample in 1950), ranging from 0.45 in Kinkheda to 0.79 in Shirapur. In other words, in several of the villages, ranking the landed households by the size of landownership in 1950 would not have been a precise predictor of relatively how much land they owned in 1982. Amongst the landed, the correlation coefficient between the change in the size of the holding between 1950 and 1980 and the amount of land owned in 1950 was negative in all the villages and statistically significant at the 5 percent level in four.

Transactions

What processes led to the change in the village land distributions between 1950 and 1982? To answer this question, we numerically describe the transactions underlying these trends in table 6.2, which reports data aggregated across the six villages for two broad landholding categories: (1) landless families who gained land between 1950 and 1982, and (2) landowners divided into terciles by relative landowning position in the village in 1950.

Table 6.2 brings out several salient features of the recent evolution of the land market. Families who owned more land in 1950 lost more area both relatively and absolutely. In contrast, the smallest tercile of land-

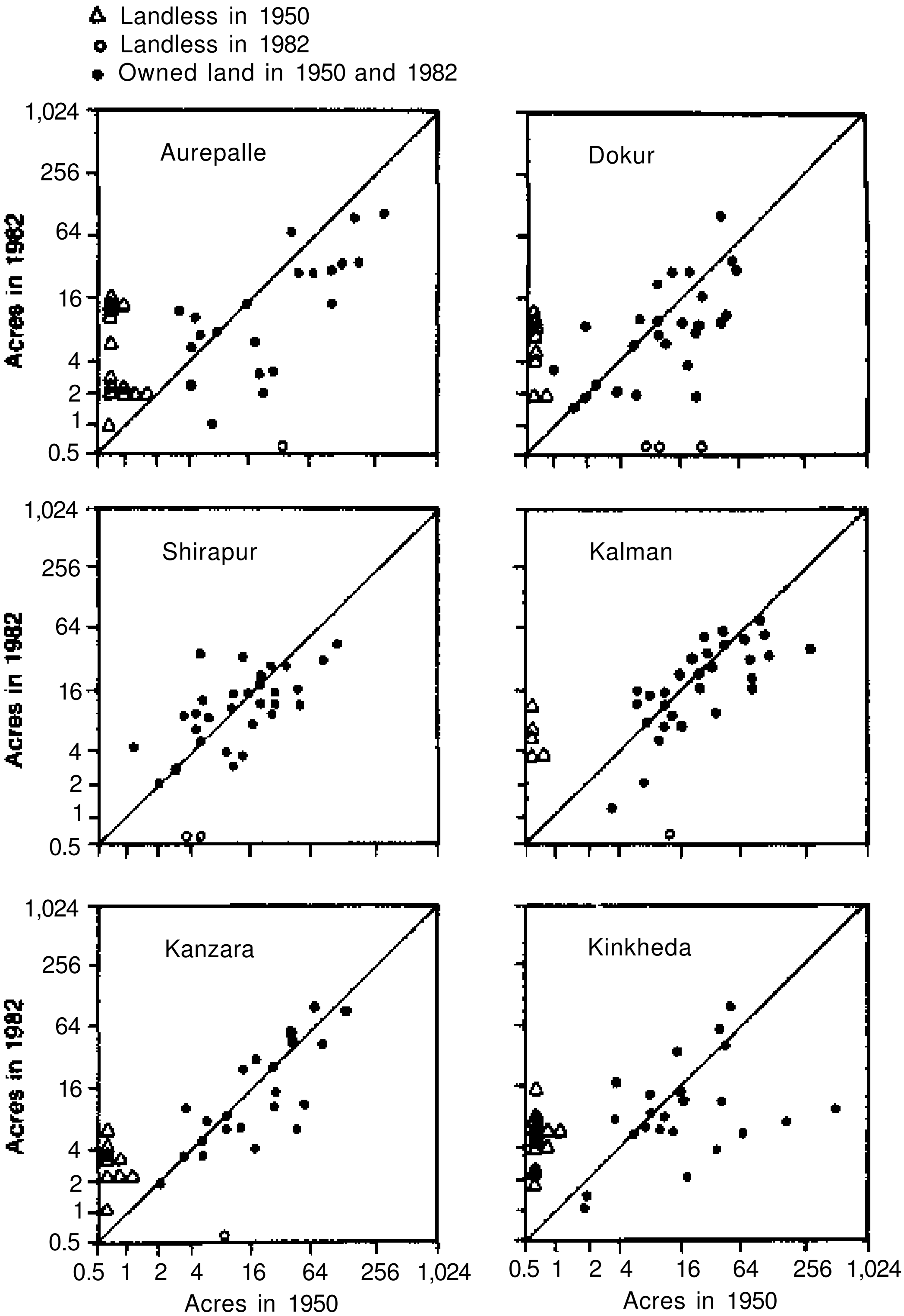


Figure 6.2 Changes in landownership between 1950 and 1982 (in acres log base 2) by village

owners in 1950 enlarged their landholding. Clearly, larger holdings have not expanded at the expense of the smaller ones. Smaller holdings also disproportionately bought more land than larger holdings, who were characterized by relatively more sales. For the small holders in the lowest tercile, purchases more than compensated for sales so that the mean size of landholding did not fall. Thus, activity in the land market did not exacerbate landholding inequality. In contrast, the proportional size of land partitioning was about the same across the three terciles: about half

Table 6.2. Land market transactions from 1950 to 1982 according to the relative size of holding in 1950

	Land Status in 1950			
		Landowner		
Particulars	*Landless*	*Smallest Tercile*	*Middle Tercile*	*Largest Tercile*
Sample Households (N)	69	54	50	52
Total area of holding in 1950 (acres)	0	263	729	2,634
Transaction (acres)[a]				
Purchased	338	247	307	483
Sold	-70	-89	-173	-502
Partitioned	-89	-128	-394	-1,331
Gifted[b]	46	24	38	-30
Others[c]	9	-12	-7	-94
Total area holding in 1982 (acres)	234	305	500	1,160
Net change in area (in % of total holding in 1982)		16	-31	-55

[a]Negative figures indicate that land left the respondents' households.

[b] Usually from relatives.

[c] Includes land affected by tenancy legislation or land ceilings, government land grants to landless households, and illegal occupation of land that ultimately resulted in ownership by or transfer from the respondent's household.

the area owned in 1950 was subsequently subdivided to other family members.

Because land is the primary stock of value, means to production, and source of collateral and because activity in the land market is often distorted or even hampered by imperfections in other markets, particularly in rural financial markets, the land market is often viewed as rather illiquid in developing country agriculture (Binswanger and Rosenzweig 1986a). The data in table 6.2 do not reinforce the perception of a frozen land market. Purchase and sale transactions since the father's inheritance to 1982/83 were greater than the number of sample cultivator households in each study region. Across the six villages, about as much land (1,800 acres) was bought and sold as was partitioned (1,853 acres).

Between 1950 and 1982, the amount of land bought and sold expressed as an annual percentage of the land endowment of the sample households in 1950 varied from 1 percent in Kalman to 4 percent in Dokur. This level of activity is probably comparable to what obtains in developed country agriculture (Harriss 1986).

Undeniably, the land market is thin because the reservation price of the seller usually exceeds the offer price of the buyer. The land market is also not impersonal. Neighbors and the desire to maintain good village relations are often important considerations in the choice of buyers. But entry as a buyer is not restricted. Although adjudication of land disputes is often costly and tedious, property rights to land are established and secure, limiting the scope for opportunistic land grabbing. As indicated in table 6.1, several immigrants have also purchased land in the study villages since 1950. As table 6.2 makes abundantly clear, landless households have also bought land, although as Binswanger and Rosenzweig (1986a) point out, land and credit market interactions potentially favor the landed as bidders. Thirty-one of the forty-six land gainers since 1950 in table 6.1 purchased land through self-generated savings. Aurepalle was the only village where government land grants to erstwhile landless labor households figured prominently in the decline in landlessness.

The relatively low incidence of distress sales is a major reason why purchases and sales in the land market have not led to greater inequality in landownership. Given the ecological and demographic conditions of the villages, distress sales should be fairly common (Binswanger and Rosenzweig 1986a). But relatively few of the land sales since 1950 could be described as distress sales to cancel debt to satisfy short-run consumption needs (Cain 1981). When the frequency of sales is charted over time, we see no evidence of clustering in bad production years, which is what Binswanger and Rosenzweig's analysis of production relations would predict.

The distress motive was dominated by other forces. Raising money for dowry and financing the purchase of assets—two motivations often characterized by stress but not to the point of distress to maintain consumption—were the most common reasons given by respondents for selling land. The felt need for social investment in dowry by large landowning households was associated with heightened land market activity. Many sales and purchases were also fully or partially motivated by the demand to consolidate one's holding.

As elsewhere in India (Vyas 1979), not much land directly changed hands because of government land reforms. In the early 1950s, five households lost land through tenancy legislation. Across the six-village sample, transfers through land reform amounted only to about one hundred acres.

Farm Size and Owned and Operated Area

Perhaps the most striking change in the land market in recent decades has been the decline in the median owned holding in the six villages (table 6.3). Again, Shirapur is the outlier.

Table 6.3. Median size of owned holding in dryland equivalent acres in 1950 and 1982, by village[a]

	Year	
Village	*1950*	*1982*
Aurepalle	23.3	7.2
Dokur	13.1	8.0
Shirapur	11.0	12.3
Kalman	22.5	14.3
Kanzara	18.4	6.1
Kinkheda	13.5	7.3

[a]Wetland was multiplied by four to convert to an equivalent amount of dryland.

The distributions of owned area are positively skewed; therefore, owned mean area is substantially larger than owned median area. But the gap between owned mean and median area is narrowing; that is, the distribution of owned area is becoming more symmetrical over time. In 1940 across the six villages, owned mean area was on average about twice as large as owned median area. By 1982, the difference had shrunk to about 25 percent of owned median area. This coming together of these two measures of central tendency again reflects the greater propensity for land disposal by the larger farm households.

Because of the prevalence of tenancy in the villages, the reduction in median owned area has not been translated into an equivalent decrease in the size of median operational holding. The size of operational holdings has followed owned holding downward, but the median operational holding is still larger than the median owned holding. Recent evidence suggests that the gap between the size of the median operational and owned holding is not narrowing and could be widening largely in response to a tighter labor market described in chapter 5.

Differences in the village operated and owned area distributions are illustrated by the Lorenz curves in figure 6.3. Those curves refer to 1983/84, a year when we were certain that tenancy was not underreported. The six panels in figure 6.3 share a common feature: the smallest farmers have a lower fraction of operational holdings area than owned holding area; that is, initially, the smooth operated area curve is to the right of the crossed owned area distribution. Some of the smallest farm households are leasing out, usually sharecropping out, their land to larger farm households in each of the villages. This reverse tenancy is not surprising in these dryland villages where farming small amounts of land does not confer much economic advantage over participating more actively in the casual labor market or, in the case of Dokur, temporarily migrating for construction work. The absence of a well-developed market for the hiring of draft power in several of the villages also increases the supply of

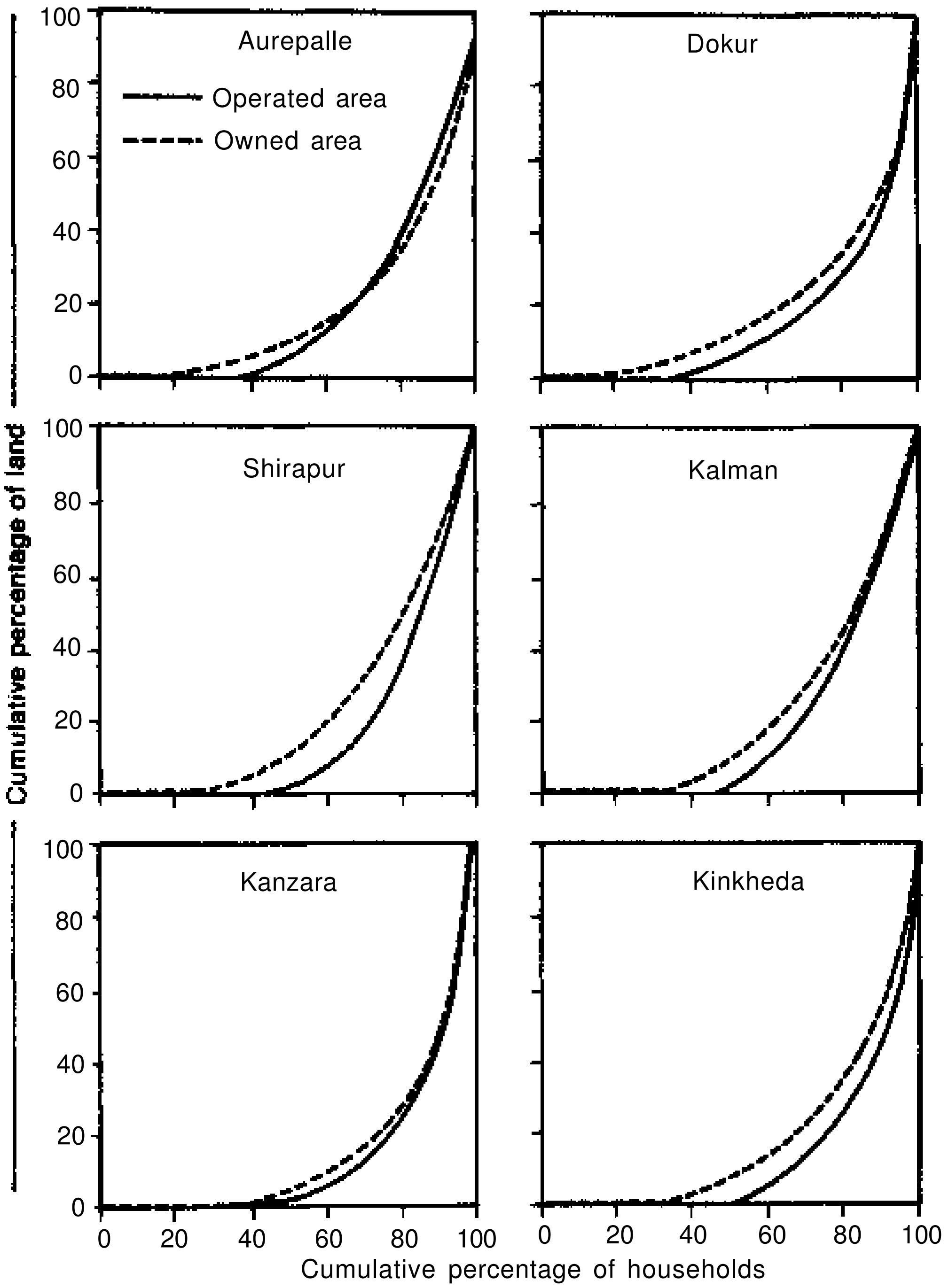


Figure 6.3 The distribution of owned and operated area by village in 1983/84

tenancies. Not unexpectedly, the operated area distribution most closely approaches the owned area distribution in rainfall-assured Kanzara, where the profitability of dryland agriculture is higher and production risk is less than in the other villages.

The finding of dwindling average farm size is not new and has important implications, discussed later in chapter 10, for technological policy, particularly for a watershed-based approach to dryland agricultural development. Indeed, declining median farm size, although not a member of the set of stylized facts of the 1940s, 1950s, 1960s, or even the 1970s, certainly enjoys that position in the 1980s (Dantwala 1985).

Recent Corroborating Evidence

The above findings on the evolution of the land market in the study villages are corroborated in recent studies at the macro and micro levels. Laxminarayan and Tyagi (1982) juxtaposed the NSS data from the eighth, seventeenth, and twenty-fifth rounds, corresponding to 1953/54, 1961/62, and 1971/72, to information, mostly based on land revenue records, from the 1970/71 agricultural census. They persuasively show that the area under large holdings had declined and both the area and number of small and marginal holdings had unambiguously increased. Recent comparisons of the provisional 1981/82 agricultural census data, based on a 10 percent sample, and 1970/71 census data also reveal a swelling in the ranks of the marginal and small farm holdings, a less substantial increase in operated area of those same households, and a sizeable reduction in area and number of holdings operating more than 10 ha (Bussink and Subbarao 1986).

Fairly fresh evidence from in-depth village studies in India's semi-arid tropics in general and in the study regions in particular also lends support to these trends. In comparing landownership distributions at three points of time—inheritance, 1973, and 1983—in four villages in semi-arid North Arcot district in Tamil Nadu, Harriss (1986) found that small holders frequently added to their landholding after their inheritance while large holders more often than not lost land. Research described in chapter 3 by Caldwell, Reddy, and Caldwell (1982) in southern Karnataka substantiated increasing equity in landownership in nine predominantly dryland villages.

Attwood's analysis of the dynamics of the land market between 1920 and 1970 in a large, irrigated, sugarcane-growing village on the Bombay Deccan is very informative on how consequences reflected in the land market are shaped by accelerated economic growth. Attwood documented many of the same trends: large landholders losing ground both absolutely and proportionately to small landholders, leading to decreasing polarization in the land market over time, a decline in the median size of owned holdings, some upward mobility, and major roles for both partitioning and sales in influencing these trends. In contrast to our results, the proportion of landless villagers also increased because of the slump in sugarcane prices during the depression but, more important, because of migration of landless laborers into the village in response to expanding agricultural employment opportunities.

A summary of more recent micro research by Gadre, Wahile, and Galgalikar (1987) on land market dynamics in a village in the Vidarbha region of Maharashtra conveys a similar picture to what was observed in the Akola villages, which are located in the same region. Tilekar, Ratnaparkhe, and Hinge's (1987) resurvey of villages ecologically resembling the Sholapur villages in western Maharashtra suggests far less change and a relatively inactive land market, which we also documented for Shirapur.

Explanations for These Trends

Reasons for declining economic polarization in village landownership are not hard to find. Increasing population pressure should be assigned pride of place in explaining changes in landholding in the recent past.

Institutional considerations also played a major role. Although little land has changed hands directly because of land ceiling and tenancy legislation in the six villages and although land ceilings are relatively easy to evade, the threat of confiscation because of ceiling legislation is perceived as real by large farmers. When visitors from other states in India travel to the study villages, inevitably the first question they are asked by farmers is, What is the size of the exemption from the ceiling legislation in their state? Ceiling legislation increases the risk in accumulating land, and it is this indirect effect that has led to a more equitable distribution of land in the study villages during the last thirty years.

Equally, if not more importantly, with the possible exception of Kanzara and Kinkheda, acquiring more rainfed land is a much less profitable alternative than investing in irrigation and seizing the limited off-farm investment and employment opportunities that are available near the villages. Land transactions since inheritance were often associated with productive investment. Landowners sometimes sold more remote dryland fields and either purchased land adjacent to their well or sank the sales receipts into well digging, desilting, or deepening. The profitability of wetland agriculture was further enhanced by public subsidies on fertilizer, diesel, and, most important, electricity. Such subsidies and the greater pace of technical change in irrigated agriculture certainly diminished acquisitive pressures on predominantly rainfed land in the study villages.

Conspicuous for their absence were events such as the great depression in the early 1930s in Attwood's study village that significantly determined the course of landownership. Most notably, distress sales of land since 1950 were few and far between. Undoubtedly because of substantial government assistance, the "never in a hundred years" Maharashtra drought from 1971 to 1973 was not one of those events.

Last, but not least, the initial conditions for polarization in landholding were not present in the villages. As we shall see later in this chapter, none of the villages, with the exception of Aurepalle, has a recent history of landowner absenteeism. The incidence of pure tenancy is also low and has been declining over time. Hence, a scenario of landowners evicting tenants in response to abrupt technical change was and is extremely unlikely.

Farm Size

In chapter 5, we explored the relationship between farm size and labor use. In chapter 10, we analyze the degree to which disparities in resource endowment between small and larger landowners translate into significantly different factor use ratios. In this section, we examine the relationships between farm size and two land-related themes: land productivity and quality. The empirical relationships estimated in these chapters provide the basis for the discussion of interactions among farm size, factor markets, and technological change in dryland agriculture in chapter 11.

Land Productivity

Probably no issue has received as much analytical scrutiny in the Indian agricultural economics literature as the nexus between farm size and land productivity. Based on the Farm Management Studies described in chapter 2, a negative relationship between owned area and production per acre owned was conclusively documented in the 1950s (Berry and Cline 1979). (Irrigated agriculture was well represented in the Farm Management Studies, which were undertaken in six Indian states: Mahrashtra, Madhya Pradesh, Tamil Nadu, Punjab, Uttar Pradesh, and West Bengal.) Based on the NCAER data referred to in chapter 4, the inverse relationship was still visible six years after the advent of the green revolution (Bhalla 1979). Findings from more recent microstudies suggest that the inverse relationship between land productivity and farm size has weakened considerably (Parthasarthy 1987).

The two explanations most commonly put forward to account for the inverse relationship are the superior land quality of small vis-à-vis large farms and labor market dualism, described and tested for in chapter 5 and reflected in a higher effective wage cost of hired than family labor derived from hiring frictions and unemployment (Bhalla 1979). Although this stylized relationship and its explanations are clouded by conceptual and empirical difficulties (Verma and Bromley 1987), knowing its direction and underlying causality is important because land is increasingly scarce.

The neglect of tenancy is one of the more glaring deficiencies of this literature. In analyzing production relations for agriculture satisfying many of the assumptions and conditions found in the villages, Binswanger and Rosenzweig (1986a) hypothesize the scale of owned and operational holding should have differential consequences for land productivity. Holding owned area constant, expanding the scale of operation through renting or sharecropping in area, should be associated with decreased land productivity because of the greater use of hired laborers, who are not motivated to put forth as much effort as family labor, resulting in increased supervisory costs. To test the Binswanger and Rosenzweig prediction of differential partial effects on land productivity from operated and owned area, gross returns (i.e., the value of production) per acre of operational holding was regressed on resource endowments and personal characteristics of the household. To arrive at the size of operational holding, the net area leased or sharecropped was added to owned area. Thus the denominator of the dependent variable includes area leased or sharecropped in minus the area leased or sharecropped out plus owned net cultivated area plus owned fallowed area.

Household resource endowments included the number of owned bullocks, family size of the work force, owned land area, and land quality reflected in access to irrigation and in the price of owned land (table 6.4). We expect that all of these household endowments would be positively correlated with land productivity.

Personal characteristics such as age, education, and caste of the head of the household were added as explanatory variables to control for the systematic variation in management skills (table 6.4). Caste, aside from being a marker of traditional farming occupations, may also represent differences in market access.

The propensity to enter into tenancy arrangements could be another index of differences in managerial ability. In each village, some farmers usually operated more land than they owned, others sharecropped out or leased out land so their operated area was often less than their owned area, and yet a third group did not participate in the market for tenancies as their owned and operated area was always equal from 1975/76 to 1983/84. If tenancy acts as a means to match differences in managerial ability to the variation in land endowment, we should see differences in land productivity across the three groups.

Some of the explanatory variables are more exogenous than others. Caste is clearly exogenous and could influence the level of resource endowments, which in turn can have consequences for tenancy transactions and the disparity between operated and owned area. Therefore, the regression results should not be interpreted in terms of cause and effect but rather in the context of summary and partial associations.

The village data from 1975/76 to 1983/84 were pooled within each region, and cropping year effects were added to control for systematic variation over time. The regression results in table 6.5 show that in each region the strongest statistical correlate with land productivity was land quality measured by percent irrigation and land value of operated area. The strength of this relationship again reflects the presence of considerable variation in land quality in the village and farmers' allocation of higher valued crops and more inputs to the better quality holdings.

The results in Maharashtra villages confirm the Binswanger and Rosenzweig hypothesis that operational and owned holding will be signed differently: *ceteris paribus,* operated area is negatively associated with

Table 6.4. Means and standard deviations of the variables in the regression analysis of land productivity, from 1975/76 to 1983/84 by region

Variable[a] (Unit of Measurement)	Region		
	Mahbubnagar	*Sholapur*	*Akola*
Resource endowments			
Irrigation (% of gross cropped area)	41	19	6
	(41)	(29)	(2)
Land value (Rs 1,000/ha)	7.1	6.6	4.3
	(7.1)	(4.6)	(2.6)
Owned area (ha)	4.4	5.7	5.4
	(6.3)	(3.8)	(6.8)
Operated area (ha)	4.3	7.4	6.0
	(5.3)	(4.0)	(6.6)
Bullocks *(N)*	1.4	1.3	1.7
	(1.9)	(1.2)	(2.0)
Workers *(N* 15-64 years)	3.6	3.9	3.5
	(1.9)	(1.8)	(1.8)
Personal characteristics			
Age (years)	51	47	43
	(12)	01)	(11)
Education (years)	1.7	2.0	3.9
	(2.7)	(3.1)	(3.9)
Caste[b]			
1	0.30	0.66	0.30
2	0.17	0.09	0.39
3	0.30	0.23	0.16
4	0.23	0.02	0.15
Other[c]			
Tenancy behavior[d]			
Neither leased in nor leased out	0.36	0.09	0.25
Leased in more than leased out	0.35	0.68	0.48
Leased out more than leased in	0.29	0.23	0.27
Village[e]			
Village 1	0.52	0.50	0.50
Village 2	0.48	0.50	0.48
Gross returns (Rs/ha)[f]	2,064	903	1,139
	(2,925)	(928)	(874)
Observations *(N)*	510	506	508

[a]For the continuous variables, means are reported and standard deviations are given in parentheses. For dummy variables, proportions in each category are reported.

[b]Ranked with regard to ritual status (Doherty 1982). Caste 1 is the highest, Caste 4 is the lowest.

[c]Cropping year dummy variables were included in the regression analysis but they are not presented in this table.

[d]Based on the divergence between operated and owned area from 1975/76-1983/84. The first group corresponds to pure owner operators, the second to net leasers in, and the third to net leasers out.

[e]Village 1 is Aurepaile in Mahbubnagar, Shirapur in Sholapur, and Kanzara in Akola; village 2 is Dokur in Mahbubnagar, Kalman in Sholapur, and Kinkheda in Akola.

[f]Dependent variable.

Table 6.5. Correlates of land productivity from 1975/76 to 1983/84, by region

Variable (Unit of Measurement)[a]	*Region*		
	Mahbubnagar	*Sholapur*	*Akola*
Resource endowments			
Irrigation (% of gross cropped area)	18.3**[e]	14.7**	18.5**
	(3.29)	(11.3)	(8.01)
Land value (Rs 1,000/ha)	23.9**	29.2**	70.0**
	(12.8)	(3.44)	(4.98)
Owned area (ha)	-42.9	32.5*	20.4
	(-0.99)	(2.53)	(1.74)
Operated area (ha)	-93.8	-35.4**	-28.0*
	(-1.85)	(-3.60)	(-2.31)
Bullocks (N)	-36.4	16.4	28.7
	(-0.53)	(0.43)	(0.96)
Workers (*N* 15-64 years)	68.2	2.70	-24.3
	(1.38)	(0.12)	(-1.40)
Personal characteristics			
Age (years)	-0.39	1.86	7.29*
	(-0.57)	(0.58)	(2.51)
Education (years)	-1.40**	-0.50	13.22
	(-3.05)	(-0.04)	(1.20)
Caste[b]			
2	-647	-190	225**
	(-1.90)	(-1.61)	(2.80)
3	-1,343**	-284**	17.3
	(-3.91)	(-3.31)	(0.17)
4	-1,625	-635	-81.1
	(-4.36)	(-2.78)	(-0.75)
Other			
Tenancy behavior[c]			
Leased in more than leased out	22.3	-157	-184*
	(0.11)	(-1.28)	(2.47)
Leased out more than leased in	886**	-127	-590**
	(3.76)	(-0.92)	(-6.67)
Village[d]	-582*	-335**	-227**
	(-2.01)	(-4.26)	(-3.87)
Intercept	1,098	502	488
$\bar{R}^2$	0.68	0.48	0.52

[a]Cropping year dummy variables were also included in each regional regression.

[b] Reference is caste 1.

[c] Reference is pure owner operators who neither leased in nor leased out land.

[d] Reference is village 1.

[e]t ratios are in parentheses; * and ** denote statistical significance at the 0.05 and 0.01 levels, respectively.

land productivity while owned area is positively correlated with land productivity. The explanation for the strong negative association between operated area and land productivity is discussed at length in the next section on tenancy.

The other resources endowments (i.e., the number of bullocks owned and the size of the family work force) are not highly correlated with land productivity in any of the regions. Of the personal characteristics, differences in land productivity among caste groups are quite sizable and statistically significant in the three regions. Reddis in Mahbubnagar, Marathas in Sholapur, and Malis in Akola have significantly higher average land productivity than other communities in their respective villages. The traditional and primary occupation of these three castes is farming. Although these communities also figure in the upper echelons of the caste hierarchy in their villages (Doherty 1982), high caste status is not necessarily strongly and positively associated with average land productivity. For example, the Deshmukhs, the higher status, traditional landowning caste, are characterized by significantly lower land productivity than Malis in Kanzara. Unlike Malis, Deshmukhs generally adhere to a restriction prohibiting their wives from doing farm work.

Apart from the effect on operated area, the longer-term propensity to lease in or lease out land was associated with significant differences in land productivity in the Mahbubnagar and Akola villages. But the estimated effects are sharply different in the two regions: in Aurepalle and especially in Dokur those farmers who are net leasers out have significantly higher average land productivity than net leasers in or pure owner operators; in Akola the opposite obtains as land productivity of net leasers out is significantly less than owner operators or net leasers in.

These contrasting results can be attributed to differences in the quality of the production environment. In the drought-prone, red-soil Mahbubnagar villages, the leasers out tend to follow a strategy of marshaling their effort and resources on their better quality, often irrigated land. More marginal land is leased out, and it does not pay for those who lease in to farm that land intensively. In the rainfall-assured, black-soil Akola villages, spatial variation in land quality is less than in the Mahbubnagar villages. As we shall see in the next section, land leased out for sharecropping in Kanzara and Kinkheda is not as good as but not decidedly inferior to owned and operated land. Thus farmers who lease in land in the Akola villages have a higher quality, fixed resource base more conducive to the intensive application of variable inputs than similar owner operators cum tenants in the Mahbubnagar villages. Moreover, the ranks of the leasers out in the Akola villages are largely filled by individuals who are not that committed to farming. Farmers who suffer from alcoholism and gambling have a greater propensity to lease out their land. Others are primarily interested in occupations outside agriculture. Thus, in the Akola villages, where dryland can be productively and profitably farmed, information on tenancy behavior over several years is valuable in identifying management skills and commitment, which translate into higher land productivity. Because such management differences exist and are manifested in the market for tenancies, more economic value can be produced from land with tenancy than if each farmer were restricted to cultivating solely their own landholding.

Land Quality

Differences in land quality favoring small farmers are often cited as one reason why, mostly in irrigated agriculture in South and Southeast Asia, productivity per unit of area is usually higher as farm size decreases (Bhalla 1979). Several reasons, including Sen's (1964) Malthusian hypothesis and Bhagwati and Chakravarty's (1969) distress sales hypothesis, have been put forward to account for why small farm households may own better quality land than larger farm households. The idea underlying the Malthusian hypothesis of Sen is that more fertile land can accommodate more population growth, which in turn will result in smaller farms and plot size. The distress sale hypothesis is more transparent. Behind it is the argument that farmers will cling to their better quality land and sell their worse land. Because small farmers are more likely to incur distress sales than large farmers, land quality over time should be higher on smaller farms.

We evaluated the variation in land quality by farm size from three perspectives: (1) an index of resource stability estimated from plot data for cultivator households in the six villages from 1975/76 to 1979/80, (2) subjective land prices, and (3) land revenue rates. The first measure builds on an analysis of crop failure in the study villages (Singh and Walker 1984). Crop failure is an extreme and transparent consequence of interacting agroclimatic, biological, and soil conditions. It offers an empirically clearer although perhaps cruder approximation to differences in the quality of the resource endowment than any other measure. The second index, subjective land prices, was assigned to each field by the resident investigators. They incorporate information from a number of sources, including revenue records, farmers' subjective evaluations of land quality, and perceptions of the resident investigator on qualitative differences in land. The third measure, land revenue rates, was taken from records of the village clerk. The revenue rates, which are the basis for taxing land, have not kept pace with inflation and are still based largely on assessments made in the nineteenth century.

Each measure projects about the same picture regarding mean significant differences in land quality by farm-size group (table 6.6). In Aurepalle, small farmers cultivate an inferior quality resource base. Compared to large farmers, they have less access to irrigation. Part of the

Table 6.6. Paired comparison for significant differences in means of household resource stability indices, subjective land prices, and land revenue rates, by farm-size class and village

	Farm-size Class Comparison		
Village	*Small and Medium*	*Small and Large*	*Medium and Large*
Aurepalle	-0.13[a]	-2.93**	-2.55*
	-0.75[b]	-5.94**	-4,91**
	-1.82[c]	-3.87**	-2,31*
Dokur	-0.18	-0.73	-0.53
	0.17	-0.21	-0.36
	4.28**[d]	6.95**	1.37
Shirapur	2.12*	2.24*	-0.24
	2.60**	3.57**	0.52
	3.87**	6.04**	1.62
Kalman	0.18	2.23*	1.92
	0.12	1.63	1.40
	2.92**	5.56**	3.09**
Kanzara	0.29	-0.94	-1.19
	-0.71	-5.74**	-5.59**
	0.57	-1.19	-2.43*
Kinkheda	-0.61	-0.60	-0.32
	-1.03	-3.20**	-1.58
	0.59	-0.35	-1.02

[a] A positive t value marked with asterisks shows that per hectare household resource stability of the first group is significantly greater than the second. The converse applies to a negative t value. Means are estimated with pooled data from 1975/76-1979/80.

[b] t values for differences in mean household subjective land prices.

[c] t values for differences in mean household land revenue rates.

[d] * and ** indicate statistical significance at the 0.05 and 0.01 levels, respectively.

disparity in land quality in Aurepalle arises from government land grants of wasteland or land without immediate access to irrigation to landless labor households. In contrast in Dokur, many small farm households own land in the command area of the large village tank. In Shirapur and Kalman, the opposite obtains; the soils of small farms are usually deeper, with greater soil moisture retention capacity. In Kinkheda and Kanzara, where the dryland resource endowment is richer and more homogeneous, systematic differences in land quality across the three farm-size classes did not emerge.

These results appear to be location specific, and they cast doubt on the universality and applicability of broad generalizations about farm size and land quality in India's semi-arid tropics. Furthermore, they suggest that if differences in economic efficiency by farm size are measured either with a simplistic framework of factor output ratios (Paglin 1965) or with a more appropriate dual theoretical approach, such as the profit function (Lau and Yotopoulos 1971), and differences in land quality were not considered, biased inferences could be drawn in three of the six villages.

Tenancy

Tenancy is one area of applied survey research where longitudinal studies can markedly improve the quality of information. Unraveling landownership and contractual arrangements is a complex task made more difficult by tenancy legislation, which induces some landowners to underreport tenancy. Increasing rights with duration of occupancy are explicitly recognized in the Tenancy Acts. It was only after two years of observing respondents working in their and others' fields and others working in respondents' fields and crosschecking information in the plot cultivation, resource endowment, and transactions schedules that we were reasonably confident that the tenancy data were reliable.

The findings reported in this section are derived primarily from survey research by Jodha (1981a) on sharecropping and fixed rent transactions among respondents in the six study villages from 1975/76 to 1978/79 and from recent analysis of plot cultivation data by Shaban (1985, 1987) on the productive efficiency of tenancy compared to owner operation. The results from those two studies, particularly Jodha's, are often counterintuitive or at least do not conform with the popular perception of a limited incidence of tenancy (Omvedt 1981) or of large landlords exploiting small farmers and landless laborers in uniform, narrowly specified, and rigid contractual arrangements. We do, however, find substantial evidence to support the widely held view that sharecropping does result in a loss in production efficiency compared to owner operation or fixed renting.

Incidence and Characteristics

The incidence of tenancy varies sharply from region to region across India's SAT. Tenancy is most common in the drought-prone Sholapur villages, where from about one-fifth to one-third of the gross cropped area of respondents was sharecropped from 1975/76 to 1982/83 (table 6.7). In contrast, only about one field in twenty was farmed by a tenant in Aurepalle, where fixed renting is more popular than sharecropping. Landlord absenteeism is greater in Aurepalle than in the other study villages. Absenteeism tips the scales in favor of fixed renting because the landlord has a harder time monitoring the tenant's effort. Also, Aurepalle is the only village where small groups of tenants band together to lease in wetland on a fixed rent contract known as *arkapalu,* in which output

Table 6.7. Incidence of tenancy in the study villages[a]

	Tenure		
Village	*Owner-operated*	*Sharecropped*	*Fixed Rent*
Aurepalle[b]	96.4	0.5	3.1
Dokur[c]	84.1	15.0	1.0
Shrrapur[b]	64.5	35.5	0.0
Kalman[c]	77.6	22.1	0.3
Kanzara[b]	83.9	12.3	3.8
Kinkheda[c]	92.2	*7,7*	0.1

Source: Shaban (1985: table 6.3).

[a]% of gross cropped area, based on cropping season observations for 7,678 cultivated plots.

[b]Refers to eight cropping years, 1975/76-1982/83.

[c] Refers to five cropping years, 1975/76-1979/80.

is divided proportionally to the share of draft power contributed (Mohan Rao 1985).

This regional variation has persisted over time. Wage relations, characteristic of owner operation, do not appear to be displacing tenancy. Plotting the incidence of sharecropping and fixed cash renting from 1975/76 to 1984/85 even suggests an upward trend in the incidence of tenancy. Much of that trend is illusory because respondents underreported tenancy in 1975 and 1976 in all the villages, particularly in Shirapur, where the level of tenancy today is about the same as chronicled by Dantwala and Donde (1949) for comparable villages in the Bombay Deccan immediately after Independence.

Although both sharecropping and fixed renting coexist in each village, sharecropping is clearly more prevalent in the Maharashtra villages and Dokur. But the incidence of pure sharecropping, identified with the cultivation of only sharecropped land, is low, about one household in twenty-five during any cropping year. As in much of India, most tenancy is mixed: sharecroppers and fixed renters also cultivate their own land during the cropping season. The ratio of mixed to pure tenancy in the six villages in the late 1970s and early 1980s was about 3.8 : 1.0.

A considerable share of the land leasing—*tenancy* and *leasing* are used interchangeably in this section to embrace both fixed renting and sharecropping—would also be called reverse tenancy, defined as larger owners leasing in land from smaller owners. Reverse tenancy, accounting for 43 and 55 percent of the tenancy transactions from 1975/76 to 1978/79, was most prevalent in Kalman and Dokur, respectively, and least widespread in Kinkheda (13 percent of the transactions) (Jodha 1981a). Nonetheless, on average across the six villages, partners coming from the same farm-size group were more common (47 percent) than reverse tenancy (32 percent) and land leasing by larger to smaller farms (22 percent).

The majority (168 of 211) of heads of cultivator households owning land in 1982/83 at some time in their lives have participated in tenancy transactions. Across the six villages, the number (forty-three) of cultivator households that had not participated was about the same as the number (thirty-six) that had taken both sides of a transaction.

Although the tenancy market is active, tenancy does not appear to be a means to acquire land or accumulate wealth. In only 5 percent of land purchases, documented in the retrospective survey, did the prospective buyer farm the plot before purchasing it. Only 2 percent of the sample households have histories consistent with the concept of a tenancy ladder, with a progression from landless labor to tenant to owner operator.

The brief duration of most leases represents one feature of tenancy that is widely shared by the study villages. The majority, or about 60 percent of the sharecropping and fixed rent contracts, were for only one cropping season. Although enforcement of tenancy legislation has been directly responsible for the transfer of little if any land in the study villages, landowners are certainly aware of the legislation and the threat of losing land to tenants on longer-term leases (Cain 1981). Tenancy legislation has led to the demise of longer-term contractual arrangements such as *rehan* tenancy in Aurepalle. The practice of *rehan* was similar to usufruct mortgage, where the owner signs over the cultivation rights of the land to the tenant in exchange for a loan. No cases of *rehan* were reported in Aurepalle among the respondents from 1975 to 1985. *Rehan* was a common practice before the advent of tenancy legislation (Mohan Rao 1985). Moreover, landowners know that cultivating public land in the village is the most direct means to establish an entitlement claim by the tiller.

Thus, tenancy legislation could partially explain what appears to be the annual shuffling of partners and land in tenancy transactions. Shorter duration leases even in a geographic area as small as a village mean that it is more difficult for the landowner to obtain and utilize information on the work performance of the tenant and harder for the tenant to gauge the agronomic worth of the plot in allocating household resources for field cultivation between his own and leased in plots. As pointed out by classical economists, short leases discourage the use of inputs such as manure that farmers (rightly) believe have a residual or more lasting effect (longer than one year) on crop yields.

How much contract duration would lengthen without tenancy legislation under the present agrarian structure is a matter of conjecture. If tenancy legislation substantially reduces the periodicity of leasing, increasing the costs of acquiring and acting on information for both partners, then the static inefficiency costs of sharecropping, which are discussed later in this chapter, cannot be broken down to measure the separate contributions of tenancy per se and the periodicity effect induced by tenancy legislation.

Another tenancy-related feature common to several of the study villages is the inferior soil quality of sharecropped compared to owner-operated plots. Across the six villages the mean per acre value of owner-operated plots was about 15 percent higher than sharecropped plots. When evaluated from a perspective of crop failure, there were also positive and statistically significant differences in the resource stability indices, described earlier in this chapter, between owned and sharecropped fields in Dokur, Shirapur, and Kalman (Singh and Walker 1982). Differences were positive but not statistically significant in the Akola villages, where land quality is more homogeneous. These differences are consistent with a scenario of owners farming their better fields and leasing out their more marginal plots when the owner decides to sharecrop out some land. A more marginal production environment in turn implies that one impetus for tenancy is risk sharing, assuming that returns to farming on more marginal land are more variable than what is obtained from cultivating better land.

Terms and Conditions of Leasing

From Jodha's (1981a) careful evaluation we can draw the following generalizations about the terms and conditions of sharecropping transactions. First, there was a great deal of variety in leasing conditions to reflect individual landowner and tenant circumstances, particularly in the Maharashtra villages. Nonetheless, in a village like Dokur, where purchased inputs are intensively utilized, fifty-fifty input and output sharing describes more than 90 percent of the transactions. In contrast in Shirapur, where little if any improved inputs are used on owner-operated dryland fields, the tenant is responsible for supplying all inputs, mainly seed, labor, and draft power, and receives a 50 to 75 percent output share.

Second, tenancy contracts were not cast in stone but were often flexible enough to incorporate information from midseason production contingencies. For example, in the Maharashtra villages the tenant's share in output could be negotiated upward if the landowner failed to provide his input share stipulated in the lease. Within-season production adjustments resulting in increasing cultivation costs borne by the tenant usually enabled him to claim a higher share of output.

Third, linked transactions between land and other factor and product markets were not that prevalent but still did represent a sizable share (about 12 percent) of tenancy transactions. Most of these transactions spanned the land and credit markets. Linked transactions were most common in Shirapur and Kalman, where tenants provided advances or loans to landowners to lease in land. The amount given was usually adjusted against the landowner's share at harvest. Tenants who did not furnish such advances often had to bear a higher proportion of input costs.

Forth, many tenancy arrangements improved the risk-bearing capacity

Table 6.8. Risk implications of tenancy arrangements in the Sholapur villages, 1975 to 1978

Tenancy Arrangement (N farms)	*Risk Implication*
Rent essentially fixed but subject to harvest (1)	Implicit risk sharing
Rent fixed, independent of harvest (2)	Risk transfer to tenant
Advance loan, rent subject to harvest (2)	Implicit risk sharing; risk/loss management
Input and output sharing (14)	Explicit risk sharing
Input (excluding bullock) and output sharing (29)	Explicit risk sharing; risk/loss management
Input and output sharing with adjustable advance loan (30)	Explicit risk sharing; risk/loss management
Net output sharing (19)	Risk transfer to tenant
Net output sharing with adjustable advance loan (17)	Risk transfer to tenant; risk/loss management
Risky plot tenancy with no fixed rental, no advance loan, meager crop share (19)	Implicit risk sharing
Mid-season leasing with share in output (9)	Risk transfer to tenant
Land lease linked to labor and credit contracts (22)	Explicit risk sharing; risk/loss management

Source: Walker and Jodha (1986: table 2.6).

of the landowner as risk was transferred to or shared by the tenant (table 6.8). Additionally, about 60 percent of the tenancy transactions in the Sholapur villages from 1975/76 to 1978/79 had implications for intertemporal adjustment to risk (Walker and Jodha 1986). These transactions represented a continuing attempt by farmers to adjust to resource losses, particularly depleted bullock stocks, incurred during the 1971 to 1973 drought.

Finally, unless the owner provided a considerable quantity of purchased inputs, such as inorganic fertilizer and seed of modem cultivars, the tenant decided what crop to plant. In general, tenants made management decisions or the decisions were taken jointly by the two parties. Eswaran and Kotwal (1985) have explained the coexistence of fixed rental, sharecropping, and owner operation in the same locality by highlighting the managerial role of the landlord and the supervisory function of the tenant. Jodha's evidence suggests that in most contracts in the study villages tenants were also intimately involved in managerial decisions.

Taken together, these five generalizations all point to the overriding conclusion that tenancy agreements were entered into by mutual consent and not by coercion.

Determinants of Tenancy

Although farmers gave many reasons why they leased in and leased out land, the most common explanation for most transactions centered on resource adjustment (Jodha 1981a). In Shirapur and Kalman, the 1971 to 1973 drought led to increased bullock mortality and sales by many cultivator household who faced rapidly rising fodder prices. Following the drought, many households could or did not buy bullocks to reinitiate cultivation. About 24 percent of all households in the two villages had to lease out their land in 1974/75 (Jodha, Asokan, and Ryan 1977).

A seasonal hiring market for draft power does exist but is thin mainly because the shrinking and swelling properties of the heavy clay soils in the Sholapur region greatly increase the need for timely tillage and cultivation, which in turn means that the demand for bullock hiring is extremely seasonal. Jodha's analysis of the tenancy data from 1975/76 to 1978/79 clearly shows that tenancy transactions tended to equalize land : bullock ratios. Before leasing, the mean land area per owned bullock in Kalman and Shirapur was 18.3 and 30.9 ha for landowners and 3.4 and 7.2 ha for tenants. Following tenancy, land area per bullock declined to 5.5 and 5.8 ha for landowners and increased to 7.2 and 8.2 ha for tenants.

Saying that farmers sharecrop to adjust owned bullock endowments to their land base still begs the question of what motivates sale and purchase transactions in the bullock market. Undoubtedly, resource adjustment in the bullock market underlies much of the motivation for tenancy in South Asia (Bliss and Stern 1982; Nabi 1985), but such an explanation is to some extent superficial without a deeper understanding of why the market for draft power does not adjust.

The attractiveness of alternative employment opportunities in preference to cultivation and to a demand for timely loans (supplied by tenants) were other fairly common explanations given by landowners for tenancy. One potential explanation that was not cited by farmers and that did not receive any statistical support in later analysis by Jodha (1981a) and Pant (1981) was the need to engage in tenancy transactions to adjust to differences in household labor availability. This finding further reinforces the notion that the village labor markets are competitive.

The market for leasing is also dynamic in the study villages. *Arkapalu,* with group farming by tenants, was not practiced in Aurepalle twenty years ago. Most recently, larger farmers in Shirapur have shown a preference to give attached laborers tenancy contracts rather than employ them as RFSs. As we saw in chapter 5, the supply of attached laborers at the going wages is declining, which in turn enhances the comparative profitability of sharecropping from the landlords' perspective.

A tightening market for permanent servants precipitating a rise in tenancy is not unique to Shirapur. For example, in some dryland villages in Medak district of Andhra Pradesh, the number of permanent servants has declined markedly over the past decade in response to emerging off-farm employment opportunities, mainly in construction in Hyderabad, 100 km away (CRIDA and ICRISAT 1986). Contractors nowadays provide interest-free loans to laborers. Agriculture in these villages is not profitable enough for farmers to offer wages that are as attractive as those in the construction sector. The decline in attached laborers has led to an abrupt rise in sharecropping because permanent servants are no longer available as plowmen.

Overall, the picture that emerges is broadly consistent with Binswanger and Rosenzweig's statement that "tenancy contracts allow people to make better use of individual endowments and to arrive at combinations of income, effort, and risk that reflect their endowments and tastes" (1981: 33).

Static Efficiency Losses

The popular perception is that sharecropping is productively inefficient because there is less incentive to apply variable inputs to rented land relative to fixed renting or owner operation. Indeed, this perception is what would be predicted by the traditional Marshallian approach to modeling the production consequences of tenancy. The main competing school of thought is Cheung's (1969) approach, which assumes that landlords can effectively and inexpensively monitor tenants' activities. With this assumption one obtains the general result that sharecropping does not imply an efficiency loss because the intensity of cultivation and the marginal products of the factors of production are equated across owned and sharecropped land. Conversely, the presumed inability of the landlord to monitor the tenant's work directly leads to less intensive cultivation and lower productivity on sharecropped land in the Marshallian approach.

Implications from the two competing models are not easily tested because in most empirical applications it is extremely difficult to disentangle the pure tenancy effect from differences in household resource endowments and personal characteristics, access to nontraded inputs, and prices of traded inputs and outputs (Shaban 1987). The easiest way to circumvent these confounding effects is to compare factor intensities and productivity indices between owned and sharecropped land in the same household (Bell 1977). One only has to control for plot-specific differences in resource endowments.

The high incidence of mixed tenancy in the study villages allowed Shaban (1987) to carry out such a comparison. The core of Shaban's elegant, simple analysis is presented in table 6.9. The third line shows the mean percent difference in average input intensity and output on sharecropped relative to owner operated plots for the same household.

Table 6.9. Partitioning differences in factor intensity and productivity between owned and sharecropped land to irrigation, soil quality, and tenancy

Mean Differences, Tenancy effect, and % Share[a]	*Labor*							
	Family		*Hired*					
	Male	*Female*	*Male*	*Female*	*Bullock Draft*	*Seed*	*Fertilizer*	*Output*
Mean difference[b]	29.4	23.5	10.1	38.9	11.1	10.1	6.3	195
Tenancy effect[c]	17.4 (47)	16.1 (3.4)	6.2 (3.4)	17.1 (7.9)	8.7 (1.6)	5.8 (3.5)	0.3 (3.4)	94.7 (28.1)
% mean difference[d]	39.7	55.8	29.4	33.6	29.0	30.7	28.9	38.4
Irrigation share	32.6	35.9	34.5	59.9	14.8	62.7	77.5	52.4
Soil quality share	8.2	-4.4	4.1	-3.9	6.8	-20.1	17.7	-1.0
Tenancy share	59.2	68.5	61.4	44.0	78.4	57.4	4.8	48.6
Relative contribution of tenancy[e]	23.5	38.2	18.1	17.1	22.7	17.6	1.4	18.7

Source; Adapted from Shaban (1985).

[a]Based on 270 observations of mixed tenancy from the six study villages for the years listed in footnotes *b* and c in table 6.7.

[b]Average difference in input intensity or output productivity/acre between owned and sharecropped land. Labor and draft power are measured in hours/ha; seed, fertilizer, and output are in Rs/ha.

[c] Estimated regression coefficients for tenancy holding soil quality and irrigation differences between owned and sharecropped land constant. Positive values indicate that factor intensities or output productivity were greater on owned relative to sharecropped land. Standard errors are in parentheses.

[d]The share represents % of the mean difference that can be attributed to each variable. The mean difference is estimated relative to owned land.

[e]The tenancy share multiplied by % of the mean difference.

These mean differences in average input use and output are truly large, but there was considerable variation from village to village. (Shaban suggests that this variation can be explained by differences in terms of the contract. For example, in Dokur, where average factor intensities and output productivities were not statistically different at the 1 percent level, the terms were usually more favorable to tenants than in the other villages.) Controlling for the effects of soil quality and use of irrigation, tenancy significantly explains differences in the use intensity of family labor, hired female labor, bullock draft, and seed use and output productivity between sharecropped and owned fields within the same household in the same cropping year.

Tenancy's relative contribution is recorded in the bottom line of table 6.9. These differences are also substantial. Sharecropping accounted for an 18.7 percent reduction in output and a sizable decline in the average use of family labor and bullock draft. Differences in fertilizer use were amost entirely because of differences in access to irrigation. That tenancy an explain a substantial share of the difference in seed use is surprising nd suggests that farmers were planting more extensive crops on land harecropped in. When Shaban carried out the comparison on the most common cropping system in the sample, sole-cropped post-rainy season orghum, he still attributed sizable differences in labor and draft power intensity and output productivity to tenancy, but seed use on owned and harecropped in land did not differ appreciably. Those results indicate hat farmers are apt to apply less labor and draft power to the same ropping system and to sow more extensive, lower-valued crops on share-ropped land. Additional analysis of mixed tenancy between owner-operated and fixed rented plots showed that differences in input ratios vere not large.

Disparities in input use intensities and output productivity on owner operated and sharecropped in land could stem from either differences in input qualities or quantities. Again, focusing the analysis on the 1,300 orghum plots in the sample, Shaban found that family labor and draft power were significantly more productive on owned relative to share-ropped plots. Differences in input quality accounted for roughly half he difference in output productivity per hectare while the other half was :xplained by differences in input quantity.

Clearly the data confirm the popular perception, based on the Mar-hallian approach, that sharecropping does result in fairly sizable effi-iency losses in dryland agriculture. Landlords cannot cost effectively monitor the work performance of tenants.

Implications for Theoretical Models

The empirical evidence, presented in this section and in other chapters, suggests that theoretical models consistent with the land market for ten-ancy in the six study villages should be based on some of the following assumptions: (1) significant costs of monitoring tenants' effort, (2) thin bullock hire markets, (3) incomplete insurance markets, (4) competitive labor supply open to both tenants and landlords, (5) landownership by tenants, (6) risk-averse landlords and tenants, and (7) management de-cisions taken by tenants or jointly between tenants and landlords. Models such as Cheung's that assume away monitoring problems do not generate refutable hypotheses relevant to the market for tenancies in India's semi-arid tropics. The more practical implications of Shaban's estimates on the productive inefficiency of sharecropping are discussed in the con-cluding section of this chapter.

Fragmentation and Consolidation

In 1917, Mann observed that land fragmentation was an important constraint to raising productivity in dryland agriculture in Pimpla Soudagar, a village in the Bombay Deccan ecologically similar to Shirapur and Kalman. Unanimity or even consensus is rarely obtained in economics, but seasoned observers, regardless of nationality or ideological persuasion, of agrarian structure and reform in India agree with Mann: Land fragmentation exacts a heavy toll in economic inefficiency (Dantwala 1959; Ladejinsky 1977; Mosher 1966; Nanavati 1953; Thorner 1965). Consolidation potentially enhances the attractiveness of farm investment opportunities, particularly those such as tubewell irrigation that relate to land and water management, improves market access, diminishes the cost of labor supervision, and in general sets the stage for the expression of improved managerial performance. Despite these apparent benefits and operational programs in most states, consolidation schemes have only been successful on a widespread scale outside India's dryland semi-arid tropics in irrigated Punjab, Haryana, and western Uttar Pradesh.

In this section, we analyze several aspects relating to land fragmentation and the demand for consolidation in India's semi-arid tropics. One can hypothesize a priori that the demand for consolidation is not as strong as in irrigated agriculture in India's northwestern states because the incidence of fragmentation is not as great, the scope is less to exploit groundwater resources, and the demand for spatial diversification within a village is higher in dryland agriculture. While the general outlines of those hypotheses undoubtedly have some validity, there is much we do not know about land fragmentation and the prospects for consolidation in India's SAT. We have precious little empirical evidence on (1) the level of land fragmentation, (2) how fragmentation is changing within and between generations, (3) the effects of land subdivision on fragmentation, (4) reasons why some fields are subdivided at inheritance and others are not, (5) effective means to make subdivision more costly, (6) how farmers perceive the costs and benefits of fragmentation, and (7) how closely those perceptions are reflected in empirical estimates of costs and benefits.

Research on these issues is increasingly topical because the Government of India, together with state governments, has embarked on an ambitious technology transfer program within the context of watershed management. Several hundred watersheds, ranging in size from several hundred to several thousand hectares, are envisaged or are being developed in the Seventh Five-Year Plan. The experience with small-scale watershed development in dryland agriculture in India's SAT has thus far shown that the potential scope for group action is limited (Doherty, Miranda, and Kampen 1982), and voluntary acceptance of soil conservation and land and water management practices is predicated on respecting farmers' field boundaries (Ryan, Virmani, and Swindale 1982). Gaining such respect often involves a sharp tradeoff between what is technically optimal and logistically feasible. Additionally, almost every watershed contains some defaulters who are not eligible for institutional credit. Therefore, the prospects for watershed development (and for using a watershed as a locus for technology transfer) are conditioned by the relative number of farmers and plots in the watershed, which in turn partially depends on the incidence of land fragmentation and land subdivision at inheritance. Accordingly, fragmentation in this section is viewed not only from the private vantage point of the individual farmer but also from the public perspective of government-financed watershed development.

This section draws heavily on Ballabh and Walker (1986). Because land fragmentation means different things to different people, we define what we mean by land fragmentation in the next subsection.

Definitions

Land fragmentation is synonymous with a spatially dispersed farm holding in which land held by an individual (or undivided family) is scattered throughout the village (or in neighboring villages) in plots separated by land in the possession of others (Royal Commission on Agriculture 1928, as cited by Roy 1983).

Fragmentation is often equated with small farm size (Igobozurike 1970; Government of India 1976). Data are seldom available that allow the researcher to separate fragmentation and farm size. When working with group or secondary data, most researches use as proxies for measuring fragmentation the number of fields per household (Evenson and Binswanger 1984) or the number of fields per unit area (Bardhan 1973). Both of these measures are usually highly correlated with farm size.

To measure fragmentation properly, one needs information on three attributes: (1) the number of noncontiguous fields in the holding, (2) the area of each field, and (3) the location of each field with reference to every other field in the same holding and to the village homestead.

We have data on the first two attributes and on how near each plot is to the village residence. Information on the number of noncontiguous fields per holding and the size of each field can be readily combined into a land fragmentation index by relying on measures of economic concentration or statistical diversity. We define a land fragmentation index as one minus the Simpson index of diversity (Patil and Taillie 1982). The index F is calculated for each farm house i for cropping year t and represents one minus the sum of the squared proportional area of each field:

$$F_{it} = 1 - \sum_{j} (W_{iJt})^2$$

where W_{ijt} equals the proportional area of field j to owned land of household i in year t. The index equals O for a holding containing one field, approaches 1 for an extremely fragmented holding comprised of many spatially dispersed parcels of equal size, and, unlike the measures cited earlier, is independent of farm size.

Incidence of Land Fragmentation

In this subsection, we review evidence on the level of fragmentation in dryland agriculture in India's semi-arid tropics. We rely on two sources: secondary information from the NSS and primary data from the study villages.

Data that permit interregional or intertemporal comparisons of the incidence of land fragmentation in India are exceedingly sparse. To our knowledge, the only published regional estimates of land fragmentation are based on data collected during the seventeenth round (1961/62) of the NSS (1968). The NSS data are not sufficiently disaggregate to allow one to calculate the land fragmentation index described earlier in the paper; therefore, only the conventional measures of land fragmentation are reported in table 6.10. Those estimates suggest that land fragmentation is much more severe in eastern India and in the northern irrigated belt comprising western Uttar Pradesh, Punjab, and Haryana than in the semi-arid tropical states (table 6.10).

Because of the success of consolidation programs in Haryana, Punjab, and western Uttar Pradesh, land fragmentation in that region is undoubtedly much less today than what is suggested by the 1961/62 data. Consolidation programs have not made any inroads in other states since 1961/62, so the main message transmitted by the data in Table 6.10 remains valid: Fragmentation in the semi-arid tropical states pales in comparison to what is found in eastern India.

In the study villages, the estimated incidence of land fragmentation in table 6.11 is considerably less than what is conveyed by the NSS data in table 6.10. Farm households on average own from one to three parcels; in contrast, the mean estimates for the semi-arid tropical states in table 6.10 range from more than three to less than six parcels per operational holding.

Casual empirical evidence further suggests that the level of land fragmentation is not that great in the study villages. The most fragmented holding in the sample of 173 cultivator households in 1982/83 contained nine parcels. Only about 20 percent of the parcels are less than two acres. Extreme fragmentation (in terms of postage stamp size or exceedingly irregular dimensions) was not encountered. (The literature is replete with cases of extreme fragmentation; for example, the Royal Commission on Agriculture in India in 1928 reported finding plots "as small as 1/160th

Table 6.10. Land fragmentation in India in 1961/62, by region and state

	Land Fragmentation	
Region[a] *and state*	*Parcels per Operational Holding (N)*	*Parcels per Acre of Operational Holding (N)*
Semi-arid tropical	4.41	0.60
Andhra Pradesh	4.32	0.61
Gujarat	4.30	0.39
Karnataka	3.79	0.37
Madhya Pradesh	5.30	0.53
Maharashtra	3.78	0.32
Tamil Nadu	4.96	1.35
Eastern	6.90	1.70
Bihar	7.18	1.92
West Bengal	7.12	1.85
Orissa	6.39	1.32
North irrigated	6.27	1.13
Punjab (including Haryana)	4.76	0.50
Uttar Pradesh	7.78	1.75
Other	3.53	0.90
Assam	2.75	0.76
Jammu and Kashmir	5.09	1.45
Kerala	2.01	1.09
Rajasthan	4.27	0.31

Source: National Sample Survey, seventeenth round, 1961/62.
[a]Regional averages are the simple means of the state averages.

of an acre" and other fields "over a mile long but only a few yards wide" [Royal Commission on Agriculture 1928: 134].)

Comparing the data in tables 6.10 and 6.11, one arrives at the inescapable conclusion that the state data overstate the incidence of land fragmentation in predominantly dryland farming communities in India's SAT. One can list three reasons for a biased picture. First, several rounds (the seventeenth round appears to be no exception) of the NSS on landholding count the homestead, that is, the village residence, as a parcel. Arable and nonarable land are not distinguished (Cain 1983). In contrast, only arable land is included in table 6.11. Second, fragmentation is undoubtedly greater in the more highly irrigated tracts and humid tropical costal regions within the SAT states. Hence, we would expect the state estimates to show a higher level of fragmentation than estimates based on largely unirrigated villages in the dry semi-arid tropics. Third, the data in table 6.10 refer to operational holdings, while those in table 6.11 pertain to owned holdings. Operated holdings on average are somewhat more fragmented than owned holdings for the sample households.

Table 6.11. Land fragmentation in 1982/83, by study village

		Land Fragmentation		
Village	*Observations (N)*	*Parcels per Farm Holding (N)*	*Parcels per Acre of Farm Holding (N)*	*Mean Fragmentation Index*[a]
Aurepalle	30	2.23	0.37	0.37
Dokur	27	2.48	0.52	0.41
Shirapur	30	2.13	0.28	0.32
Kalman	29	2.24	0.17	0.34
Kanzara	29	1.89	0.26	0.28
Kinkheda	28	1.57	0.22	0.16
All villages	173	2.09	0.30	0.31

[a]One minus the Simpson Index of Diversity. This fragmentation index equals zero for a household owning a single parcel and approaches one for a household having many parcels of equal size.

In spite of the rather low level of fragmentation in the study villages, interregional variation in the spatial dispersion of parcels is marked. Fragmentation is greatest in the Mahbubnagar villages and least in the Akola villages. More than half the cultivator households in the Akola villages own only one parcel.

Resource endowments and (to a lesser extent) institutional regulations in the land market account for a sizable share of the interregional variation in land fragmentation. The land : man ratios are higher in the Maharashtra villages than in the Andhra Pradesh villages. Less population pressure on land is also signaled by lowered irrigation intensity in the Maharashtra villages.

Variation in land quality also matters. Within each village, soils are more homogeneous in Kanzara and Kinkheda than in the other villages (chapter 3). Less soil heterogeneity limits the scope for spatial diversification, which in turn should reduce the pressure for land subdivision, resulting in fragmentation. Greater soil heterogeneity in Aurepalle and Dokur also makes it more difficult for brothers to strike a bargain without having to resort to the equal partition of all plots at inheritance or at family division.

Some rules and regulations apparently have had an impact on the incidence of land fragmentation. Foremost among these is *agrah kriya,* literally meaning "on request," which was enforced until the early 1960s in some regions, including Akola, of the erstwhile Central Provinces. *Agrah kriya* stipulated that a farmer had to obtain a declaration certificate from each brother before he could sell his land. The certificate stated that the brother(s) were not interested in buying the land or could not buy the land at the prevailing market price. If a brother wanted to purchase the land at the market price, then the seller was obliged to sell it to him.

Agrah kriya dampened land fragmentation in two ways. First, it increased the cost of transacting land, thereby enhancing incentives for heirs to demand fewer larger-size plots in preference to more smaller-size plots at inheritance. Second, it stimulated consolidation through land market transactions by giving brothers, who often subdivided contiguous plots, first option on prospective land for sale. Although *agrah kriya* has not been enforced in many years, older farmers in Kanzara and Kinkheda remember it as inhibiting land subdivision and as promoting the exchange of plots among brothers.

Has land fragmentation, measured independently of farm size, increased over time? Intergenerational changes in land fragmentation can be estimated by comparing the landholding immediately preceding inheritance to the ownership pattern in 1982/83. The first inheritance was in 1943, the last in 1982. Because the median year of inheritance was 1962/63, a reference point of 1982/83 provides a comparative picture spanning roughly twenty years.

In contrast to secularly declining farm size, documented earlier in this chapter, the level of land fragmentation, measured independently of farm size, has not changed appreciably since before inheritance. Heads of households in 1982/83 possessed holdings which were as spatially scattered as those owned by their fathers. Only in Dokur has the mean level of fragmentation noticeably increased intergenerationally. But from the more social point of view of a watershed development authority, fragmentation has risen because the number of owners and parcels within a given area, usually encompassing many owners, has increased substantially between generations. As viewed from that perspective, the mean land fragmentation index across the six villages increased from about 0.35 before inheritance to 0.60 immediately after inheritance.

Land Subdivision

Land subdivision is a potential consequence of inheritance following the death of the household head or from the division of the joint family consisting of one or more married brothers. In either event, the Hindu Law of Inheritance prevails by which "every male member of the family obtains a share in the ancestral property of the family not only on father's death but at his own birth; and like the prodigal son in the parable he may demand a partition of the property at any time" (Keating 1912: 53, as cited in Pandit 1969: 153). There are several variations on the Hindu Law of Inheritance in terms of what assets are transferred and when property passes from one generation to another, but the unifying feature of all variations is the right of all surviving males to a fair share of the ancestral property.

Table 6.12. Division of land after respondent became head of the household, until 1982/83, in number of households and plots by region

	Number of Households, by Region				Number of Plots	
Division Category	*Mahbubnagar*	*Sholapur*	*Akola*	*Total*	*Divided*	*Undivided*
Undivided plots	21	27	23	71	0	261
One heir	15	13	9	37	0	130
Multiple heirs, multiple plots, joint household	3	3	7	13	0	51
Multiple heirs, one plot, joint household	3	5	5	13	0	13
Multiple heirs, household divided, no plots divided	0	6	2	8	0	67
Divided plots	41	38	22	101	259	110
One plot divided equally among heirs	6	9	10	25	25	0
Multiple plots divided equally among heirs	18	10	1	29	90	0
Multiple plots, each heir receiving a share of each plot, but unequally	5	5	0	10	38	0
Multiple plots all divided, but each heir does not share each plot	3	2	0	5	24	0
Multiple plots, at least one plot undivided and one divided	9	12	11	32	82	110
Total households and plots	62	65	45	172	259	371

When the joint family splits or the father dies, the sons negotiate on the subdivision of the property. Often relatives and village elders are called upon to mediate disputes. If the sons cannot achieve unanimity on fair division, the extreme form of land subdivision occurs, where equal shares of each plot are allocated to each male heir. Hence, equal land subdivision usually arises as a consequence of last resort when alternative allotments have been explored and avenues for arriving at consent have been exhausted.

A detailed picture of the incidence of family division and land subdivision for the sample households is presented in table 6.12, which presents data on land subdivision between the time the respondent became household head, usually at inheritance, and 1982/83. About 29 percent of the sample households did not inherit land (i.e., they were landless at inheritance). About 40 percent of the remaining households that had land to bequeath did not subdivide plots. They were comprised of single-heir households, joint households that did not divide intergenerationally after the respondent became household head, and multiple-heir households that transferred land intact from one generation to the next. But the majority (or 60 percent) of households did subdivide some land intergenerationally; 95 percent of multiple-heir households that split subdivided some land at inheritance. About half those households subdivided each plot equally among heirs.

Removing the thirty-seven single-heir households gives a sample population of 135 farm households that could have subdivided land at inheritance. Of those, about one household in three engaged in equal land subdivision among heirs, indicating that that outcome is not as rare as some authors like Roy (1983) suggest but also that equal land subdivision is not an inevitable consequence of the Hindu Law of Inheritance.

At the plot level, the empirical probability of plot division was 0.41 based on the 630 plots in the sample and 0.52 based on the 500 plots owned by multiple-heir households. Actual subdivision resulted in 880 plots passed on to the succeeding generation, an increase of 34 percent. If all plots of multiple-heir households had been equally subdivided among heirs, the original 630 plots would have been subdivided into 1,575 plots, about a 250 percent increase. Hence, about 23 percent of the potential for subdivision was realized. Actual land subdivision resulted in considerably less fragmentation than if equal plot subdivision had been rigidly followed.

Regional contrasts in the propensity to subdivide land are also exhibited in table 6.12. In the Akola villages, households seldom divide each plot equally among heirs if there is more than one plot to subdivide. In the Mahbubnagar villages, equal subdivision of all land at inheritance is a frequent outcome.

For the 135 multiple-heir landowning households in the sample, Ballabh and Walker (1986) analyzed the forces responsible for the interhousehold variation in the incidence of land subdivision. Several plot, household, and regional characteristics significantly ($p < .05$) influenced subdivision, but the impact of demographic determinants, such as number and age of heirs, had the strongest effect on subdivision. An additional heir above the mean level of 3.0 changed the predicted probability of subdivision from 0.45 to 0.57. A proportional 10 percent increase in the mean age of heirs resulted in a 12.7 percent increase in the incidence of subdivision. The relative strength and statistical significance of age corroborate the hypothesis that family division is a life cycle event partially determined by age. Clearly, population growth has strongly conditioned the trajectory of plot subdivision, leading to land fragmentation in the study villages.

Turning to land characteristics, the area of the plot has a less marked effect on subdivision than the total land endowment in number of plots and farm size. Nonetheless, small plots—those falling below the 25 percent cumulative distribution quartiles—are much less likely to be subdivided. For such plots, the estimated probability fell from 0.45 to about 0.15. This result suggests that there are strong economic and other forces acting as a friction to subdivide relatively small plots. Those forces to some extent make consolidation legislation, specifying the size below which land cannot be subdivided, redundant.

Variation in soil quality also has a marked influence on the decision to subdivide land. Villagers appear to be extremely reluctant to subdivide plots on shallow black soil. The estimated probability of subdividing a plot on deep black soil is 0.55. Switching to shallow black soil results in a steep decline to 0.20.

These results do support somewhat the frequently cited hypothesis in the literature that better quality land is found on smaller plots because of a higher propensity to subdivide such land (Roy 1983). Additionally, they call attention to the likely difficulties in exchanging land in a public-sector consolidation program in villages with heterogeneous soils.

Fragmentation and the Land Market

Changes in the incidence of land fragmentation within a generation are determined by the level and nature of land market transactions. If the demand for consolidation was strong, intragenerational transactions in the land market should pave the way for reduced fragmentation or should at least partially restore the integrity of holdings which were subdivided at family division. We saw earlier in this chapter that consolidation motivated many transactions in the land market. Consolidation directly or indirectly played a role in about half the land purchases made by respondents since inheritance.

Nonetheless, land market transactions did lead to increased fragmentation for 52 of the 127 sample households that owned land at inheritance and in 1982/83. For that sample, which held land at both points in time, the land fragmentation index increased only marginally from 0.29 immediately after inheritance to 0.35 in 1982/83. Overall, then, intragenerational land market transactions did not have much effect on mean levels of land fragmentation. Fragmentation did not increase within the same generation for the majority of households.

Costs and Benefits

In general, farmers owning more than one parcel felt that the costs of land fragmentation outweighed the benefits (table 6.13). All 119 multiple-parcel holders perceived that land fragmentation entailed some costs. Increased travel time and greater problems in supervising cropping op-

Table 6.13. Farmers' perceptions of the benefits and costs associated with land fragmentation, by village in 1985

	Village						
Perceptions[a,b]	*Aurepaile*	*Dokur*	*Shirapur*	*Kalman*	*Kanzara*	*Kinkheda*	*Total*
Costs[c]							
Increased travel time	21	18	21	16	12	7	95
Greater problems in supervision	15	13	20	7	12	6	73
Increased time in operations	2	16	5	4	6	6	39
Increased risk of crop loss from stray cattle	7	7	12	5	0	2	33
Increased theft and/or watching charges	1	0	1	0	0	0	2
Reduced incentives to irrigate	0	1	0	0	0	0	1
Benefits							
Fragmentation has some benefits	12	3	21	13	9	10	68
Reduced production risk	12	1	20	13	5	6	57
Enhanced resource adjustment	6	2	9	4	9	10	40
Decreased pest infestation	6	1	1	2	3	1	14
Fragmentation has no benefits	13	19	4	3	9	3	51

[a]Perceptions of cultivator households that owned more than one parcel in the study villages in the Mahbunagar, Sholapur, and Akola regions.
[b]Perceptions are not mutually exclusive as some households cited more than one reason for associated costs or benefits.
[c]All households thought that land fragmentation entailed some costs.

erations figured prominently as costs. Only one farmer mentioned that fragmentation acted as a deterrent to investing in irrigation.

One suspects that if this study had been conducted in the Indo-Gangetic Plain the pattern of responses would have been significantly different. Many more farmers would have viewed fragmentation as exacting a dynamic cost in eroding incentives to invest in irrigation. The lack of response on investment disincentives, potentially associated with fragmentation, amply reflects the scarcity of groundwater resources in the study villages.

On the benefit side, the majority of the farmers thought that some benefits did accrue from spatially scattered plots. Risk reduction was frequently alluded to as a beneficial consequence of fragmentation. Holding several spatially dispersed parcels was often associated with greater opportunities to exploit soil variation within the village. Farmers perceived that some crops can only be profitably grown on some soils in the village; hence, access to soil variation through fragmentation encourages crop diversification, which in turn facilitates resource adjustment as seasonal input demands vary by crop.

Nevertheless, more than 40 percent of the households felt no benefits were derived from spatially dispersed holdings. That feeling was particularly strong in the Mahbubnagar villages. Ironically, as we saw in the previous section, that is the region where the tendency to subdivide land is also the highest. Apparently, the perceived costs are not large enough to induce heirs to negotiate land allocations that preserve field integrity.

Based on farmers' perceptions, the costs of land fragmentation should be much more numerically visible than the benefits. Costs were estimated by adding the land fragmentation index as a regressor in the relationship, explaining the variation in household land productivity in tables 6.4 and 6.5.

In contrast to our earlier focus on gross returns, land productivity was measured in household net crop returns per hectare, which is equivalent to net returns to family labor, owned bullocks, land, management, and capital. Finding a negative estimated coefficient on the land fragmentation index would be consistent with farmers' perceptions that fragmentation is indeed costly.

Across the three regions, we found no compelling evidence that land fragmentation per se led to diminished land productivity. Only in the Akola villages was land fragmentation inversely related to land productivity, and that relationship was not statistically significant. In the Mahbubnagar villages, farm households that had more fragmented holdings and/or owned more parcels of land *ceteris paribus* were characterized by significantly higher net returns per hectare. The Mahbubnagar result, suggesting productivity benefits to more fragmented landholdings, was also obtained for two other study regions in Gujarat and Madhya Pradesh. To explain this finding, one could hypothesize that less able farmers in a sense deselected themselves from the set of fragmented landholders by selling off or leasing out parcels to more committed and capable farmers. While that hypothesis merits closer scrutiny, one can at least infer that land fragmentation in and of itself is not an economic liability at the existing level of technology in the study villages.

Probing deeper at the field level, three different measures of land productivity were used to identify the effect of distance on land productivity (Ballabh and Walker 1986). The results were village-specific: statistically significant and negative in the Sholapur villages, significantly positive in Aurepalle, and insignificant in Dokur and the Akola villages. An inverse relationship with distance accords well with results of Shaban's (1985) analysis of differences in productivity between owned and leased in plots within the same household. Supervising and monitoring costs on tenant's effort would presumably become greater for fields farther from the village. The conflicting results on distance across the six villages could also be explained by soil quality differences correlated with distance, which are not adequately reflected in the variation in parcel value.

To sum up, we have not been successful in imputing a cost to land fragmentation. The farmers' responses in the surveys are undoubtedly valid to some extent, but the perceived cost of land fragmentation is not sufficiently large to be readily quantified.

Switching from prospective costs to anticipated benefits, casual empiricism would also suggest that the potential for spatial diversification to reduce production risk is not that large in the majority of the villages. Although rainfall and to a greater extent soils change within the villages, especially Aurepalle, topography does not vary that much. Variation in slope typical of farming on a toposequence in West Africa's SAT or on the undulating fields of the English Commons (McCloskey 1976) probably more than any other physical characteristic determines the potential for spatial variation to result in reduced production risk. Such variation is usually lacking in India's dry SAT and most likely explains why many farmers feel that spatial diversity is not highly conducive to risk reduction.

Implications

The empirical results in the three study regions suggest that land fragmentation, measured independently of farm size, is not an important problem in the dry SAT in India. Holdings are much less fragmented than in some other Indian regions, most notably eastern India, where consolidation could foster the harnessing of underutilized groundwater resources. In most of India's dry SAT, untapped resources are not abundant; thus, the dynamic cost of reduced productivity potential, usually attributed to fragmentation, is considerably less than in the more favorably endowed environments. Furthermore, from the private perspective of individual farmers, the level of land fragmentation is not increasing appreciably over time. Holdings today are about as fragmented as they were twenty years ago.

Although farmers perceived that the costs of fragmentation exceeded the benefits from holding more spatially dispersed holdings, estimates at the household or field level did not show *ceteris paribus* that land productivity was lower on more fragmented farms. Indeed, for Aurepalle and Dokur and for other study villages in Gujarat and Madhya Pradesh, household net returns per hectare were strongly and positively correlated with land fragmentation. While that result merits closer examination, the evidence was clear from the detailed longitudinal plot and household data that fragmentation was not an economic liability at prevailing levels of technology.

From the more social perspective of watershed-based development, a different picture emerges. Within a watershed, encompassing one or more villages, fragmentation in terms of number of owners and/or cultivators and number of plots is rising. Largely because of land subdivision at inheritance, farm size declined in five of the six study villages. About one plot in three was subdivided among heirs between generations. (Still, the potential to subdivide land was much greater than what was actually realized.) The implications of shrinking farm size and increasing fragmentation for the transfer of land and water management practices within a watershed context are dealt with in chapter 10.

Based on our results, one would be hard-pressed to recommend that investing in consolidation programs should be accorded a high priority in India's dry semi-arid tropics. The significance of differences in soil quality in influencing plot subdivision within the household highlights the degree to which soil heterogeneity can inhibit plot exchange in a consolidation program within a village. Soils are much more homogeneous in the areas of northwestern India where consolidation has been successful. Undoubtedly, the consolidation programs are also structured very differently in the northwestern states and in the SAT states like Maharashtra that have committed some resources to consolidation. For example, the program in Uttar Pradesh features a high level of farmer participation; farmers play a more passive role in Maharashtra. But more fundamental reasons relating to farmer demand for consolidation were instrumental in determining regional variation in performance (Ballabh and Walker 1986). Thus, improving the track record of consolidation programs into the foreseeable future in India's SAT will be difficult and even a daunting task.

Finally, to the extent that land fragmentation is a problem it should be tackled at its source by making it less attractive for heirs to resort to the equal division of all plots. Land subdivision is not preordained but is conditioned by forces that operate at the plot, household, and regional level. We discussed one legislative rule, *agrah kriya,* that apparently has had a considerable impact in reducing the incidence of land subdivision in the Akola villages. Comparative research on ways to increase the cost of plot subdivision at inheritance should be assigned a high priority on the consolidation research agenda.

Conclusions

Much of the conventional wisdom, described at the outset of this chapter and prevailing in the 1950s, 1960s, and on into the 1970s, about agrarian change in South Asia does not presently hold for these dryland study villages. With some region-to-region and village-to-village variation, most notably the Sholapur region and the Shirapur village, the following general empirical facts about agrarian change emerge.

1. More people now own land in the villages than in the past as landowners have subdivided their land among their sons and erstwhile landless labor households have acquired some land.
2. The size distribution of owned land is characterized by greater equality and symmetry as the difference between the owned mean and median holding has narrowed.
3. Both relatively and absolutely, larger landowners have lost ground to smaller owners.
4. Pronounced downward mobility in landownership is more common than marked upward movement.
5. Some relative mobility did occur, as the rank order in 1950 was far from a perfect predictor of relative landholding in 1982.
6. Land partitioning in response to increasing population pressure and transactions in the land market both played major roles in the process of agrarian change.
7. The median size of owned holding has declined, but the decrease in the median size of operational holding has been more gradual because of reverse tenancy; that is, smaller owners leasing out their holdings to larger cultivators.
8. The incidence of mixed tenancy—sharecroppers and fixed renters cultivating their own land—does not appear to be decreasing.
9. Holding farm size constant, the level of land fragmentation has not changed appreciably.

In summary, the case for increasing household differentiation and economic polarization in the ownership of land is clearly rejected by these facts. Some measure of land reform has been implicitly and cost effectively achieved through increasing population pressure and land ceiling regulations.

The findings in this chapter are also at variance with what is often reported about land characteristics and agrarian change in canal-irrigated agriculture in India. For example, small farmers' superiority in land productivity and quality—two stylized facts frequently cited for irrigated agriculture in India—were not consistent with the empirical evidence from the majority of the study villages. Our results on the relationship between farm size and land productivity and quality varied substantially from region to region. Nonetheless, one broad generalization can be drawn: some personal characteristics such as caste were more important in explaining the variation in managerial performance among farmers within a region than some resource endowments such as workers per household. In particular, cultivators whose traditional occupation was farming fared better economically than others for whom farming was traditionally of secondary or tertiary importance.

Other potential contrasts with irrigated agriculture were pointed out. As Attwood's (1979) study shows, in-migration to irrigated villages, characterized by high rates of economic growth, within these same dryland regions can figure prominently in explaining changes in landlessness. In contrast, in-migration has been negligible over the last thirty years in the dryland study villages.

Another difference centers on the incidence of and scope for ameliorating land fragmentation, which is often endemic in irrigated tracts, particularly in East India. Our evidence suggests that land fragmentation is much less of a problem in these dryland regions. Moreover, the scope for effective consolidation via government programs is considerably reduced because of the pervasiveness of soil heterogeneity, which greatly increases the transactions cost of plot exchange, in dryland agriculture.

Several results from the analytical studies of tenancy in the villages were also counterintuitive. Tenancy legislation has to some extent served its purpose and has led to the demise of contractual forms, such as *rehan* in Aurepalle, that were conducive to exploitative acquisition of land. Now pure tenancy is rare in the village, mixed tenancy is relatively common, and so is reverse tenancy. The agrarian climate the legislation was designed to modify represents a substantial departure from current village reality. In general, tenancy arrangements, particularly sharecropping contracts, are flexible oral agreements arrived at by consent and based on differences in household resource endowments and preferences.

As discussed in chapter 5, changes in the labor market have been accommodated in the market for tenancies. The demand for tenancies also arises from incompleteness in the market for insurance and the unavailability of draft power. Because, as we argue in chapters 8 and 10, improvements in these markets are unlikely in the near future, mixed tenancy should be quite prevalent in the study villages for some time to come.

One of the potential shortcomings of such arrangements is their short duration. A considerable reshuffling of owners and tenants takes place every year. How high a toll brevity of contractual terms exacts on economic efficiency and how much the existing legislation generates incentives for shorter-term land leasing are unanswered empirical questions, but it should be recognized that in the present environment tenancy legislation could not only be outdated and redundant but could also entail costs.

One popular belief was supported. Sharecropping was indicted for its productive inefficiency. Mixed tenants cultivate the land they own significantly more intensively than the land they sharecrop. The difference in output and input use between owned and sharecropped fields within the same household implies that the landlord cannot readily monitor the effort of the tenant.

Two aspects of these fairly sizable efficiency losses warrant comment. First, the losses are attributed primarily to the underutilization of labor and bullock draft per unit of land. Allocation of purchased inputs at these relatively low use levels was not affected significantly by alternative tenurial forms. Variation in fertilizer use was largely conditioned by irrigation. Second, and more important, it would be wrong to infer that banning or legally eliminating sharecropping would yield significant gains to society. If the option of sharecropping was made less available, we suspect that some of the owners would have had to fallow land that was sharecropped. Others would have cultivated land destined for sharecropping as or even more extensively than did prospective tenants. Moreover, in Akola villages, longer-term tenancy behavior appears to reflect commitment to farming, as those less skilled or less interested in farming lease out their land to those more able or better motivated. To the extent that sharecropping arises from a desire to spread risk and adjust resources, the productive inefficiency of sharecropping should be assigned to incomplete markets for insurance and capital and seasonally unavailable draft power.

In discussing market imperfections in these poor dryland villages, rural financial markets should be the center of attention. Having empirically found a reasonable amount of competition in the land and labor markets, we now turn to the village credit markets.

7 Village Financial Markets

Like many other countries, India has followed a supply-leading approach to agricultural credit. Direct government lending, mainly in the form of *taccavi,* or short-term crop loans, to farmers started in the 1880s. The initial seeds of public-sector credit infrastructure in the countryside were planted in the early 1900s with the legal establishment of the Primary Agricultural Cooperative Credit Societies (PACSs), patterned on the German Raiffeisen model. Shortly thereafter, state land mortgage banks were founded, and they became the term lending arm of the cooperative movement. In 1935, formal recognition of the importance of agriculture in the economy was conveyed with the establishment of the Reserve Bank of India with a separate Agricultural Credit Department (Reserve Bank of India 1985).

After Independence, the publication of the report in 1954 of the All-India Rural Credit Survey Committee marked a watershed in rural credit policy. A most publicized finding was that more than 90 percent of farmer borrowing in 1951/52 was supplied by informal sources, mainly money-lenders; the share of the cooperative sector was only 3 percent. The committee recommended a large and rapid expansion of public-sector credit to agriculture.

More equitable access to institutional credit, both across and within regions, became the guiding principle. The state land mortgage banks were converted into land development banks (LDBs). The larger commercial banks were nationalized, and the Reserve Bank of India emitted minimum guidelines on the share of agricultural loans in their portfolios and on the ratio of rural to urban branches. In 1975, regional rural banks, designed to cater to the needs of poorer households with limited or no access to commercial banks, were instituted. In 1978/79, several poverty-relief programs focusing on asset generation for the rural poor were consolidated into the Integrated Rural Development Program (IRDP). And, most recently, the National Bank for Agriculture and Rural Development (NABARD), with a broader mandate for the refinancing of agricultural credit than that of previous organizations, was created. These developments have resulted in a dramatic increase in rural credit and branch banking, particularly since the early 1970s. For example, rural branches of commercial banks numbered only 5,000 in 1969; by 1984 the number of rural branches had risen to 40,000.

The supply-leading approach is rooted in the overriding concern for increasing agricultural production and in diminishing the scope for farmers to be burdened by oppressive debt to informal sources, particularly moneylenders (Reserve Bank of India 1985). The latter concern is embedded in historical events more than one hundred years old. Initially, under British rule, the civil court system strengthened the position of moneylenders, so much so that reported abuses became widespread in the late 1800s. In 1875, riots took place near Poona on the Bombay Deccan. In the disturbance-affected areas, farmers forcibly evicted Marwari and Gujarati moneylenders from their villages (Catanach 1970). The moneylenders were accused of engaging in strategic behavior to acquire farmers' land, especially in the wake of the downturn in cotton prices following the American Civil War and the drought in the early 1870s. While the precise and immediate causes of the Deccan Riots are debatable (Catanach 1966; Kumar 1965), the Riots Commission recommended that restraints be placed on moneylenders and further cited the need for competition with them in the provision of credit (Catanach 1970).

The commission's report left an indelible imprint on the agricultural credit landscape. Subsequently, the Deccan Agriculturalist Relief Act, passed in 1879, was the first in a wave of legislation that sought to curb the power of lenders (Nanavati and Anjaria 1970). It stipulated that unmortgaged land could not be forcibly sold to moneylenders to recover debt and that borrowers could declare bankruptcy if debt exceeded Rs 50. That legislation set the tone for Land Alienation, Usurious Loans, and Debt Conciliation acts. More recently, many state governments have passed legislation that legally absolves borrowers from debts to moneylenders (Grewal 1983).

The legal atmosphere for collateral recovery has deteriorated, and local political pressures to reschedule or write off loans during bad production years are still intense. That acquiescing to political pressure ultimately engenders financial indiscipline is epitomized by the following comments of secretaries of PACSs in Tamil Nadu: "Secretaries complained about the lack of respect that they unwittingly invited by encouraging timely repayment, collecting it, and then finding that the borrower had missed out on a Government loan waiver. Regular repayers of loans have been made fools of and many others have been discouraged from repaying by the ever present expectation of further debt relief (Rogaly 1987: 65-66). With some notable exceptions, such as the cooperative sector in Punjab and Haryana, the multiagency institutional rural credit system is beset by poor loan recovery. The worst offenders are the PACSs and the LDBs, but, overall, the recovery performance of commercial banks also leaves a lot to be desired.

The limited scope for the lender to procure the borrower's collateral, the culture of delinquency, and the need for financial discipline are themes that weave their way throughout the sections of this chapter, which draws heavily on Binswanger et al. (1985), Bhende (1986), and Binswanger and Rosenzweig (1986b). First, we scan the regional variation in the importance and general characteristics of the informal and formal lending sources. The second section contains an in-depth description of informal market activity, featuring the traditional moneylending system. Credit delinquency and diversion in institutional lending are the subjects of the third section, which is followed by a discussion of the changing village credit markets. The focus then turns briefly to summarizing who borrows from whom and who is more likely to default. The chapter concludes with an appraisal of what can be done to enhance positive interactions between rural financial markets and technical change in dryland agriculture.

General Features and Regional Variation

The infrastructure for institutional lending is similar across the six study villages (table 7.1). Primary agricultural cooperative societies were or-

Table 7.1. Institutional credit infrastructure in the study villages

	Credit Agency			
	Cooperative		*Nationalized Commercial Bank*	*Regional Rural Bank*
Village	*PACS*	*LDB*		
Aurepalle	In village, defunct; revitalized	31 km from village	10 km	Since 1982; 2 km
Dokur	In village, defunct; merged with a larger society	40 km	Adopted village in 1980; 35 km	None nearby
Shirapur	In village since 1954	12 km	Since 1981; 3 km	Since 1981; 3 km
Kalman	In village since 1954	33 km	In village since 1980	None nearby
Kanzara	In village since 1945	8 km	Adopted village in 1981; 3 km	None nearby
Kinkheda	In village since 1945	14 km	Adopted village in 1981; 14 km	None nearby

ganized in the villages in the late 1940s and early 1950s; term lending from the Land Development Bank started more than twenty-five years ago in offices located at some distance from the villages. More recently, branches of commercial banks have been established in towns near the villages. In the early 1980s, these branches "adopted" Dokur, Kanzara, and Kinkheda. Households in Shirapur and Aurepalle have also benefited from the recent opening of regional rural bank branches in the vicinity of their villages.

In spite of the similarity of public-sector credit infrastructure, the composition of the sources of credit varies sharply between the Maharashtra and Andhra Pradesh study villages (table 7.2). In the Maharashtra

Table 7.2. Credit market transactions in number of loans taken by the sample households, by sector, source, and village from 1976/77 to 1984/85

	Village		
Sector and Source	*Aurepalle*	*Shirapur*	*Kanzara*
Formal	43	75	317
	(26.4)[b]	(23.0)	(69.0)
Government	5	12	23
	(0.7)	(0.5)	(7.7)
Commercial bank	18	5	27
	(8.4)	(2.1)	(22.8)
Cooperative"	20	58	267
	(17.3)	(20.4)	(38.5)
Informal	1,419	1,130	478
	(73.6)	(77.0)	(31.0)
Moneylenders	960	181	60
	(52.5)	(18.5)	(6.7)
Relatives	77	184	33
	(8.8)	(14.3)	(3.2)
Friends	3	399	16
	(0.1)	(26.6)	(1.6)
Landlords	0	30	3
	(0.0)	(1.0)	(0.1)
Employers	119	12	10
	(4.3)	(0.1)	(1.5)
Tenants	5	28	0
	(1.2)	(39)	(0.0)
Private shop owners	143	58	35
	(5.2)	(1.6)	(2.0)
Other villagers	112	238	321
	(1.5)	(11.1)	(15.9)
Total loans *(N)*	1,462	1,205	795
Total amount in Rs	536,443	535,465	356,903

[a]Includes PACs and LDBs.

[b]% of total amount in Rs.

villages, the PACSs are still the main financial intermediaries for short-term lending; in Aurepalle and Dokur, misappropriation of funds or wanton borrower delinquency has limited the historical impact of the village PACSs. Professional moneylenders still provide the bulk of credit used by households in the Mahbubnagar villages, particularly in Aurepalle. Informal lending also loomed large in Shirapur, where direct borrowing by respondent households from relatives, friends, and other villagers, who do not fit into any of the other categories in table 7.2, accounted for about eight hundred loan transactions between 1976/77 and 1984/85, a period characterized by considerable borrower default, which in turn decreased the supply of institutional credit in Shirapur.

One of the most conspicuous features of the village financial markets is the marked absence of lending from commission agents, who play such a prominent role in financial intermediation in the rice-growing regions of South India (Harriss 1982). Almost all informal credit comes from within the village. Cloth merchants, originally from Kanzara but with shops in Murtizapur town, are the only outside informal intermediaries to supply appreciable amounts of credit.

Turning to institutional lending, most of the loans listed in table 7.2 for the PACSs in the Maharashtra villages were short-term, financing crop cultivation. Before the establishment of the PACSs farmers relied on *taceavi* loans from government revenue authorities. Wells have been dug, machinery purchased, and livestock bought with term loans from a land development bank.

Lending by government agencies in table 7.2 refers to socially oriented, targeted lending schemes. Before the studies started, the government also provided loans to repair and deepen wells and to purchase livestock, fodder, and agricultural inputs to hasten recovery from the early 1970s Maharashtra drought in the Sholapur villages.

Loans from commercial banks in the late 1970s comprised only a small share of total borrowing in the three continuous study villages during the period of analysis. The figures in table 7.2 probably do not do justice to the present role played by commercial lending, which is expanding over time. Also, if transactions data were available for Dokur and Kalman since 1980, they would show a surge in borrowing from commercial banks. Such borrowing has been instrumental in financing dug wells in Dokur and grape gardens in Kalman.

Another regional contrast pertains to the volume of lending: much higher in drought-prone Aurepalle and Shirapur than in rainfall-assured Kanzara, where more investment is financed out of equity and is associated with more divisible dryland agricultural techniques. In both Aurepalle and Shirapur, the bulk of agricultural investment centers on indivisible dug wells. Less risk and seasonality in production also reduce the demand for consumption and production credit in the Akola villages.

With more credit outstanding that is nonrecoverable, the Sholapur villages have about 20 percent more debt than the other villages and higher debt:income ratios. Debt:equity ratios were identical in the three regions.

The traditional moneylending system in the Mahbubnagar villages supports no less credit than the formal system in the Maharashtra villages. If we focused only on recoverable debt, the comparison would be even more favorable toward Aurepalle and Dokur because default on institutional credit was widespread in the Maharashtra villages, particularly in Shirapur. Still, we cannot say conclusively that formal sources have only substituted for moneylenders' activities because the volume of traditional moneylending could have been substantially lower in the Maharashtra villages before the PACSs were established.

The Informal Sector

Professional Moneylending

A well-developed, traditional moneylending system still exists in the Mahbubnagar villages, particularly Aurepalle. In the Sholapur and Akola villages, older informants, including former professional moneylenders, provided historical insight on the traditional system before it was supplanted by the cooperative credit societies in the 1950s (Binswanger et al. 1985).

Without competition from subsidized institutional credit, a village would typically have had from one to fifteen major moneylenders, each with a clientele from fifteen to fifty. (To put this small number of clients into perspective, a comparable number of customers per officer in a sample of branches of commercial and regional rural banks ranged from two hundred to four hundred in rural Tamil Nadu in the mid-1980s [Wiggins and Rajendran 1987].) For the largest moneylenders in Aurepalle, the size of the loan portfolio outstanding was about Rs 100,000 in the late 1970s. Some moneylenders were completely specialized, renting out whatever land they owned; most also farmed or traded.

Farmers would be associated in a personalized long-term relationship extending over several years or even decades with a single moneylender. For a sample of nineteen households in Aurepalle, the average length of relationship with the same moneylender was nine and a half years, with the longest lasting four decades. In such a relationship, the farmer would rely exclusively on that moneylender for large loans; the farmer could still obtain small loans from other moneylenders. Switching from one moneylender to another is feasible but not common. Repayment of debt to the first moneylender is a necessary condition for switching.

Both parties attempt to veil their transactions in secrecy. Only with delays in loan recovery would details about a client's borrowing be made public. But moneylenders in Aurepalle do exchange some information about clients. In particular, they know who lends to whom.

Unlike institutional sources, moneylenders explicitly lend for consumption and production. Moreover, borrowing terms do not differ for the same client between loans for consumption and production. But moneylenders are interested in the purpose of borrowing to obtain information about the client's overall financial position and behavior. Indeed, they record the purpose of each loan. Both parties have reputations as good or bad moneylenders or clients. Disclosing a borrower's financial difficulty in repaying loans threatens his reputation. Village elders assist in resolving recovery disputes by mediating between borrowers and lenders in public meetings.

The low level of financial intermediation among moneylenders and between moneylenders and other actors in the village financial market is one of the most notable features of traditional moneylending in these dryland villages. Moneylenders usually try to satisfy the financial demands of their clients in good standing from their own funds. If they are short of funds, they refer their client to another moneylender instead of borrowing from that lender and relending to their client. Moneylenders also rarely use funds borrowed from other sources, such as deposits from clients or even funds from relatives. Financial intermediation between moneylenders and traders is also limited. Apparently, moneylenders, traders, and other wealthy villagers have ample direct lending opportunities which curtail the demand for financial intermediation.

Explanations for moneylenders not accepting time deposits and lending solely out of equity are related to seasonality and covariate risk, which can be pronounced in dryland agriculture. Within years, seasonal and synchronic timing of operations implies that depositors would want to withdraw their funds for planting at the beginning of the growing season, precisely when borrowers will want to finance production. Deposits and repayments would similarly coincide at harvesting. Over years, covariance of weather risks leads to the bunching together of default risks. If crops fail in one year, most depositors will want to withdraw their deposits when many borrowers experience difficulty in repaying loans. In those adverse production years, lenders would be exposed to price risk on collateral in meeting depositors' demand for withdrawals.

The composition of borrowers in the traditional moneylending system differs somewhat but not appreciably from the mix of recipients of subsidized institutional credit. Depending on their asset positions and reputations, villagers face sharply different borrowing opportunities. Except for borrowing extremely small amounts, the landless are effectively excluded from the system. For farmers, the market is segmented into two loan classes, medium term and seasonal, varying markedly in term structure, interest rate, and monitoring activity by the moneylender. Moneylenders did not engage in long-term lending in any of the villages.

Farmers with a poor credit history can only borrow in the seasonal loan market. Their borrowings are closely tied to expected crop production. In contrast, large farmers with good reputations enjoy a relationship which resembles an open line of credit given by a commercial bank to trustworthy clients; that is, they borrow without pledging formal security and can use credit flexibly with regard to repayment terms and purpose in the medium-term loan market.

Medium-term loans are offered with an expectation that repayment will occur within one to three years. A precise repayment schedule is often not fixed in advance. In poor agricultural years, repayment could be extended for as long as five years. Such rescheduling demands that moneylenders who lend to farmers out of equity carry a high level of reserves.

Medium-term loans as large as Rs 10,000 for marriage were reported in the past, but nowadays loans of that size (in equivalent real prices) are rare. In the Mahbubnagar villages, the annual interest rate on medium-term loans is about 18 percent, but in the Maharashtra villages interest charges were considerably higher, as much as 40 percent per annum.

Seasonal loans are given at the start of the growing season to poorer clients for purchasing production inputs or for consumption. These loans have a long tradition and are referred to as *nagu* loans in Telegu, *savai* or *didhi* in Marathi. Interest rates are high as the total repayment of the principal and interest at the end of the crop season is one and a quarter to one and a half times the amount borrowed. For shorter duration crops of three to four months, interest charges usually amount to 25 percent of the principal; for longer duration crops of five to six months, 50 percent of the principal is commonly charged.

In Aurepalle, the repayment of *nagu* loans is closely monitored. The large moneylenders have regular employees who visit clients to learn the harvest date. The moneylender will then go to the threshing floor himself or send his employee with a bullock cart to recover the principal and interest at the threshing. In the other villages, seasonal loans do not seem to have been monitored as intensively.

While we have not scrutinized the accounts of the professional moneylenders in the villages to determine returns from their business, real interest rate charges do not appear to be exorbitant, especially when one considers that non-interest rate borrowing costs are negligible. Such costs can be considerable in the formal sector. For example, Datey (1978) estimated that only the nominal interest and share contributions resulted in annual charges around 17 percent per year on loans from the PACSs.

In the market for medium-term loans in Aurepalle, interest charges are what one might expect given the opportunity cost of funds and limited default risk arising from the moneylender's intimate knowledge of the borrower's personal characteristics and resource endowments. Moneylenders maintain that traditionally default was rare. A crude upper bound estimate would be that about one client in twenty completely defaulted on his medium-term loans in a given year.

We do not know why interest rates on medium-term loans were considerably higher in the Maharashtra villages. The successful penetration of the PACSs into those villages is reliable evidence that interest rates were indeed higher.

Interest charges on seasonal loans appear outwardly usurious, but borrowers take such loans only once a year. Given limited financial intermediation, moneylenders have few alternative uses of funds for the rest of the year (Bottomley 1965). Thus, the annual return on seasonal loans would seldom approach 100 percent. Moreover, seasonal loans are often negotiated in kind, with the lender bearing the seasonal price risk. Usually, prices are somewhat lower at harvesting, when the loan is repaid, than at sowing, when the loan is taken.

The majority of medium-term loans are given without security; collateral is only demanded of relatively unreliable clients. Security requirements could be added later if the borrower experienced repayment difficulties. The collateral for most seasonal short-term loans is the standing crop. Most informal loans negotiated by respondent households in the six villages are unsecured. Collateral was stipulated for only about one loan in six. Land was required as collateral for only about one loan in thirty.

Collateral substitutes have assumed primary importance in conditioning repayment incentives. Foremost among these is the threat of loss of future borrowing opportunities. For immobile populations, traditional moneylending systems transmit default information quickly to all potential lenders.

In the past, claims on assets figured more prominently as collateral. Gold traditionally was an important form of security but its use as collateral has virtually disappeared in the traditional moneylending system. Promissory notes were the other major form of collateral. Such notes enabled lenders to recover defaulters' debts from land sales. Many state governments, such as Maharashtra's, no longer honor promissary notes issued to moneylenders; consequently, the collateral value of land has sharply declined.

The erosion of the collateral value of tangible assets is firmly rooted in lack of legal enforcement in debt recovery described at the outset of this chapter. A deteriorating judicial environment for debt recovery also largely explains why recent microeconomic theoretical work emphasizing the role of collateral in credit market transactions does not do a good job in predicting aspects of collateral use in the study villages.

One strand of this literature focuses on the economics of information and incentive problems that distinguish personalized financial markets from impersonal markets for good and services (Virmani 1982; Shetty 1984; Binswanger 1986). Depending on assumptions about risk preferences, willingness to repay, and informational asymmetries, one of the functions identified in these models for collateral is to substitute, albeit imperfectly, for interest charges. Lenders can increase the rate of return on their loans either by charging higher interest rates or by raising collateral requirements.

Although these models provide substantial insight into the workings of rural financial markets, their narrower collateral implications are refuted by empirical data from credit surveys in the villages (Binswanger et al. 1985). The statistically most important determinant of collateral requirements in the informal market was the borrower's previous credit history. Borrowers with higher default ratios more likely had to ante up collateral, which suggests that lenders were primarily concerned about default from higher risk clients. *Ceteris paribus,* interest rates were higher when land was taken as collateral, which is inconsistent with the hypothesis that collateral is used as a rate of return substitute. Moreover, the practice of adding security if recovery was delayed also indicates that collateral is not used by moneylenders as a rate of return substitute but primarily as a means to improve repayment incentives.

The other strand of literature applies to monopolistic lending in traditional, simifeudal agrarian regions. These models attempt to explain why interest rates are exorbitantly high in such environments. Lenders engage in strategic behavior by charging usurious rates to encourage default, thereby accumulating borrowers' assets. Collateral pricing acts as an accomplice to interest rate manipulation to hasten the transfer of assets. Either by assumption (Bhaduri 1977) or by implication (Basu 1984), collateral is underpriced by the lender.

While moneylenders are motivated by self-interest, neither asset accumulation through lender-induced default nor collateral underpricing accords well with contemporary behavior in these village financial markets. Moneylenders do everything in their power to induce repayment. To instigate default would be bad for business in these immobile village populations, where the size of a moneylender's clientele is essentially limited. Default would be equivalent to reducing the number of clients that would be eligible for certain types of loans.

Recent history in the land market also does not bear out the hypothesis that moneylenders specified and enforced adverse contractual terms to acquire borrowers' assets. As we saw in the last chapter, distress sales of land are uncommon. Collateral underpricing is also not a salient feature of village financial transactions. We know of only one case—tied labor and credit contracts, described in chapter 5, for permanent servants in Aurepalle—where collateral in the form of the borrower's labor was underpriced during the study period.

Tied Labor-Credit Transactions

Landless laborers who possess few assets of security value are for all practical purposes outside the traditional moneylending system. Entering into a longer term labor contract is the only way the landless can borrow large amounts. These contracts were described in detail in chapter 5.

Relatives, Friends, and Other Villagers

Short-term loans and advances among friends and relatives are negotiated in all the villages but are especially prevalent in Shirapur and Kalman. Short signifies weeks or even days. Loan size ranges from Rs 5 to 50 for landless and small farmers to Rs 200 for more affluent groups. These loans are not given with the expectation that the borrower will have to reciprocate at a later date by advancing money to the lender. Reciprocity could take other forms than informal credit transactions. In the Sholapur and Akola villages, employers or potential employers may also give very small amounts to workers for a few days, but these loans are generally not repaid in labor. They do not represent an advance labor booking system as reported in eastern India (Bardhan and Rudra 1978).

Default on short-term loans and advances is rare. Selected informants in the Maharashtra villages maintain that interest-free loans from friends are the first ones they repay. Presumably, prompt repayment ensures the availability of this credit line.

In Aurepalle and Dokur, interest is typically charged even on loans involving relatives. The practice of taking interest is much more firmly established in the Mahbubnagar villages.

Women's Access to Credit and Chit Funds

Women have a hard time borrowing in their own right in the study villages. Widows who are heads of households are the only women who are not completely rationed out of the credit market. Furthermore, because women are not offered long-term labor contracts, they cannot obtain loans via labor-credit linkages. Some women lend and borrow small amounts among themselves. Indeed, a small minority of the small moneylenders are women.

One of the forms of borrowing and lending used by women is chit funds, which are essentially revolving credit and savings societies. Each fund is comprised of a group of participants who periodically, usually monthly, contribute to a fund which is earmarked to each member by lot or by auction. In the Maharashtra villages, chit funds are the exclusive domain of women, who use them to accumulate cash for lumpy purchases in an environment where no alternative credit or savings instruments are available to them.

Chit funds comprise a larger share of the informal credit market in the Mahbubnagar villages, particularly in Aurepalle. Mostly, the participants are regular-salaried workers or those who have a steady source of income such as tailoring, toddy tapping, or moneylending. Monthly contributions of Rs 100 to 400 of each of the ten to twenty participants in each fund are much higher than in the Maharashtra villages. Very few farmers without access to off-farm income are members. Because of the seasonality of receipts and expenditures in crop farming, pure cultivators would have a hard time in meeting the fixed regular contribution each month. The larger chit funds in Aurepalle satisfy the individual-specific needs of both lenders and borrowers. They supply liquidity to traders, savings toward the purchase of large consumer durables by salaried employees, and investment options to moneylenders and other participants. Each month the chit (i.e., the total amount contributed by all members) is auctioned, and the difference between the value of the auction price and the chit is loaned to participants at 2 percent interest per month. Returns on investment in the chit fund often compare favorably with those on official savings instruments.

Chit funds work best in a diversified urban environment or in a rural region such as Kerala, where covariate production risk is low or where off-farm or part-time earnings or receipts loom large in farm household income. In the study villages, the presence of covariate production risk, the seasonality of dryland agricultural production, and the paucity of off-farm income earning opportunities combine to limit the effectiveness of chit funds as financial instruments for agriculturalists.

The Formal Sector

The lack of financial discipline is the salient feature of the market for institutional credit. Repayment on institutional loans in the Maharashtra villages is clearly in line with or even worse than the all-India performance cited earlier in this chapter. Residents in the Sholapur and Akola villages have acquired a "culture" of delinquency in which defaults on institutional loans are public knowledge. In contrast to the social consequences of defaulting on a loan in the informal market, no stigma is attached to the failure to repay loans from official sources.

In Sholapur, following the severe drought of the early 1970s, several government agencies issued a variety of loans for procurement of fodder or for purchase of inputs or bullocks when the drought lifted. Farmers have completely defaulted on these loans. Among funds channeled through the cooperative sector, loans from the land development banks have the worst performance record. Financial discipline with the PACSs is not that much better. Only about 40 percent of all loans from the cooperative societies were not overdue in 1980.

In the Akola villages, most borrowers from official sources have loans which are overdue or in default. Government loans were mainly from a compulsory contour bunding program aimed at reducing soil erosion. Among respondents, all but one of those loans are in default for more than five years. Of total loans, only 22 percent were in good standing in Kanzara in 1980.

The poor repayment performance arises even though a comprehensive legal framework would appear to give official agencies ample power to recover credit. In the Akola villages, credit can also be recouped via the monopoly procurement agency for cotton, which can subtract outstanding debt to official credit agencies from the sellers' receipts.

Almost all institutional loans have a collateral requirement in the form of land or third-party guarantees. Third-party surety is especially common in the Akola villages, but instances of repayment from a guarantor are few and far between. Official credit agencies have also never (to our knowledge) succeeded in using their power to foreclose on land used as collateral in any of the study villages. In Kanzara, when the cooperative sector did attempt to foreclose on several occasions in the 1980s, no farmers would come forward to bid on the land to be auctioned. Almost always, loan rescheduling and subsequent term conversion are preferred to recovering collateral.

Gold still has considerable value as collateral in the institutional sector. So-called jewel loans play an important role in advances made by private commercial banks, nationalized banks, and even by the PACSs that have the authority to grant them (Wiggins and Rajendran 1987; Rogaly 1987). Such loans are characterized by minimal non-interest rate borrowing costs and are approved in fifteen or twenty minutes. PACSs with more of their lending portfolio in jewel loans are often found to be financially healthier.

In spite of the effort of official credit institutions to ensure the productive use of funds, credit is fungible and is readily diverted to alternative uses. For example, in the Akola villages only about two-fifths of the initial institutional loans were destined exclusively for the agricultural productive purpose for which they were taken (Binswanger et al. 1985). Another two-fifths had some leakage, although the bulk of the loans were spent on productive investment. About one-tenth of the borrowers used their first loans entirely to repay moneylenders. Similar data on the use of current loans suggest even less congruence between actual and stated use than for the initial loans. Nevertheless, institutional sources finance proportionally more investment for agricultural production than informal sources in the Maharashtra villages.

The Recent Evolution of the Village Financial Markets

The penetration of subsidized institutional credit into these villages during this century, especially since the early 1950s, has eroded the profitability of traditional moneylending, particularly in the Maharashtra villages. Large farmers were the main borrowers in the beginning of the cooperative movement. Moneylenders thus lost their best clients. In the Maharashtra villages, only one of the major moneylenders is still in business; the others have shifted their assets to farming or to off-farm investment opportunities often located in towns and cities. Moneylenders in Aurepalle claim that their clientele has decreased in size over the past ten years and that they have or are inclined to invest in other options. The erosion in repayment discipline is commonly cited as the principal motivation for their desire to reduce moneylending activities. The exit of professional moneylenders from their business in the Maharashtra villages and their inclination to do so in the Andhra Pradesh villages make for perhaps the most persuasive statement that the profitability of traditional moneylending has lessened over time.

In the Maharashtra villages, the large moneylenders have been partially replaced in the informal sector by several minor, less specialized moneylenders who supply smaller amounts. These lenders are usually farmers or small traders. Loans from these "newer" moneylenders are characterized by their short stipulated repayment period and high interest rate structure. In Shirapur, annual interest rates charged by minor moneylenders of 40 to 60 percent are common.

The medium-term informal loan market has vanished from the Maharashtra villages. Only the relatively unattractive forms of lending have survived; that is, short-term crop/consumption loans and tied labor-credit market transactions. These sources are only resorted to by people who do not have access to institutional credit. The quality (in terms of repayment capacity) of the pool of applicants coming to moneylenders has declined.

Borrowing and Overdues

In this section, we take a harder look at interhousehold variation in borrowing behavior and repayment performance in Aurepalle, Shirapur, and Kanzara, where data are available from 1976 to 1985. These topics have been investigated with different data sets and econometric specification in Bhende (1986), Binswanger et al. (1985), and Binswanger and Rosenzweig (1986b). Binswanger et al. and Bhende used data on loans outstanding from the credit endowment schedule from 1976/77 to 1980/81; Binswanger and Rosenzweig analyzed information on loan transactions from the transactions schedule from 1976/77 to 1983/84. Because the results are based on different data sources and econometric specifications, the estimates vary somewhat across the three studies.

In such research, causality is often difficult to impute; the estimated effect could be a supply or a demand influence or a joint effect of both (Binswanger and Rosenzweig 1986b). For example, age is positively related to institutional credit outstanding and default in Shirapur because some of the younger farmers were not heads of household when relief loans were administered during the "never in a hundred years" Maharashtra drought in the early 1970s. Such loans were not available in the other villages; thus, the link between age and institutional borrowing and default was pronounced in Shirapur but tenuous in Aurepalle and Kanzara.

We complement the findings in these three studies with tabular analysis and case study material. Because of the differences in the rural financial markets among the villages, we look at borrowing behavior and repayment performance for each village separately for the continuous sample of 104 households.

Borrowing

Borrowing opportunities should largely be shaped by current wealth, which is partially determined by past credit access, which in turn is ultimately linked to inherited wealth. How strong is the linkage between inherited wealth and borrowing in the segmented formal and informal credit markets? To answer this question, we focus on land, which comprises the bulk of the value of inherited assets, and chart the amount borrowed from 1976 to 1985 and the household's land inheritance by village and credit sector in figure 7.1 (As in chapter 6, wetland at inheritance was multiplied by 4.0 to convert to dryland equivalent area.)

Starting with Aurepalle and the formal sector, six landowning households did not take a loan from an institutional credit source from 1975/76 to 1984/85. Two of the households are headed by widows, who are illiterate. Men who head the other four households are also illiterate. They regard farming as a secondary occupation and largely come from the ranks of the small-farm stratum in the sample. None of the households has a previous history (before 1975) of institutional default on credit. Several own or occupy land which is not registered in their name, effectively precluding their borrowing from some institutional sources such as the land development bank. Among borrowers of institutional credit, the scatter of points is consistent with a positive association between the amount of land inherited and credit borrowed. In contrast, all thirty-four continuous respondent households in Aurepalle actively participated in the informal market as borrowers. A positive relationship between land inherited and the quantum of credit borrowed is not visible in the right-hand panel in figure 7.1a.

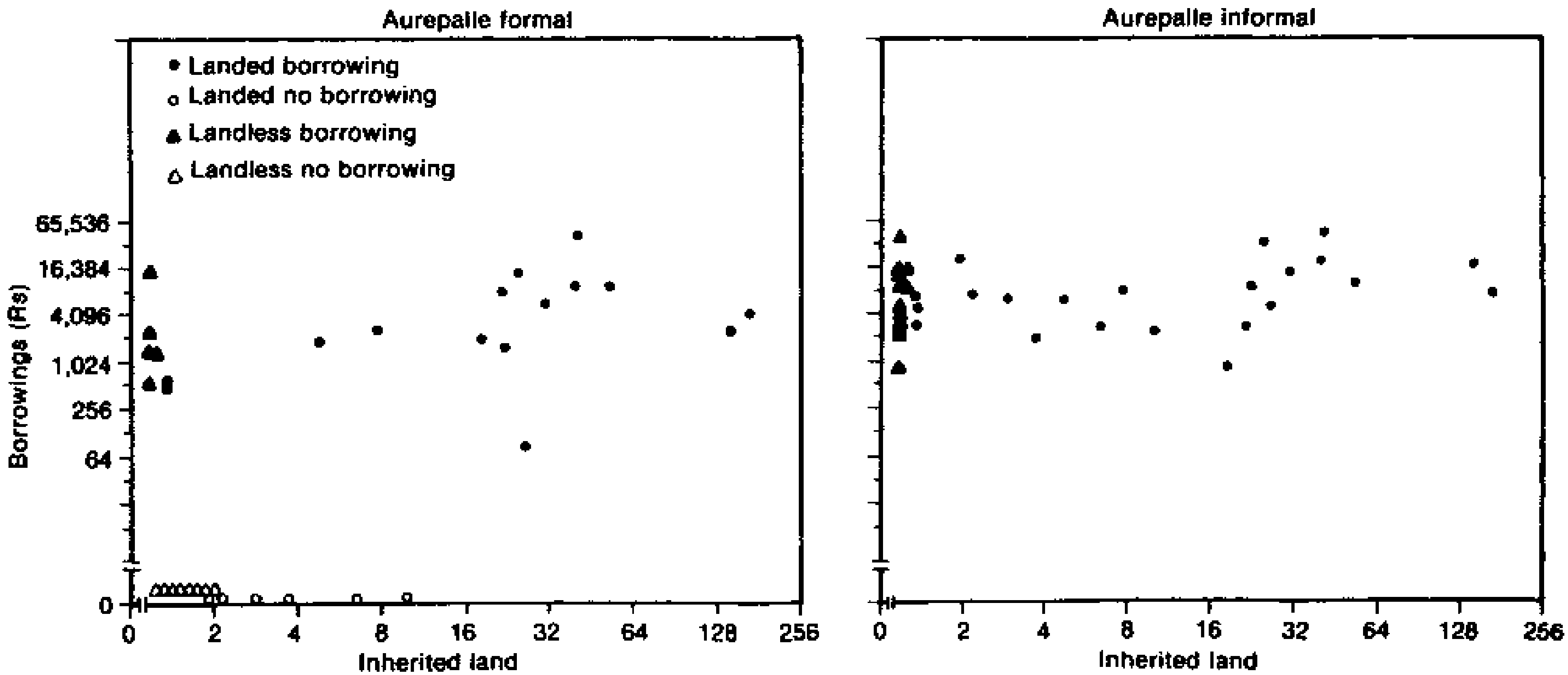


Figure 7.1 a Household borrowing (in Rs log base 2) from 1976/77 to 1984/85 and inherited land (in acres log base 2) by village and sector

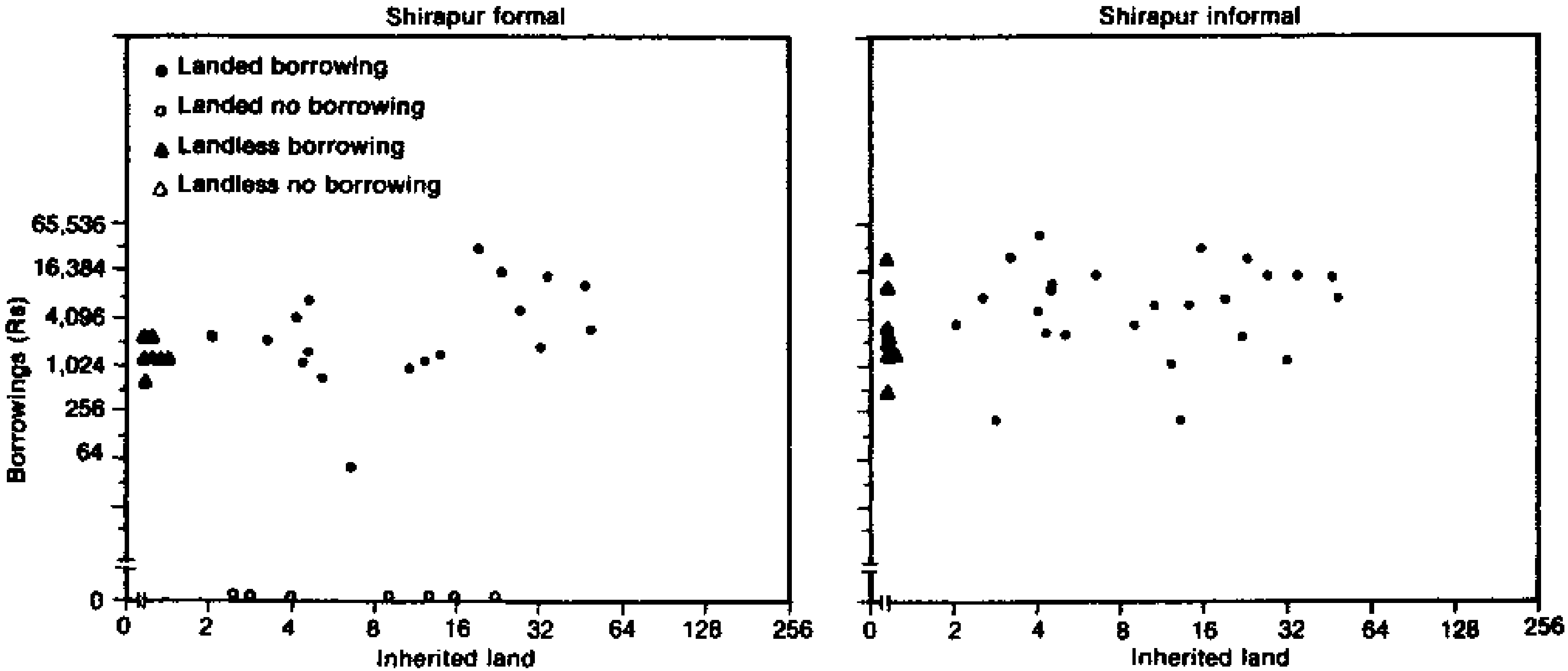


Figure 7.1 b Household borrowing (in Rs log base 2) from 1976/77 to 1984/85 and inherited land (in acres log base 2) by village and sector

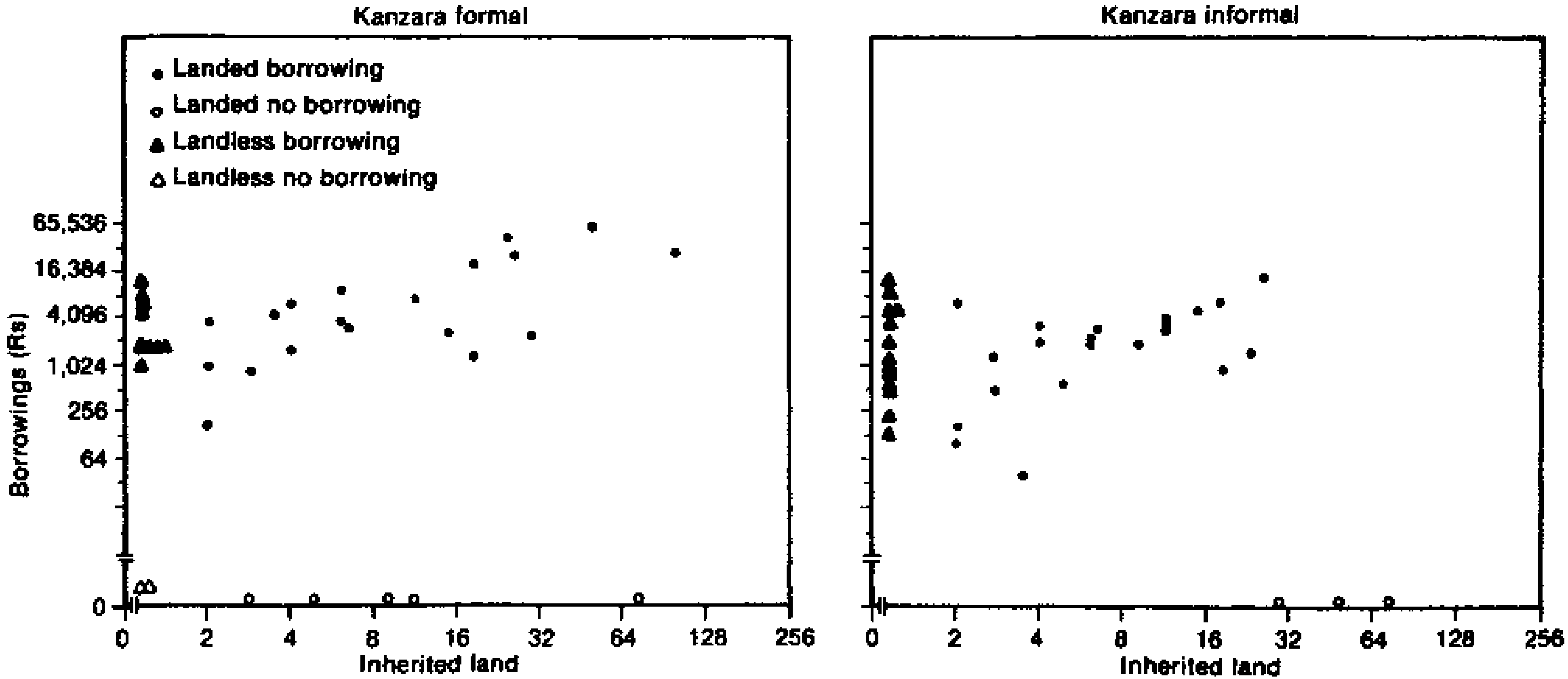


Figure 7.1 c Household borrowing (in Rs log base 2) from 1976/77 to 1984/85 and inherited land (in acres log base 2) by village and sector

Turning to Shirapur, a high incidence of default has weakened any latent relationship between institutional borrowing and the size of the inherited holding. The nonborrowers of institutional credit in the Shirapur sample from 1976 to 1984 are comprised of three defaulters, three widows, and one farmer who does not believe in going into debt. Of the borrowers, several households with inherited land have engaged in more institutional borrowing than any of the landless households, but the scatter of points only hints at a weak positive nexus between land inheritance and institutional borrowing. As in Aurepalle, every household in Shirapur participated in the informal credit market, and the scatter of points betrays no association between the amount of inherited land and informal borrowing.

Kanzara is the only village where a semblance of a correlation between inherited land and borrowing in both the formal and informal sectors is shown in figure 7.1. The five nonparticipants in the formal sector include four defaulters and a large progressive farmer who prides himself on never having taken a loan. He was joined by two other large farmers in not participating in the informal credit market. An assured-rainfall environment affords this luxury to households who do not like to carry debt.

Overall, one would be hard-pressed to say that the village households are chronically short of borrowing opportunities. The emphasis on "aggregate" analysis in figure 7.1 disguises the nature of segmentation and rationing that takes place within the institutional and informal sectors, but the only people systematically excluded from the institutional sector came from landless labor households in Aurepalle and from households headed by widows in the three villages.

Overdues and Default

Because overdues predominantly occur in the institutional sector, characteristics that are associated with public-sector borrowing are highly associated with default. Across the three villages and based on data on loans outstanding from 1976 to 1981, wealth, caste status, education, the dependency ratio, and residence in the Maharashtra villages were significantly and positively related to overdues (Binswanger et al. 1985).

Evaluating relative repayment performance by standardizing for the amount of credit received in terms of default ratios results in a much smaller set of statistically significant variables (Bhende 1986; Binswanger et al. 1985), Households with high dependency ratios are significantly greater credit risks than others. Differences in resource endowments did not explain the variation in relative repayment performance. The latter result differs from other empirical work, such as that of Patil (1967) and Pandey and Muralidram (1977), that found significant farm size by willingness or by ability to repay interactions. For our sample, small farmers seem as able to repay as large farmers, who appear to be as willing (or unwilling in the case of institutional credit) to meet their financial obligations as small farmers. Again, what matters somewhat in relative repayment performance are life cycle demographic characteristics, especially the dependency ratio. What matters most is the source of credit. Much of explained variation in relative repayment performance comes from pooling the data across villages and adding dummy variables that capture the greater use of and default on institutional credit in the Maharashtra villages (Binswanger et al. 1985).

Conclusions

What lessons can be drawn from our analysis of village credit markets for institutional lending in dryland agriculture in India's SAT? First, the marked timeliness of dryland agricultural operations necessitates flexible lending procedures. Much of the recent popularity of the commercial banks with large farmers in the villages stems from their relative lack of restrictions on how farmers use their loans. In the cooperative sector more rigid, stipulated in-kind lending prevails. Moreover, the emphasis by both traditional moneylenders and modern commercial banks on the overall financial position and prospective repayment performance of the borrower as the main criteria for lending makes a lot of sense in dryland agricultural regions. Once clients have established a reputation for creditworthiness, restrictions on how and when loans should be used should be kept to a minimum.

Focusing on specifics, fixed crop loan scales and seasonal repayment discipline are particularly hard to administer in dryland agriculture. As we shall see in the next chapter, if the monsoon is late, the farmer needs flexibility to be able to change the cropping enterprise. Staying with the planned cropping activity on which the scale of finance was based is often a prescription for agronomic and economic disaster. Thus, scales of finance for specific cropping activies are notional at best. Likewise, in the better-endowed dryland tracts with some prospects for double cropping in both the rainy and post-rainy season, a single loan disbursement for the cropping year is preferable to two allocations, one at the start of the rainy season and one contingent upon repayment of the first season's loans (Ryan, Virman and Swindale 1982). Verification of the first season's repayment often runs the risk of delaying if not missing the sowing of the second season, which in turn jeopardizes the repayment prospects of the second season's loan.

Second, marked seasonality in the timing of agricultural operations coupled with covariate production risk limit the scope for the potential of rotating credit societies, such as chit funds, to contribute to financing agricultural investment in dryland tracts. With the gradual growth in off-farm income opportunities documented in chapter 4, chit funds should become a more important segment of the informal market in these villages, but they will not have much effect on the financing of agricultural production.

Third, variable and covariate production risk has several implications for the development of rural branch banking (Binswanger 1986). If crops fail for most clients, debts have to be rescheduled, translating into unsatisfactory indicators of branch performance. Economic performance of individual branch offices may be poor for several consecutive years even with an excellent manager. Because inefficient branch managers cannot be distinguished from efficient ones in bad years, central managers have no reliable yardstick from which performance can be gauged. In turn, local managers posted to dryland regions will try to reduce the year-to-year fluctuations in their branch performance by choosing clients who represent exceedingly low default risk. An emphasis on meeting lending and deposit mobilization targets may offset these conservative tendencies in the short run but only at the risk of increasing the incidence of bad loans. Dealing effectively with such incentive problems, which may be particularly severe in dryland agricultural regions, requires that managers explicitly share in the long-term performance of the branch, which in turn means that the manager has to be posted in the branch for a long time.

The effectiveness of rural branch banking and the efficiency of rural credit markets will be greater where production risks are smaller and less covariate, sowing and harvesting are less synchronous across crops and farms, double or triple cropping is more widely practiced, transport and communications systems are better developed, and farmers are nearer to each other (Binswanger 1986). These production conditions describe irrigated regions much better than dryland production tracts. Nonetheless, the study villages are not starved for credit as the overwhelming majority of households engaged in institutional borrowing during the period of analysis. The most notable exception to that generalization were households headed by widows, who were effectively excluded from the market for institutional credit. The well-developed informal market in the Mahbubnagar villages also supported a considerable amount of productive investment.

The supply-leading approach has clearly been felt in all the villages. On the benefit side of the ledger, the entry of the nationalized commercial banks into rural branch banking in the late 1970s and early 1980s has supported considerable rural investment that may not have occurred or would have taken place at a much slower pace. Notable examples include investments in well digging, deepening, and desilting in Dokur and loans for the establishment of grape gardens in Kalman. As discussed in chapter 5, such investment has increased the demand for labor and is partially responsible for the tightening labor market in those two villages.

Aside from rural branch commercial banking, the other recent bright spot on the agricultural credit landscape in the villages is the availability of savings instruments offering rates of interest that have more than kept pace with inflation. From a small base, the number of households that have invested in time deposits or national savings certificates is growing (chapter 4).

The blemishes of a supply-leading approach are also evident in the villages. The additionality of institutional credit supplied has been less than unity. Farmers who rely on term lending from commercial banks were also the best clients of moneylenders for medium-term lending. Formal lending agencies also cannot provide several of the services offered by moneylenders. For example, more than three-quarters of the respondent households in Aurepalle made more than ten and as many as sixty-five loan transactions with moneylenders from 1975 to 1984. Most of these transactions were small consumption loans averaging Rs 50 to 100. The non-interest rate borrowing costs of supplying such loans through the institutional sector would be prohibitive. With the rapid expansion of institutional lending and the subsequent erosion in the profitability and the gradual demise of traditional moneylending, loans for small consumption items will become less available or more costly.

More important, aggressively supplying credit for increasing production sets in motion incentives for default. Repayment performance in the villages largely reflects expectations of government waivers on loan repayment. Loans for drought relief and for soil conservation have the worst repayment record. Drought relief loans were viewed by farmers in Shirapur as grants from the government, while loans for soil bunding in Kanzara have not resulted in perceived technical or economic benefits. Likewise, if farmers valued the services of the cooperative sector more highly, their repayment performance should have been better. Inherently, what cooperatives offered was not that attractive to induce farmers to maintain a good credit rating. In contrast, the more progressive farmers in the villages are doing their best to keep in good standing with the nationalized commercial banks.

In drought-prone Aurepalle and Shirapur, informal lending will continue to play an important role in village financial markets into the twenty-first century. Taking notice of that fact and subsequently trying to strengthen the informal sector would call for a substantial departure from (if not reversal in) thinking about rural credit policy since 1954. At least, that path is not uncharted, as a substantial literature is available on how to strengthen rural financial markets (Miracle 1973; von Pischke, Adams, and Donald 1983).

Looking into the near future, the lack of credit availability should not severely constrain the spread of technical change in these dryland agricultural regions. As argued, the villages are reasonably well-endowed with rural credit infrastructure. More important, profitability considerations loom larger than credit constraints. Shrinking farm size, particularly among the largest landowners in the villages, diminishes the profitability of owning tractors—a subject discussed in detail in chapter 10—and covariate risk circumscribes the scope for the development of tractor hire markets.

The other lumpy investment option in the villages is dug wells, described at length in chapter 3. Dug wells, although a risky investment prospect, hold the key to agricultural intensification in the Mahbubnagar and Sholapur regions. The profitability of other indivisible, farm-level land and water management options, such as small farm ponds for supplementary water harvesting and percolation structures for enhancing groundwater recharge, has not yet been conclusively established in these dryland agricultural study regions. Moreover, private demand for public-sector soil conservation works is weak.

If the recent past is any indication, the effective demand for credit should stem from cash-cropping opportunities associated with crop diversification or from intensifying fertilizer and pesticide use. Grape gardens in Kalman, small orchards of fruit trees in Shirapur and Kanzara, short duration pigeon pea in Kanzara, and hybrid castor in Aurepalle all fit the description of present or emerging cash cropping opportunities. With the exception of grape gardens, these opportunities are to some extent divisible. The penchant of agricultural scientists to emphasize synergism and complementary effects in a package approach and of agricultural economists to model credit gaps in a linear programming framework imparts a spurious sense of lumpiness to separable components. Such thinking and analytical method magnify the size of credit constraints.

The preceding discussion does not mean that farmers will not continue to face liquidity problems. They will. For example, in Kanzara, differences in fertilizer use on hybrid sorghum will endure for several years after the initial adoption of the sorghum hybrids and fertilizer. Mung bean will continue to be popular in large part because it improves the farmer's seasonal cash flow.

The issue is no longer how much institutional credit is allocated to these poor dryland regions or even what are the bankable prospects. The important questions are how the delivery system can be made more efficient in addressing timeliness and flexibility requirements endemic to dryland agricultural production and how the culture of delinquency can be reversed.

Part Three Risk, Nutrition, and Technical Change

8 Risk

What most distinguishes the SAT from more humid environments is the high incidence of rainfall-related production risk. If insurance markets were complete, capital markets allowed households to save and borrow to smooth income variability, and futures markets gave information on prices, risk would not be a source of concern in a country as large as India. But India's SAT, like most regions in the developing world, is characterized by incomplete insurance markets, fragmented rural financial markets, and rudimentary or nonexistent futures price markets. Therefore, production risk can exact a heavy toll on human welfare.

The consequences of risk are potentially numerous. They can range from direct reductions in utility for households unwilling to take risk, to slower diffusion of more profitable but riskier technologies, to spatially diversified but more fragmented landholdings, and even to higher population growth rates to compensate for the absence of an income safety net outside the family.

The consequences are also debatable. Much of human behavior can be assigned to risk (Roumasset 1976). Indeed, as the reader is by now aware, we find it impossible to address risk in a self-contained chapter in this book. Risk-related issues crop up in almost every chapter. What is needed is careful empirical research to better understand when and under what conditions risk plays a significant role in conditioning human welfare.

We start our empirical inquiry by examining the role of risk perceptions in influencing farmer adoption decisions. We next turn to the sources of crop income risk in dryland agriculture in India's SAT compared to more heavily irrigated production environments. The discussion then shifts to farmers' willingness to take risk. The direct and indirect effects of risk aversion on technological change are assessed. The effectiveness of risk management in the study villages is the third broad topic covered in this chapter.

The first three sections set the stage for the thrust of the chapter: an analysis of the effectiveness of public sector policy responses to production risk in dryland agriculture in India's SAT. Because yield variability significantly conditions crop revenue risk, which, as we saw in chapter 4, is the main source of income variability for the overwhelming majority of cultivator households in India's SAT, and because crop insurance is the most direct policy response to address the problem of yield risk, we probe deeply into the pros and cons of crop insurance as a risk-diffusing institutional innovation in the fourth and last section of the chapter. That analysis is timely because the government has recently increased its commitment to crop insurance as a means to compensate for and mitigate production risk in Indian agriculture.

Risk Perceptions and Sources of Production Risk

In this section, we assert some simple and important points and substantiate others with empirical evidence. First, we define risk in the context of an adoption decision between two techniques, which intuitively shows that a rather narrow range of conditions is required for risk aversion to emerge as a major stumbling block to technological change. Second, we contend that different risk perceptions are usually more influential in conditioning decision choices than divergent risk attitudes. If this assertion is true, investments in activities that generate and diffuse more reliable technological information are probably more productive than alternative stabilization policies. Third, we illustrate with aggregate historical data how the relative importance of the sources of crop income risk changes markedly from an irrigated to a dryland production environment within India's SAT. This illustration is reinforced with an analysis of farmers' beliefs about yields and prices. That analysis additionally shows that the use of aggregate data may severely underestimate yield variability as a source of crop income risk when measured from the perspective of farmers' subjective beliefs on prices in nearby markets and on yields in their fields.

Adoption Decisions and When Risk Matters

Almost all models of decision making under uncertainty explicitly or implicitly embrace two concepts: risk perceptions and attitudes. Perceptions are beliefs about what will happen if alternative courses of action are followed; the values people attach to those beliefs are reflected in attitudes.

The distinction between risk attitudes and perceptions is not cosmetic. It is crucial for policy evaluation. If disparities in technological diffusion could be explained by the variation in risk attitudes among farmers, the demand for technology targeting or for crop insurance would increase. In contrast, divergent beliefs in technological performance call for investments in activities like on-farm research that generate more or better-quality information so that perceptions of farmers, extensionists, and researchers converge more rapidly.

Risk has to be perceived for it to have the potential to influence adoption decisions. When risk matters is illustrated with examples from the study villages. Suppose the farmer had risk perceptions identical to the historical plot cultivation data in the continuous study villages from 1975/76 to 1984/85. The farmer faces the choice of replacing his traditional or present practice(s) with an improved technique(s). At the risk of over-generalizing, five hypothetical and stereotypic cases, graphed in the five panels of figure 8.1, could occur.

Each panel corresponds to different perceptions of uncertain net crop return from adopting the improved technique (1) or from staying with the traditional practice (T). Panels a, d, and e are based on examples from the study villages, while the net return distributions in panels b and c are hypothetical.

The net return data in panels a, d, and e were deflated and adjusted for significant farmer-specific effects in a least squares dummy variable regression model described in Walker and Subba Rao (1982a). Because the *ceteris paribus* assumption does not hold (production techniques do vary somewhat from farmer to farmer within these stylized examples), these comparisons are only indicative and not definitive. Nonetheless, they do illustrate important points, and because of crop rotational considerations all other things cannot be held constant even with time series, agronomic experimental data.

Drawing on the concept of stochastic dominance, which is thoroughly discussed in the context of agricultural research by Anderson (1974), risk perceptions are embodied in the cumulative density functions, which index the summed probability that net returns fall below a given level. The lower cumulative density is "better" in the sense that for a given cumulative probability level a higher return level can always be obtained.

In panel a, we have the felicitous result that the improved technology (applying inorganic fertilizer to the cotton/pigeon pea intercrop in Kanzara during the rainy season) is superior to using no fertilizer for all levels of uncertain return. As long as decision makers prefer more to less, I will be preferred to T.

The result in panel a obtains more often than one usually realizes. For example, Grisley and Kellogg (1983) reported that in semi-arid tropical northeastern Thailand pairwise comparisons of farmers' subjective net return distributions for competing cropping activities resulted in forty-four of the forty-seven comparisons following the pattern displayed in panel a, where one action is risk efficient and thoroughly dominates another. Three other examples from the study villages include (1) (I) improved fertilizer-responsive, irrigated paddy varieties, described in chapter 3, sown in the rainy season in Aurepalle compared to (T) local varieties, (2) (I) inorganic fertilizer application to hybrid sorghum in Kanzara compared to (T) no fertilizer, and (3) (I) the cotton/mung bean

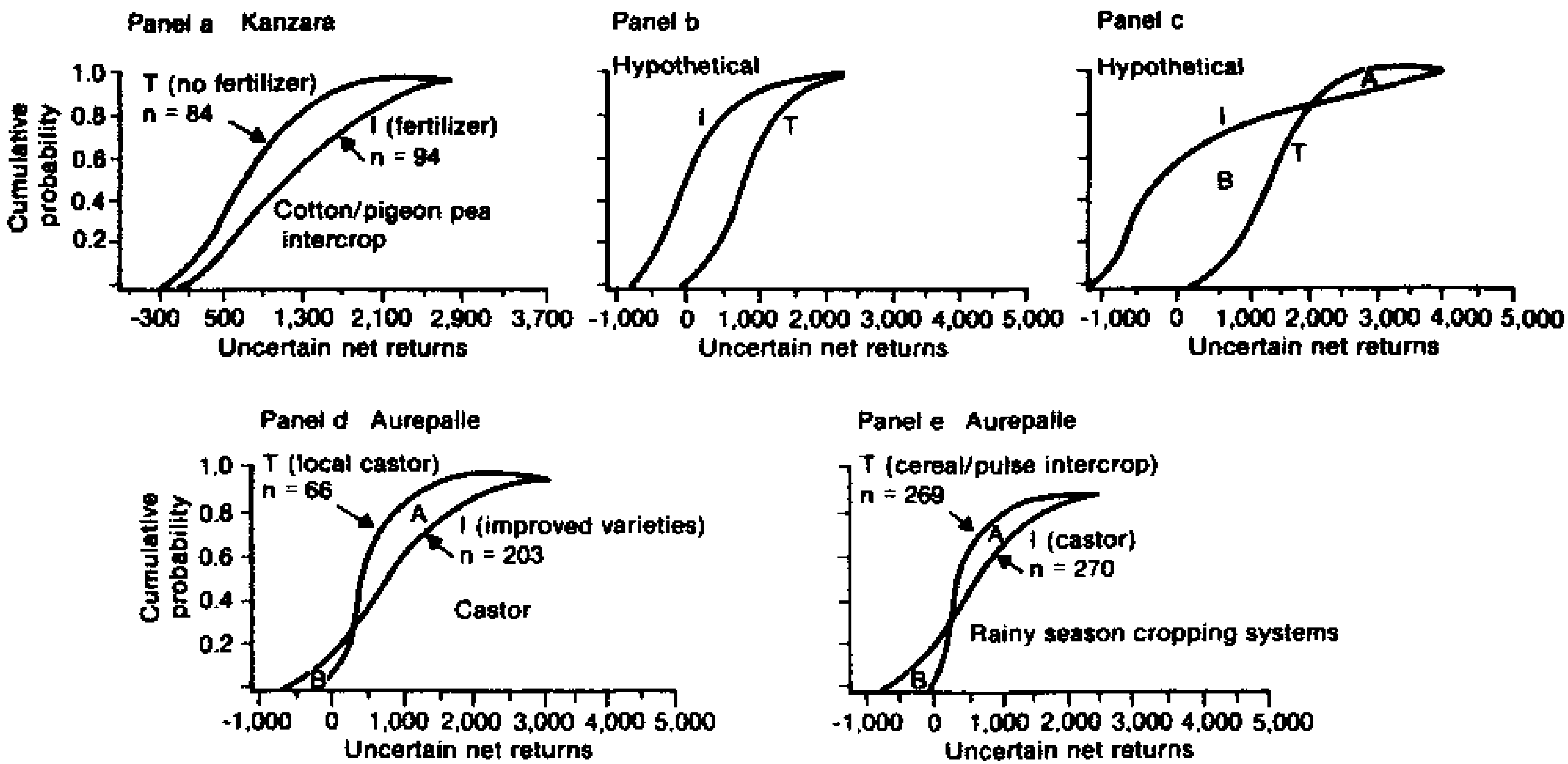


Figure 8.1 Alternative scenarios of risk perceptions between an improved technique (I) and a traditional practice (T)

Note: = Number of observations (fields) from 1975/76–1984/85.

intercrop in Kanzara compared to the (T) more extensive cotton/pigeon pea/local sorghum intercropping system.

The reverse can also occur (panel b). Farmers' present practices may dominate recommended (and rejected) techniques, particularly in more risk-prone, marginal environments. We do not have concrete empirical examples from the study villages that fit the panel b scenario because farmers would be irrational to adopt the improved technology under such conditions. Perhaps the example that best epitomizes that scenario is applying inorganic fertilizer to post-rainy season sorghum grown under farmer's management in the Sholapur villages (Dvorak 1986). Because of the absence of response to fertilizer with the farmers' late planting date, applying fertilizer only adds to production cost without increasing benefits.

Risk, or more specifically risk aversion, only becomes potentially important when the two cumulative distribution functions cross (panels c, d, and e). But crossing does not necessarily imply a conflict between risk and expected profitability. For the scenario described in panel c, the traditional technology is so much better in poor eventualities (which are relatively frequent) that its average profitability (area B is much larger than area A) greatly exceeds the mean return of the improved technology. Persistently low or even negative returns in the face of adverse events may compromise the profitability of the improved technology so much that it is perceived as being less remunerative than the traditional set of practices (Perrin and Winkelmann 1976). Cash-intensive hybrid cotton planted in dryland conditions in Kanzara could adhere to the pattern present in panel c. In abnormally good years, hybrid cotton would significantly outperform local cotton, mung bean, or hybrid sorghum, but those years of ideal growing conditions are so few that they do not make up for hybrid cotton's inferiority in the more numerous years of less than ideal growing conditions. Comparing the traditional sorghum/pearl millet/ pulse intercrop with sole-cropped hybrid sorghum in Aurepalle would also likely result in a panel c scenario.

At the other extreme, we have the case in panel d where the improved technology is superior over all but the most unfavorable events. Only severely risk-averse farmers would prefer T to I. Experimental results presented in the next section on farmers' willingness to take risks indicate that farmers are moderately to intermediately risk averse. Loosely interpreted, those results imply that they will be willing to adopt I as long as they perceive that the ratio of the change in expected standard deviation of net returns to the change in the expected mean net returns in switching from T to I does not exceed about 2.00. Farmers within the measured experimental risk attitudinal range would adopt I in panel d, which is represented by the comparative evaluation of improved castor varieties (I) to the local varieties (T) in Aurepalle.

Planting improved paddy varieties with high fertilizer levels in the post-rainy season in Dokur or Aurepalle also fits the conditions described in panel d. Because of voltage fluctuations in the dry season, electric pumps occasionally burn out, generating much larger losses than if the farmer had planted local varieties at lower fertilizer levels. The improved paddy system is immune to practically all other sources of risk, which means that the farmer does not have to accept much risk to make impressive gains in expected profitability.

Finally, we come to panel e, the only case where risk really matters. Risk and expected profitability are in sharp conflict. Choices hinge on farmers' risk preferences. After more than ten years of observing farmer behavior in the study villages, we are not hard-pressed to cite examples that fit the conditions of panel e, but there are not as many as one would think. Shifting from the traditional cereal/pulse intercrop to castor in Aurepalle (represented in panel e) is clearly one example; investing in dug well irrigation in all villages is another; switching from local cotton intercropping systems to hybrid sorghum in Kanzara is yet a third.

When we analyze the size of farmer risk aversion as a constraint to adoption we are essentially asking, What is the frequency of case e? We believe that even for the semi-arid tropics this frequency is lower than what most social and biological scientists believe. Only if perceptions fall within a fairly narrow range does risk aversion matter. This conclusion is also supported by risk programming models that show that the tradeoff between the variance and mean of expected crop income for all small, medium, and large representative farm sizes in the study villages is not steep (Hardaker and Ghodake 1984). Moreover, aggregating components into technology packages usually overstates risk because adoption is a piecemeal, sequential process. Assuming no other constraints are binding, farmers can sort through the package and adopt those components that fit panel a, reject those that conform to panel b, and obtain more information on the others through trial and evaluation in their fields. The technology level that farmers ultimately adopt usually entails much less risk than what is implied by an all-or-nothing decision, characteristic of a package approach.

The clearest example of risky decision making in the study villages is in-well borehole drilling. Bores are drilled to intercept water-bearing fissures to enhance the water yield in already dug wells (Engelhardt 1985). The drilling decision is indivisible and relatively costly, equivalent to about U.S. $175 in 1982 prices. Returns are largely conditioned by whether or not the bores intercept water-bearing fissures. Because farmers who own wells are relatively wealthy, differences in drilling behavior among well owners are unlikely to be ascribed to differential access to credit. Therefore, drilling boreholes in wells epitomizes a risky decision problem.

From survey research in the Aurepalle watershed, Engelhardt found that by 1982 (the first in-well bore was drilled in 1962) about 40 percent of the wells contained in-well bores. A random sample of thirty wells that did not have in-well bores revealed that well owners planned to drill bores in sixteen of the thirty wells. On average, well owners who planned to drill believed that the chances of hitting water were 0.78; those who did not plan to drill placed the odds much lower, at 0.54. Those who planned to drill were somewhat richer and operated wells with less multiple ownership, but the only statistically significant difference ($P < .01$) between the two groups of farmers was the difference in the subjective probability of intercepting water-bearing fissures. Although Engelhardt did not elicit farmer risk attitudes, differences in risk perceptions clearly appeared to be the driving force in the drilling decision.

Additionally, a decision analysis of in-well bore drilling revealed that for many farmers who planned to drill, the value of information from groundwater prospecting with electroresistivity soundings substantially exceeded its cost. The demand for information may also be considerable for other risky investment decisions in India's semi-arid tropics. During the last ten years, India has invested some resources in activities that generate and diffuse information over and above what commonly occurs in conventional research and extension programs. Notable examples are aspects of the Training and Visit System operating in some states, the Lab to Land Program, and the operational research projects of the Indian Council of Agricultural Research. Those activities could be deepened to place greater emphasis on diagnostic research and on researcher-managed trials in farmers' fields. Investing in regionally adaptive and on-farm research has still probably not hit the point of diminishing returns in Indian agriculture (Bredero 1987).

Emerging from our intuitive discussion is a clear realization that risk perceptions act as a screen or filter to delimit the number of times that a farmer's unwillingness to take risk actually influences choices made in adoption decisions. Holding risk attitudes constant (there is no evidence to suggest that risk attitudes change across regions), we cannot conclude that risk aversion directly acts as a greater deterrent to technology adoption in more drought-prone marginal production environments compared to more rainfall-assured producing regions within India's SAT. In the reasonably well-endowed Kanzara and Kinkheda, more competing techniques and crops mean that some will inevitably conform to the conditions of panel e. In contrast, in agroclimatically harsh Shirapur and Kalman, the frequency of case b will be much higher. We can, however, say with certainty that the sources of risk will differ markedly from region to region depending on the wider spatial variation in agroclimatic and soil characteristics. That statement is not based on intuition but is grounded in more rigorous empirical analysis described in the next subsection.

Sources of Crop Income Risk

In chapter 4, we saw that net crop revenue risk was the most important source of income variability for most farm households. Net crop revenue risk depends on variability from five sources: (1) input prices, (2) input levels, (3) planted areas, (4) output prices, and (5) yields. The relative importance of output price and yield variability conditioning crop revenue risk has received more analytical scrutiny than variability in input prices, input levels, and planted areas. The study that most directly focuses on this issue for India's SAT is that of Barah and Binswanger (1982), who partitioned gross revenue variability into price, yield, and price-yield interaction components. They used time series data (1956/57 to 1974/75) from ninety-one districts from four semi-arid tropical states: Andhra Pradesh, Karnataka, Madhya Pradesh, and Tamil Nadu. The districts were divided into three regions: (1) the unirrigated SAT with annual rainfall between 500 to 1,500 mm and with less than 25 percent of gross cropped area irrigated, (2) the irrigated SAT with annual rainfall between 500 to 1,500 mm and with more than 25 percent of gross cropped area irrigated, and (3) the humid tropics with annual rainfall exceeding 1,500 mm. Price and yield data were detrended to remove the effect of inflation and technological change. Corrected yields were multiplied by the average area share of the crop in gross cropped area of the district over time. This procedure greatly simplified the analysis and is equivalent to the strong assumption that farmers plant identical cropping patterns each year. Assuming that area variability is nil likely overstates gross revenue risk, but it should not distort estimates of the relative importance of yield vis-à-vis price variability.

The results of Barah and Binswanger's decomposition analysis using statistical identities are summarized in figure 8.2. For districts above the forty-five-degree line, along which the yield and price components are equal, yield variability is more important than price variability in determining gross revenue risk. Forty-nine of the fifty-nine unirrigated SAT districts are located above this line. For twenty-two of the twenty-seven irrigated SAT districts and for all five humid tropical districts, the price component exceeded the yield component. Clearly, the dominant source of gross revenue risk was yield variability in the unirrigated SAT; price variability was relatively more important in the irrigated SAT and in the humid tropical districts.

The majority of the districts in figure 8.2 lie above the diagonal line intersecting the 100-100 points on the price and yield component axes. Hence, for most districts, yields and prices are negatively covariate, which implies that perfect stabilization of price could destabilize gross revenues in some districts. More to the point, perfect stabilization of all output prices—equivalent to setting the price and yield-price interaction terms

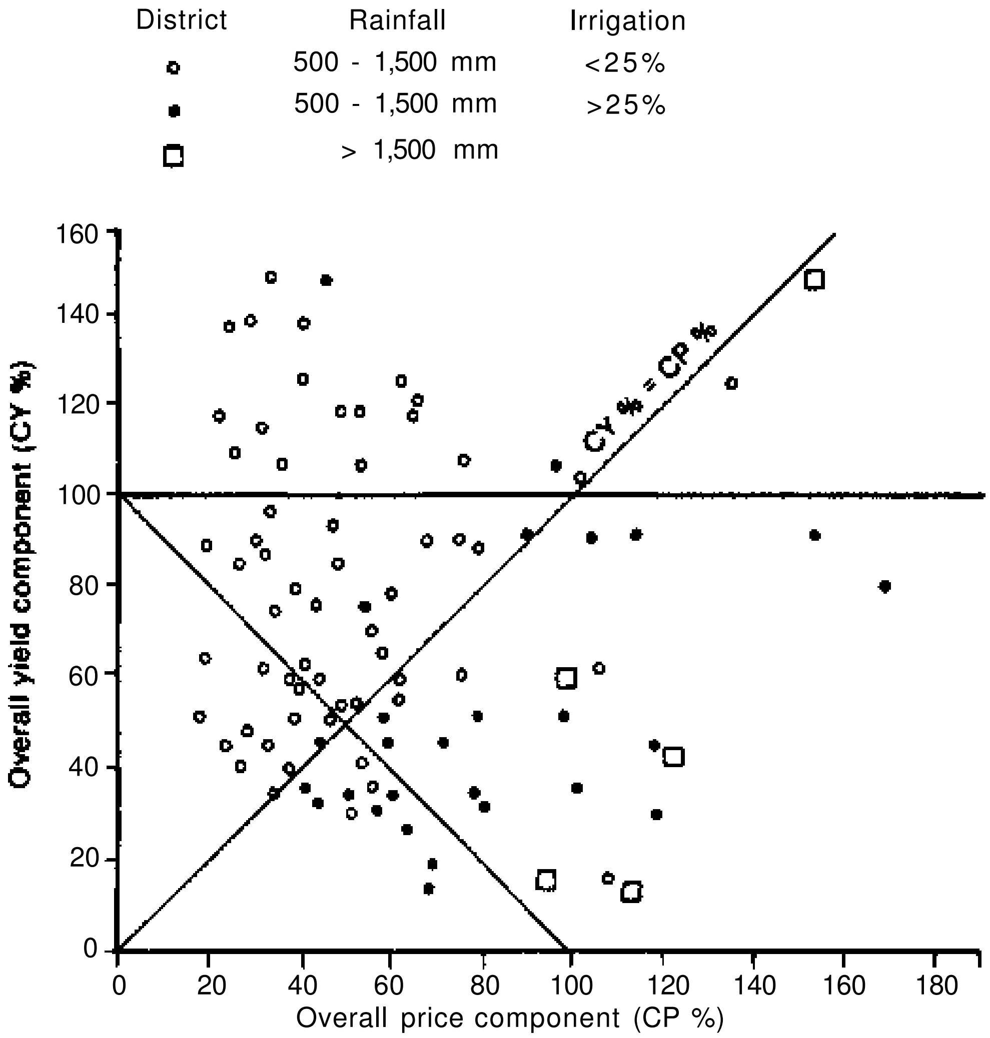


Figure 8.2 Yield versus price risk in conditioning gross crop revenue variability in SAT districts in Andhra Pradesh, Karnataka, Maharashtra, and Tamil Nadu from 1956/57 to 1974/75
Source: Barah and Binswanger (1982:figure 1).

to zero—would destabilize gross revenues in the twenty-one districts that lie above the horizontal line at 100 on the yield axis, indicating that the yield component exceeds 100 percent of the explained variation. Gross revenue risk in those twenty-one districts would increase in proportion to the vertical distance between the observed point and the horizontal line at 100. Seventeen of those twenty-one districts are from the poorer unirrigated SAT. They would be hurt by complete price stabilization. The major beneficiaries of reduced price variability would be the agriculturally richer irrigated SAT and humid tropical districts, characterized by higher gross revenue per cropped hectare. Barah and Binswanger also showed that stabilizing the yield of the dominant crop in each region would be much more effective in reducing revenue variability in the unirrigated SAT districts. In contrast, stabilizing the price of the dominant crop was much more successful in dampening gross revenue variability in the irrigated than in the unirrigated SAT.

The use of district data by Barah and Binswanger increases the likelihood that the relative importance of yield variability in conditioning crop revenue risk is understated for individual farmers. Unless yields are perfectly correlated between farms, the estimated yield variance varies inversely with the number of farms constituting the aggregate (Carter and Dean 1960). In relatively well-integrated output markets, characteristic of India's SAT (von Oppen, Raju, and Bapna 1980), prices are much more likely to be correlated across farmers than yields.

Historical data on price and yield represent an imperfect substitute for farmers' price and yield expectations, which are the basis for decision making. Experimental data on farmer perceptions of yield and price suggest that farmers believe that even for irrigated crops in an assured production season and environment, like well-irrigated paddy and groundnut grown in the post-rainy season in Dokur, yield risk exceeds price risk.

Thirty well owners, ten each from Dokur and two neighboring villages, participated in the experiment. At the start of the post-rainy season perceptions on yields, prices, and gross revenues of two competing crops, groundnuts and paddy, were assessed through a betting format similar to what is described later in this chapter in the context of the experiments Binswanger used to elicit risk attitudes. Farmers were staked with forty five-rupee notes which they assigned to ten discrete outcomes representing fixed yield, price, and gross revenue intervals. Farmers were rewarded the amount placed in the interval which contained the actual price, yield, or gross revenue. Yield was measured by crop cuts taken in each farmer's field at harvest. Actual price referred to the peak harvest price in the most frequented market.

Defining risk as the difference between actual and expected values in mean absolute percentage errors (MAPEs) highlights the relative importance of yield over price risk in conditioning gross revenue variability for these wetland paddy and groundnut producers. In the box graphs in figure 8.3, the empirical distributions of the price MAPEs are much more tightly clustered, particularly for paddy, than are the yield MAPEs. In other words, at the start of the growing season, farmers could predict harvest prices in a nearby market much more accurately than they could predict yields in their own fields.

These results from two relatively protected irrigated cropping systems again make the point that yield risk is likely to be underestimated as a source of income variability than what is usually inferred from aggregate data/Price risk is much less likely to be understated; consequently, its relative importance in India's unirrigated SAT is even less than what Barah and Binswanger estimated.

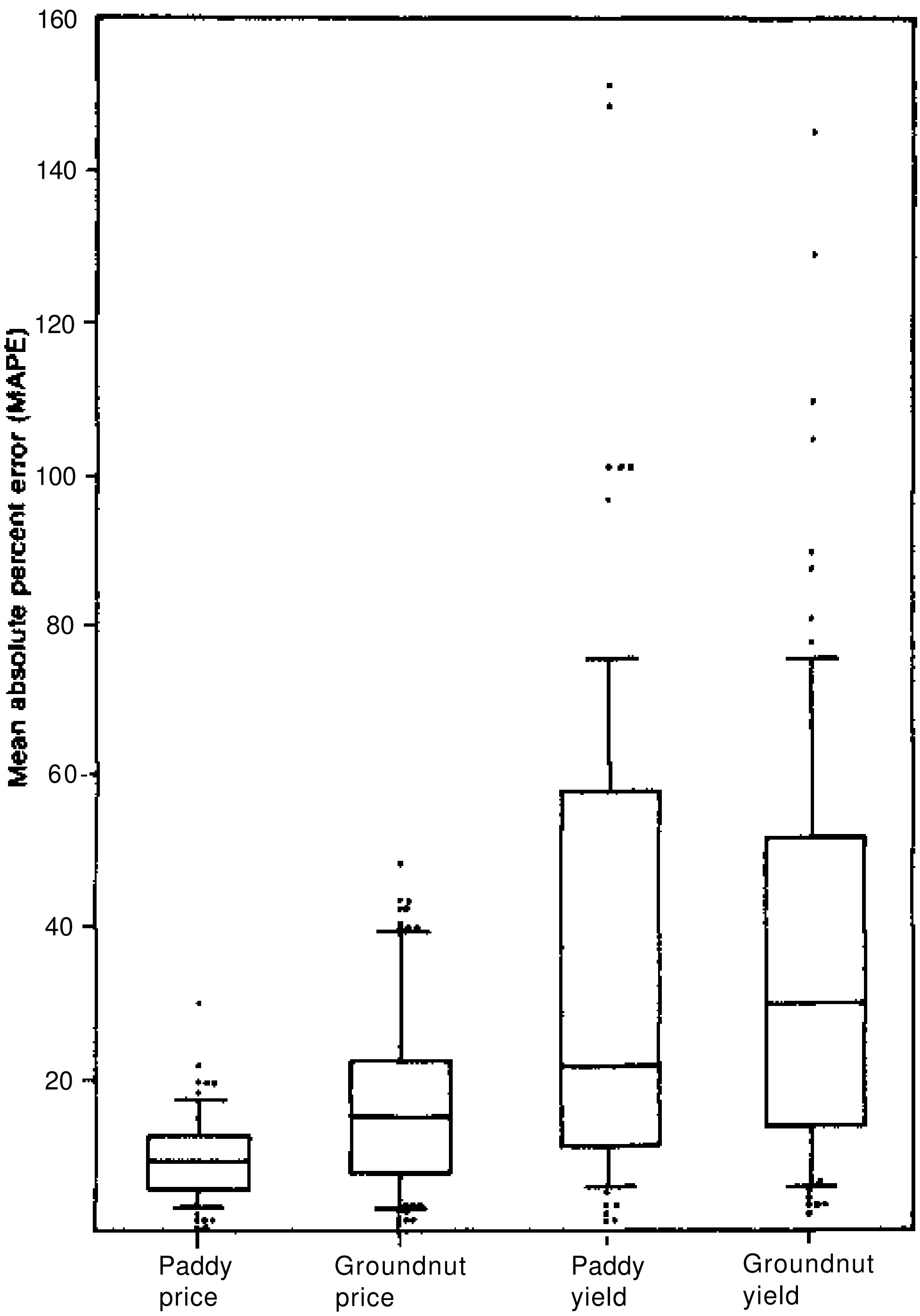


Figure 8.3 Price and yield perceptions of groundnut and paddy post-rainy season producers in Dokur from 1982/83 to 1985/86

The Nature of Yield Risk

Not only the sources of risk but also the nature of yield risk is likely to differ between dryland and irrigated agriculture. In general, the village study evidence suggests that the harshness of the production environment imparts positive skewness to yield and net return distributions in dryland agriculture. On analyzing the distribution of yields and net returns (cleansed of farmer effects that were statistically significant) for the common cropping systems described in tables 3.1 and 3.2, we found that the skewness of yield and net return distributions depended on the type of cropping system (intercropped or monoculture), technology level (traditional or improved), and the quality of the resource base (rainfall-assured and adequate fertility or drought-prone and marginal fertility) (Walker and Subba Rao 1982a). Both yield and net return distributions in low-input, sole-cropping systems like castor in Aurepalle and post-rainy season sorghum in Shirapur were positively skewed; improved cropping systems such as irrigated paddy in Dokur and hybrid sorghum in Kanzara were characterized by normal yield and net revenue distributions. Multiple components in an intercropping system, such as the cereal/pulse intercrop in Aurepalle, can also produce net return distributions that are normally distributed even in a harsh environment where component yield distributions are positively skewed.

The reason for positive skewness is not hard to find. Yield distributions are truncated (yields are nonnegative) and the combination of sole cropping, a dominant source of risk such as drought, and marginal production conditions allow nonnegativity to impart positive skewness to net return distributions. For instance, the net return distributions for post-rainy season sorghum production in the drought-prone Sholapur villages are significantly and positively skewed (table 8.1). Switching from a deep to a shallower soil is accompanied by a sharp increase from 1.28 to 4.32 in

Table 8.1. Descriptive statistics on yield and net return distributions of post-rainy season sorghum, by soil types in Shirapur and Kalman from 1975/76 to 1979/80

	Descriptive Statistic		
Soil Type	*Mean*	*Skewness*	*Observations (N)*
Grain yield (kg/ha)			
Deep black	375	2.15**[a]	95
Medium black	258	2.77**	261
Shallow black	171	5.73**	438
Gravelly and others	133	7.38**	98
Fodder yield (kg/ha)			
Deep black	988	0.36	—
Medium black	793	1.26**	—
Shallow black	746	1.00	_
Gravelly and others	535	0.72	—
Net returns to own resources (Rs/ha)			
Deep black	544	1.28**	—
Medium black	383	2.49**	—
Shallow black	283	3.61**	—
Gravelly and others	198	4.32**	—

[a]** denotes statistically significant differences from corresponding values for the normal distribution at the 0.01 level.

the skewness coefficient of net returns. Notice also in table 8.1 that fodder yields are less skewed than grain yields, which are more sensitive to drought stress.

What does positive skewness imply for risk analysis, which is often carried out under the assumption that net revenue distributions are normally distributed? If net returns in a traditional cropping system are positively skewed while those in a competing improved cropping system are normally distributed, the assumption of normally distributed net returns for both cropping alternatives will underestimate risk. This situation is illustrated by comparing the choice of cropping system between the cotton/pigeon pea intercrop (designated as cotton intercrop 2 in table 3.1) and sole-cropped hybrid sorghum in Kanzara (Walker and Subba Rao 1982b). Cotton/pigeon peas's net returns were significantly skewed; hybrid sorghum yields and net returns were normally distributed. On comparing the cumulative density functions for net returns between the cotton/pigeon pea intercrop and hybrid sorghum, we see in figure 8.4 that the conflict between risk and expected profitability is fairly sharp under the observed distributions and is considerably less when normal distributions are assumed. The incidence of low returns is substantially greater under the observed empirical distribution compared with what is implied by a normal distribution. Under normal cumulative density functions, the probability of having net returns less than or equal to Rs -300 is about 0.04 for the cotton/pigeon pea intercrop and 0.08 for hybrid sorghum (lower panel, figure 8.4). Comparable probabilities are 0.01 and 0.08 under the observed distributions (upper panel, figure 8.4). In other words, the initial crossover area is considerably larger with the observed distributions than with the assumed normal distributions. The contrasting shapes of the net revenue distribution likely reinforce the tendency of risk-averse farmers to prefer the cotton/pigeon pea intercrop to hybrid sorghum in Kanzara.

Risk Attitudes

The location and distribution of risk preferences in the farmer population partially condition the answers to almost all the important risk issues in agricultural development. Despite their importance, reliable estimates of risk attitudes for large samples are difficult to come by with conventional nonexperimental approaches. Econometric estimation of risk preferences from data on past decisions is beset by several confounding influences that are difficult if not impossible to account for (Binswanger 1982). Inferring risk preferences by comparing optimal and estimated farm plans from mathematical programming models can also give spurious results unless such models are free of specification error. Direct elicitation involving hypothetical choices (usually between lotteries) is strongly sus-

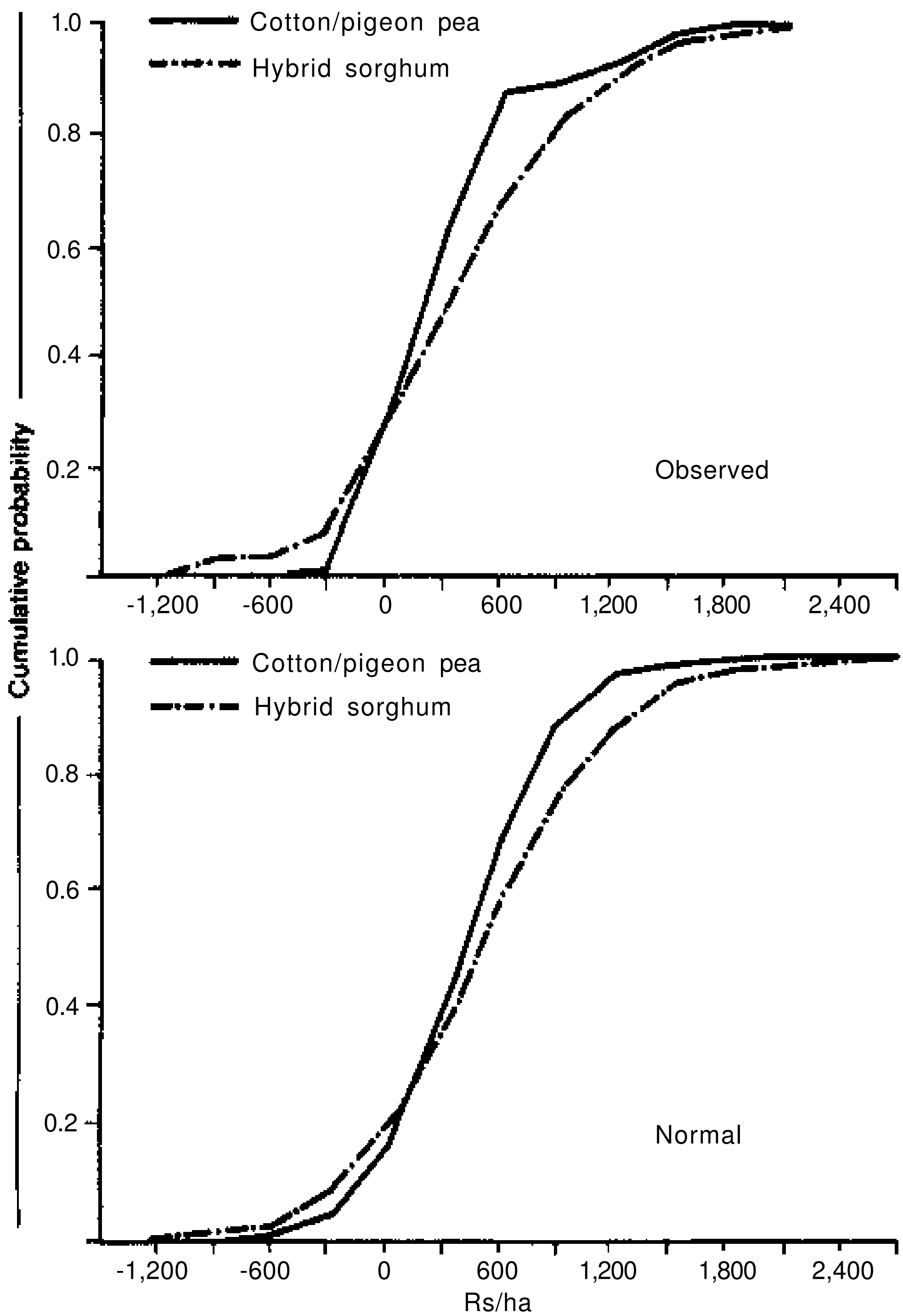


Figure 8.4 Evaluation of the choice between two common cropping systems based on observed and assured normal net return distributions in Kanzara

ceptible to interviewer bias. For example, Binswanger (1980) found in the study villages that switching interviewers markedly changed the distribution of responses elicited with a direct interview method tailored by Dillon and Scandizzo (1978) for resource-poor farmers in developing countries.

Frustrated by that experience, Binswanger (1978a, 1980, 1981) took a lead from the psychological literature and designed a series of games to measure risk attitudes. Although sharing the same foundations, the games differ in two important respects from the experimental literature in psychology. First, the game featured real payoffs to reinforce respondent choices. These payoffs were relatively large compared to what respondents could earn in the daily labor market. Second, the games were played over a number of weeks so farmers had time to reflect on their decisions.

Structure and Results of the Experimental Games

The games were played by flipping coins after each respondent chose one from six alternatives reflecting a tradeoff between the mean and the variance in winnings. The choices are presented in table 8.2 and range from the sure bet O to risky gamble F. There are several ways to describe the risk embodied in each choice. Two of the simplest are (1) the proportional insurance premium (IP), which measures the proportional reduction in expected return the respondent is willing to accept to be less exposed to risk, and (2) the ratio (called Z in table 8.2) of the change in expected value to the change in standard deviation in going from a lower to the next higher value alternative.

Although the risk aversion class labels in Table 8.2 are necessarily arbitrary, it is clear that choices O and A reflect extreme to severe risk aversion. Actions B and C are consistent with intermediate to moderate risk aversion. Alternatives E and F may imply risk neutrality or even risk preference, as moving from E to F yields the same expected return but is accompanied by an increase in the variance of the payoff.

Multiplying the payoff structure in the Rs .50 game in table 8.2 by 10, 100, and 1,000 gave three higher stake games, which were played in a sequence starting with a low stakes scale of Rs .50 for the O alternative

Table 8.2. Structure of the Rs .50 experimental game to measure risk attitutes

Choice[a]	*Risk Aversion Class*	*High Payoff (Rs)*	*Low Payoff (Rs)*	*IP*[b]	*Z*[c]
O	Extreme	.50	.50	0.5	0.90
A	Severe	.95	.45	0.3	0.74
B	Intermediate	1.20	.40	0.2	0.59
C	Moderate	1.60	.20	0.1	0.42
E	Slight-to-neutral	1.90	.10	0	0.17
F	Neutral-to-negative	2.00	0	0	0

Source: Binswanger (1980) and Binswanger and Sillers (1983).

[a]Inefficient alternatives D and D* are not presented. 0 had the same expected value as B but with a greater variance; D* had the same expected value as C but with a greater variance. Relatively few respondents chose those alternatives in any of the games. F is also risk inefficient compared to E but is kept in the format to represent a risk preference choice.

[b]Proportional insurance premium which is the difference between the expected value of the alternative and the highest return alternative (F) divided by the expected value of F.

[c]The change in expected value between neighboring alternatives divided by the change in standard deviation.

and finishing with a high stakes scale of Rs 500. Real games were played at Rs .50, 5, and 50 levels, while the Rs 500 game was hypothetical. The series of games was played with all respondent households in the six study villages. For the larger games with higher payoffs, the sample size was reduced from 240 to 120 households.

Because farmers were not exposed to losses, the responses in the games only provide information on the positive branch of the utility function. Therefore, the responses give a lower bound estimate of risk aversion; that is, we can conclusively say that respondents are at least this risk averse. Exposing farmers to real losses would have been difficult ethically and could have resulted in confounding pure risk attitudes with credit constraints. In a few games, farmers were staked with money before playing the game. Responses in the staked games were not significantly different from those in the other games.

Four main findings emerged from Binswanger's risk attitude study. First, for the higher level games, Rs 5, 50, and 500, where the opportunity losses were large, responses were tightly and unimodally clustered in the intermediate to moderately risk-averse alternatives (table 8.3). Second, respondents selected more risk-averse choices as the size of the game increased. In going from the lower to the higher stakes scales, the mean-value of the insurance premium increased linearly, signifying increasing partial risk aversion (Binswanger and Sillers 1983). These were large increases as mean IP almost doubled between the Rs .50 and 500 games from .115 to .190. Third, differences in personal characteristics and resources endowments among respondents explained little of the variation in responses. These findings were broadly supported by "second-generation" studies that also used the experimental approach to measure risk

Table 8.3. Frequency of choices by game size in percent of total observations

	Game Size (and Number)			
Choice[a]	*Rs .50 (2)*	*Rs 5 (7)*	*Rs 50 (12)*	*Rs 500 (16)*
O	1.0	0.9	2.8	2.6
A	6.5	9.3	5.6	13.9
B	31.8	27.8	38.3	53.0
C	22.4	39.8	43.9	29.6
E	16.8	13.0	7.5	0.0
F	20.6	9.3	1.9	0.9
Observations (*N*)	119	117	118	118
Mean IP	.12	.13	.15	.19

Source: Binswanger (1960) and Binswanger and Sillers (1983).

[a]Based on efficient choices. The number of respondents who made inefficient choices in the Rs .50, 5, 50, and 500 game levels was twelve, nine, eleven, and three, respectively.

attitudes of farmers in Southeast Asia and Central America (Grisley 1980; Sillers 1980; Walker 1981b). Finally, and on a more interpretative and theoretical note, the experimental evidence in the games is inconsistent with choices predicted from several bounded rationality models that enjoy widespread popularity in the social science literature on agricultural development (Binswanger 1981). Assumptions underlying the economists' most commonly accepted model of subjective expected utility theory are also at odds with experimental evidence (Quizon, Binswanger, and Machina 1984).

Validating the Experimental Approach

Econometric evidence based on input-output data on paddy cultivation in Aurepalle offers some support for the levels of farmer risk aversion estimated in the games (Antle 1987). But the most transparent test of validation is, Do the estimates generated in the experimental approach explain any of the variation in choices made by farmers in real world decisions? Digging wells and purchasing fertilizer are probably the two most important cash-intensive decisions facing farmers in India's SAT. Investing in well irrigation in India's Deccan Plateau can be a high risk venture as the probability of digging the proverbial dry hole is not negligible (Lal 1972). For example, in the watershed that contains Aurepalle about 30 percent of the dug wells are dry (Engelhardt 1985). Fertilizer, although divisible, is a costly input whose use could also be conditioned by differences in farmer risk attitudes.

Pooling the data across the six study villages from 1975/76 to 1977/78, Binswanger et al. (1982) found that risk aversion, measured by the insurance premium (IP) in the experimental games, significantly and inversely influenced wealth accumulation and investment in irrigation, which in turn heavily determined the farmer's use of fertilizer. Although the direct effect of risk aversion on fertilizer use was modest, the indirect impact through the wealth and irrigation variables was relatively substantial. Nonetheless, interpersonal variation in risk preferences did not account for a large share of the variation in fertilizer practices. Effects of differential risk aversion on fertilizer use were clearly dominated by differences in agroclimatic and other regional endowments that reflected regional disparities in risk and by interpersonal differences in wealth, fertilizer experience, and irrigation intensity. In terms of order of magnitude, differences (where statistically significant) in education were about as important as variation in risk attitudes in conditioning investment decisions on irrigation and fertilizer. Still, these results do provide some evidence that reliable estimates of farmer risk attitudes can be obtained with the experimental method.

Risk Aversion and Technological Change

Because almost all farmers are risk averse, risk aversion potentially colors adoption and investment decisions. Risk aversion may dampen the speed of diffusion of nearly all agricultural practices except pesticides, which are usually thought to be risk reducing. But what counts in the diffusion process is not who first accepts the innovation but who ultimately adopts. Unless adoption by the few precludes adoption by the majority, levels of welfare are determined by the spatial variation in diffusion ten to twenty years following the release of the recommendation. The classic exception where early adoption matters is absentee landlordism. Both in the Indian Punjab and the highlands of Ethiopia tenants reaped few of the benefits from the high-yielding wheat varieties because they were evicted by their landlords. Moreover, one cannot appeal to risk aversion to explain marked interregional differences in varietal adoption because the experimental results do not show that farmers in more risk-prone environments are significantly more risk averse than those in assured production areas. Climatic and soil differences account for the lion's share of the explained variation in the present levels of HYV adoption within major cereal-producing districts within India's SAT (Jansen 1988).

Unlike varietal change, disparities in well digging and pesticide and fertilizer use persist even in areas as small as a village. We would be much quicker to ascribe these differences to risk aversion if the experimentally measured distribution of risk preferences was not so tight. Still, Binswanger et al. (1982) were able to demonstrate that there was enough spread in the distribution of risk preferences to explain some of the variation in investment in irrigation and in fertilizer adoption among the sample households.

The potential indirect effects of risk aversion are likely to be more important than its direct influence as a friction to the adoption of technology. For instance, in unregulated rural financial markets, risk aversion by lenders and borrowers favors higher collateral requirements as a partial substitute to charging higher interest rates, thereby depressing the demand for credit for some groups like small farmers who have limited available collateral (Binswanger and Sillers 1983). Risk aversion can effectively translate differences in collateral availability and fixed administrative loan costs between borrower groups into sharper variations in credit use. Thus, risk aversion in combination with incentive problems can influence the existence and completeness of factor markets and contract options.

Based on the experimental evidence, we have no reason to believe that the level and distribution of farmer risk aversion differ significantly between India's dryland SAT and more humid and/or more irrigated regions. The indirect effects of risk aversion are, however, likely to be more pronounced in dryland than in more assured irrigated production environments (Binswanger and Rosenzweig 1986a).

Household Risk Management

The remainder and largest part of this chapter is concerned with the efficacy of public sector interventions to mitigate the adverse consequences of production risk in India's SAT. Because the extent and type of public sector investment depend on how well households manage production risk in India's SAT, we look at the effectiveness of informal and private means to self-insurance in this section. Effectiveness is examined for two types of rainfall-related occasions: (1) severe and prolonged drought and (2) the more normal course of events when scanty or excess rainfall can lead to shortfalls in income but does not threaten subsistence. During severe drought, effectiveness is gauged by the ability of the household to protect consumption from sharp declines in income. During other times, the question of how well cropping strategies reduce crop income variability becomes more relevant for measuring the effectiveness of risk management by the farm household.

Effectiveness of Income Compensation and Severe Drought

Households in India's SAT have six ways to compensate for shortfalls in income. They can sell stored produce, borrow for consumption, liquidate assets, receive transfer income from relatives, change jobs and/or increase their labor market participation, and migrate in search of work.

Some of these forms of income compensation are no longer important in the study villages. Storage of food grains or fodder between cropping years does not presently loom that large in the study villages (chapter 4). Only appreciable amounts of paddy are carried over from year to year by the largest farmers in the Mahbubnagar villages. Also, in chapter 4 we cited several reasons for the relatively minor role of transfers in dampening income volatility. Other forms are used only as a last resort. Both migration and asset liquidation fall into that category. Several empirical studies of household response to drought have shown that food consumption can decline substantially before the household parts with its assets or moves (Dreze 1988).

Borrowing for consumption in the informal credit market is by far the most heavily relied on means to compensate for shortfalls in income in the study villages. Again in chapter 4 we saw that households in the study villages, mainly in Aurepalle, partially compensated for steep shortfalls in income by relying on consumption credit. The fairly localized but prolonged three-year drought in the mid-1980s in the Telegana region, where the Mahbubnagar villages are located, precipitated a sharp rise in borrowing in the informal market in Dokur, where the large village tank did not fill for rainy season paddy cultivation from 1985/86 to 1987/88 (Nag et al. forthcoming).

Borrowing to maintain consumption is effective when risk is noncovariate, as many people do not borrow at the same time. Even during a drought year the village credit market may be quite capable of financing a surprising amount of consumption credit without an appreciable rise in interest. For instance, in the Dokur case study, appreciable changes in interest rates were recorded only well into the second drought year. But the village credit market is necessarily personal and spatially restricted (chapter 7); severe droughts over consecutive years eventually lead to rising interest rates. Drought in the well-irrigated Mahbubnagar villages is also usually accompanied by an increase in demand for well deepening, digging, and in-well bore drilling. This increase in demand for investment credit places additional strain on the informal village credit market.

Data from several microeconomic surveys have amply demonstrated how ineffective private means are in maintaining household food consumption in the face of a large covariate risk like severe interregional drought. Jodha's detailed study of the 1962/63 drought in several villages in Rajasthan is illustrative and, except for the prominence of livestock, fairly representative of farmers' response to and the consequences of severe drought in India's SAT (Jodha 1975). Traditional risk management methods did little to protect crop and livestock income, which contributed negligibly to household sustenance income during the drought year. Most households, particularly small farm households, relied heavily on wages from public relief works. Large farm households compensated for the shortfall in agricultural income by selling assets, which led to gyrating prices. Sources of credit dried up as the share of borrowings in household income only ranged from 6 to 13 percent. The annual interest rate on borrowing increased from 15 to 23 percent.

Compared to the year before the drought, food grain consumption per day per adult fell by about 14 percent. The price of pearl millet, the staple food, increased by about 60 percent; milk prices rose by 280 percent. Prices of most assets fell sharply as households faced a buyers' market during the drought and a sellers' market after the drought. The price of bullocks declined by 51 percent, dry cows by 80 percent, lactating cows by 48 percent, sheep by 60 percent, and bullock carts by 40 percent. Some assets did retain their value better than others. The price of goats, which are more divisible and better acclimated to drought than most other domestic livestock species, actually went up by about 24 percent. The drought also affected human capital formation, as 42 percent of households withdrew their children from school. Many households eventually responded to drought by migrating. Those that stayed behind lost more of their livestock than those that migrated.

Public-sector assistance is obviously needed to help households adjust to drought of that magnitude. Thus, the effectiveness of household risk adjustment depends on both private and public sector response and their interaction.

One crude but relevant measure of the effectiveness of the private and public sectors' performance in assisting households to manage risk of famine centers on the extent that regionally covariate risks, comprising both natural and man-made disasters, compel farm households to sell land to meet current consumption expenses. Such transactions are usually labeled distress sales and, as discussed in chapter 6, are often viewed as a means to economic polarization (benefiting large holders at the expense of small farm households) in rural South Asia, where land is the dominant form of wealth, source of collateral, means of production, and determinant of status (Cain 1981).

Reasons for and the frequency and timing of land sales and purchases in Aurepalle, Kanzara, and Shirapur have been thoroughly analyzed by Cain, who compared risk adjustment between these three villages and a Bangladeshi village that he studied intensively in the late 1970s. Cain's research conclusively shows that the environment for managing risk is much harsher in the Bangladeshi village, where the bulk (or 145 of 239) of land sale transactions engaged in by household heads from inheritance to 1980 were made by presently landless, small, and medium farm households. Distress sales to satisfy immediate biological needs accounted for 67 percent of transactions.

The historical frequency of transactions also exhibited prominent peaks, corresponding to the Bengal famine of 1943, the liberation war of 1971, and the flood of 1974 (figure 8.5). In contrast, about two-thirds of the sale transactions made in Aurepalle, Kanzara, and Shirapur by the household head from inheritance to 1980 were carried out by large farm households. Only about 18 percent of these transactions were made with the explicit purpose of meeting current consumption expenditures. More important, the incidence of transactions in the three Indian villages did not display sharp fluctuations over time (figure 8.5). No farmer in the Indian sample responded to the Maharashtra drought from 1971/72 to 1973/74 by selling land. Buoyed by wage earnings from public relief projects, farm households tenaciously clung to their land.

Cain attributes these differences in risk management performance to more efficient rural financial markets and to greater government investment in public works projects in the Indian study villages. In the Bangladeshi village, usufruct mortgage was more prevalent, interest rates were considerably higher, and access to institutional credit was more limited. Property rights were also less secure. The government's response to the 1974 flood consisted primarily of food aid, which was not as readily accessible and which did not appreciably deepen rural infrastructure as much as the employment opportunities generated by the crash relief

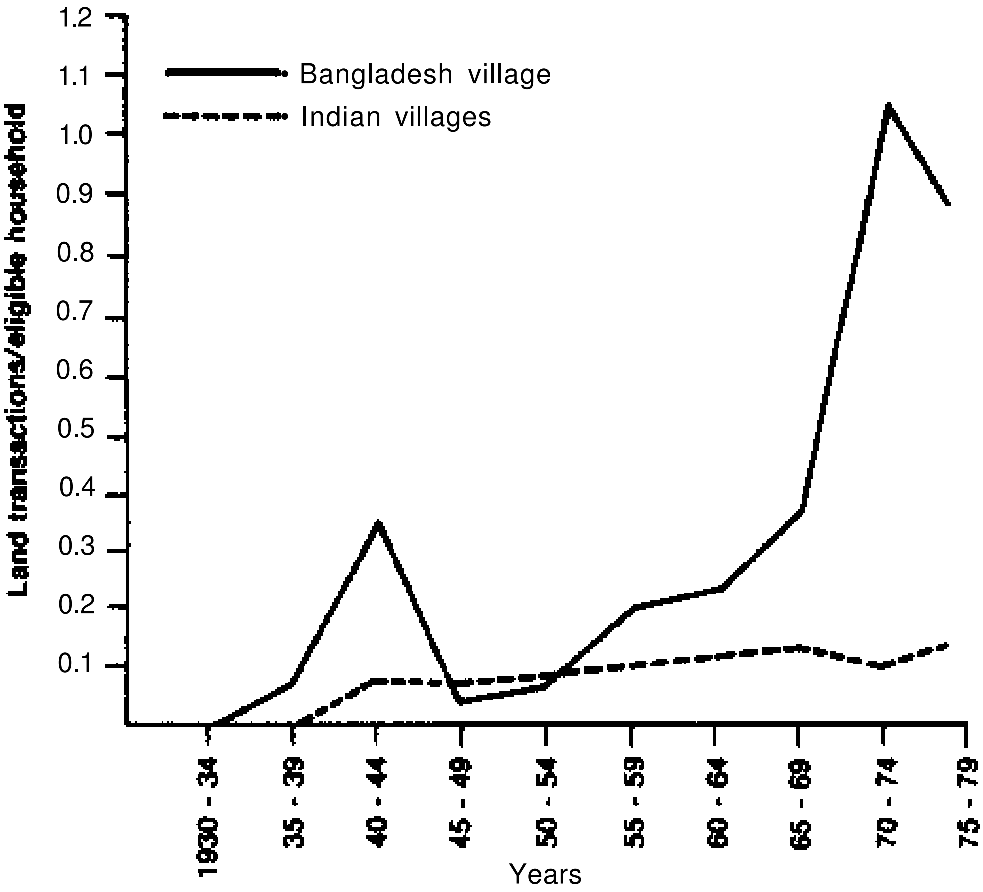


Figure 8.5 Land transactions over time in Aurepalle, Shirapur, and Kanzara and in Char Gopalpur, a village in Bangladesh
Source: Cain (1981:454, figure 2).

works occasioned by the 1971 to 1973 Maharashtra drought. Indeed, the handling of the "never in a hundred years" drought in Maharashtra in the early 1970s is clearly one of the success stories in famine prevention in recent history (Dreze 1988). At the height of distress, during the slack season summer months of 1973, as many as five million people earned cash on public works programs. Some of the credit also has to go the private sector, which responded to initially rising prices by moving food grains into western Maharashtra. Ample food grain supplies elsewhere in the country coupled with the ability of the private sector to respond kept prices in check in the hardest-hit drought-affected districts.

Effectiveness of Crop Management Strategies

In the face of a severe covariate risk, like consecutive drought years, farm management methods are usually ineffective in preserving crop income/But in the more normal course of events, farmers have access to a number of measures that can partially iron out fluctuations in crop income (Walker and Jodha 1986). Perhaps the two that have received the most commentary if not scrutiny in the literature are crop diversification and intercropping.

Crop *Diversification* Crop diversification is usually regarded as the most important weapon in the farmer's management arsenal to combat crop income risk in developing countries, where futures and insurance markets are not well developed. To what extent is crop diversification motivated by farmers' risk aversion? How well does diversification protect households from fluctuations in crop income?

The intertwined issues of the determinants and effectiveness of crop diversification were addressed with cropping year data from cultivator households in the six villages from 1975/76 to 1979/80 (Walker, Singh, and Jodha 1983). For comparative purposes, the data were analyzed by region. Crop diversification was measured by the Simpson index of diversity used in chapter 6 to quantify the incidence of land fragmentation.

The level of crop diversification both within and across villages is potentially influenced by several other factors besides variation among farm households in risk attitudes and perceptions. The determinants of crop diversification varied substantially across the three regions. Nonetheless, in each region, crop diversification appeared to be a response to differences in resource endowments. Draft power availability was an important explanation of variation in crop diversification across households within Mahbubnagar and Akola regions. As expected, larger farms with more gross cropped area were more diversified than their smaller counterparts. These differences may be attributed to a more pronounced need to reduce peak season labor requirements, more potential to exploit location-specific production opportunities associated with holding more fields, and greater access to credit to sow land to more input-intensive cropping activities.

In the Sholapur region, resource endowments were less important in explaining diversification, which was largely accounted for by differences in land quality, cropping-year conditions, and village disparities within the region. In particular, in response to low rainfall in June, July, and August and to plentiful rain in September, post-rainy season sorghum accounted for 85 percent of gross cropped area in Shirapur in 1977/78 when the diversification index fell dramatically.

The influence of irrigated area was also significant and region specific. In Mahbubnagar, irrigation leads to more specialization in paddy production; in dryland Akola and Sholapur, limited well irrigation, particularly in the post-rainy season, opens up opportunities to grow more crops such as wheat, chick-peas, and other pulses.

Although of correct sign in the three regions, only in the Mahbubnagar villages did interhousehold differences in experimentally measured risk attitudes exert a significant influence on variation in crop diversification. The size of the effect was small. At the arithmetic means of both variables, a proportional 10 percent increase in risk aversion resulted in just a 1 percent increase in diversification in the Mahbubnagar villages. Crop diversification was more responsive to changes in gross cropped area, irrigated area, and land value in the Mahbubnagar region.

Therefore, findings from the regression analysis in Walker, Singh, and Jodha (1983) are consistent with the following story. Most farmers are risk averse and they diversify their portfolio of cropping activities. But differences in risk preferences are swamped by interhousehold variation in resource endowments in conditioning the level of crop diversification, which is also heavily influenced by rainfall at planting in drought-prone villages exemplified by Shirapur and Kalman.

Results from mathematical programming models, based on the village study data, confirm the same story (Hardaker and Ghodake 1984). The level of crop diversification depended much more on the farm size than on the degree of risk aversion within a farm-size group. Greater diversification on larger farms stemmed primarily from their greater resource availability.

Does diversification dampen crop income variability? Further regression results in Walker, Singh and Jodha (1983) suggest an affirmative answer. Measured from the perspective of the coefficient of variation of household net crop income per hectare over five years from 1975/76 to 1979/80, crop diversification did appear to be effective in imparting stability to household crop income in both the Akola and Sholapur villages. At the margin, crop diversification was about three times more effective in stabilizing net returns in rainfall-assured Akola than in drought-prone Sholapur. A 10 percent proportional increase in the diversification index was associated with a 4.8 and a 13.0 percent decrease in the CV of net crop income in the Sholapur and Akola villages, respectively. That there is less scope for crop diversification to emerge as a successful self-insurance measure in the Mahbubnagar and Sholapur villages is not surprising. Most crops in those two regions are vulnerable to the same source of risk—drought. In the Akola villages, the sources of yield risk are much less covariate. This diversity in potential yield reducers in turn enhances the attractiveness of crop diversification as an effective means for Akola farmers to self-insure.

Intercropping Row intercropping and, to a lesser extent, mixed cropping are commonly observed in traditional farming systems in many regions of India's SAT (Jodha 1981b). Research shows that through more efficient use of nutrients, moisture, and light, yields from intercropping alternatives are often relatively higher than proportional areas of the same species planted in pure stands (Willey, Reddy, and Natarajan 1987). This finding applies particularly well to regions of the dry semi-arid tropics where there is seldom sufficient soil moisture to harvest heavy yields from two sequential crops but where sole cropping often fails to exploit effectively available resources. In contrast, the evidence supporting the popular view in the agronomic and economic literatures (Papendick, Sanchez, and Triplett 1976; Bliss 1976) that intercropping (in and of itself net of crop diversification effects) markedly reduces yield risk is less persuasive.

Two reasons are often given for yields being less variable in intercropping systems: (1) lower disease and insect pest incidence and (2) greater potential for yield compensation (Willey 1981). Although the generalization that intercropping (synonymous with field-level diversity) generally reduces pest abundance usually holds (Risch, Andow, and Altieri 1983), counter-factuals are easy to find in the biological science literature. Those studies emphasize the extent to which pest and disease infestation are conditioned in complex cropping systems by location interactions. A concluding comment made by the chairman to a session on plant protection and intercropping in an international workshop on intercropping is probably not far off the mark: "It appears that intercropping can sometimes reduce incidence, sometimes increase incidence, and sometimes have no effect at all'' (ICRISAT 1981: 260).

Yield compensation effects in intercropping systems are also location- and system-specific. Yield compensation is influenced by a crop's ability to take advantage of augmented light, nutrients, and/or soil moisture "released" by other crops that are adversely affected by sources of risk. For example, some cereals such as pearl millet can partially compensate for poor stand establishment of other crops through greater tillering. Compensation would not in general be possible in pure stands because all plants would be equally affected.

If yield compensation was common, yield covariances between species would be less when they are planted in an intercropping system than when they are sown in pure stands. Unfortunately, large multiyear and multilocational data sets are not available to establish the size of yield compensation effects in intercropping/pure stand comparisons. Analyzing yield covariances over time between species in common intercropping systems in farmers' fields is a poor substitute for an evaluation based on experimental data, but such an analysis does begin to outline the size of potential compensation effects. In the extreme case of high compensation in a high risk environment, yields could even be negatively covariate. Lower yield correlation coefficients therefore would imply greater risk-buffering capacity.

In the most common intercropping systems in the study villages (sorghum/pearl millet/pigeon pea in Aurepalle and cotton/sorghum/pigeon pea in Kanzara), yields between crops in the same field were more positively correlated than we expected (Walker and Jodha 1986). In the sorghum/pearl millet/pigeon pea system in Aurepalle, the local sorghum and pearl millet varieties planted in the same row are attacked by the same sources of risk and reach maturity between 120 and 135 days; therefore, it is not surprising that sorghum and pearl millet yields within the same field are positively and significantly correlated at 0.63. Because of differences in days to physiological maturity and susceptibility to different sources of risk, sorghum and pearl millet yields were insignificantly associated with pigeon pea yields at 0.06 and 0.11, respectively. For the common cotton/pigeon pea/sorghum intercrop in Kanzara, adjusted yield data show significant correlations (0.42, 0.25, and 0.15) at the 5 percent level between yields of cotton and sorghum, cotton and pigeon pea, and sorghum and pigeon pea. Positive correlations are likely because these three long-duration crops mature at about the same time and are thus exposed to some of the same sources of risk.

Although these results suggest that the potential for compensation may be small in traditional intercropping systems, they should be interpreted with caution, because we do not know how much higher the yield correlations would be when the same species are planted in pure stands. Nevertheless, these two traditional intercropping systems exhibit few temporal complementarities so important for large compensation effects. The rapid displacement of the cotton/pigeon pea/sorghum system by the cotton/mung bean intercrop (described in chapter 3) in the early 1980s further indicates that farmers believed that the traditional system with three long-duration crops did not possess many significant advantages.

The longer growing season in the Akola villages endows farmers with ample opportunities to grow intercropping systems featuring short- and long-duration crops in the same field. Opportunities to generate large yield compensation effects appear to be limited in the dryer Mahbubnagar and Sholapur villages.

Like diversification, intercropping appears to be a response to physical resource endowments, particularly to the quality of those endowments (Singh and Jodha 1986). Differences in personal characteristics, such as risk-averse attitudes, do not appear to affect the variation in the extent of intercropping between households. Lack of access to irrigation, marginal quality land reflected in low land values, and rainy season cropping are the driving forces conditioning the interhousehold variation in intercropping within the three study regions (table 8.4). Controlling for those variables, we find that farm size, as measured in gross cropped area, does not significantly influence the extent of intercropping. Tabular analysis sometimes shows that small farmers intercrop proportionally more of their land than large farmers, but those differences largely disappear when we account for the effects of irrigation, land quality, and cropping season. Likewise, differences among households in family labor and livestock endowments do not seem to matter in intercropping decisions.

Cropping season is the overriding determinant of the incidence of intercropping, which is common in the rainy season and rare in the post-rainy season. Much rainfed post-rainy season cropping occurs under a receding soil moisture regime, severely curtailing the potential for fanners

Table 8.4. Determinants of the interhousehold variation in intercropping within three agroclimatic regions of India's SAT

	Agroclimatic Zones		
Explanatory Variable	*Mahbubnagar*	*Sholapur*	*Akola*
Size of family	-0.21	-0.35	-0.66
	(-0.33)[d]	(-0.59)	(-1.51)
Livestock	0.47	-0.33	-0.10
	(0.96)	(-0.44)	(-0.23)
Gross cropped area	-0.11	-0.15	-0.02
	(-0.43)	(-1.06)	(-0.16)
Irrigated area	-0.49**	-0.12	-0.66**
	(-8.37)	(-1.38)	(-4.04)
Land quality	0.01	0.06	-0.23**
	(0.05)	(0.56)	(-2.98)
Postmonsoon cropping	-0.29**	-0.20*	-0.97**
	(-3.38)	(-2.32)	(-8.31)
Village dummy[a]	4.75	30.50**	3.01
	(1.07)	(8.70)	(1.33)
Year dummy[b]			
1976/77	-3.75	4.58	-1.45
	(-0.87)	(0.94)	(-0.43)
1977/78	0.55	17.93**	4.08
	(0.13)	(3.52)	(1.22)
1978/79	-8.71	8.17	-4.09
	(-1.91)	(1.64)	(-1.20)
1979/80	-7.25	0.63	5.98
	(-1.60)	(0.11)	(0.17)
Intercept	50.68	32.87	100.75
$\bar{R}^2$	0.43	0.27	0.45
F ratio	20.53	10.93	22.29
Intercropping (% of gross cropped area)[c]	26.17	35.06	82.70
Observations *(N)*	287	291	283

[a]Village dummies refer to Dokur in Mahbubnagar, Kalman in Sholapur, and Kinkheda in Akola.

[b]Refers to 1975/76 as the reference year,

[c]Dependent variable.

[d]t values are in parentheses; " and * indicate statistical significance at the 0.01 and 0.05 levels, respectively.

to derive species compensation benefits from intercropping. In other words, there are few resources available at the end of the post-rainy season to mop up. Consistent with this observation, sorghum/safflower intercrops in the post-rainy season are reserved for what farmers perceive to be the best soils in the Sholapur villages (Dvorak 1988). Location-specific differences in village ecologies were also important in explaining interregional variation in intercropping in Sholapur. Intercropping is much more prevalent in Kalman, which has lighter soils and more rainy season cropping than in Shirapur.

Cropping year effects reflecting household response to emerging information on agroclimatic conditions at planting were not as marked as in the Walker, Singh, and Jodha (1983) crop diversification study. Percent area intercropped rose in the Sholapur region in 1977/78 when low kharif season rainfall precipitated more intercropping in the rabi season.

The discussion of yield compensation effects and the regression analysis of the determinants of intercropping suggest that farmers in dryland regions where rainy season cropping is extensively practiced and where the growing season is longer will profit most from intercropping research. Within those regions, benefits from such research should be accessible to all households irrespective of how much land, labor, and livestock they own.

Summing up, all the evidence seems to point to crop diversification and intercropping being more effective in reducing crop income risk in the higher and more rainfall-reliable Akola villages than in the lower and more rainfall-variable Mahbubnagar and Sholapur villages. Similar comparative results have been obtained from village studies in the North Guinean, Sudanian, and Sahelian zones of West Africa's SAT. The incidence of crop diversification decreased as one went from the wetter North Guinean zone to the dryer Sahelian zone, where the paucity of rainfall curtailed the prospects for crop diversification (Matlon and Fafchamps 1988). The value of maintaining flexibility to use information emerging during the cropping season was statistically significant and large in the Sudan and North Guinean zones but not in the Sahel, which is characterized by a much shorter growing season (Matlon and Kristjanson 1988).

Public Policy Responses

In theory, crop insurance would appear to be the public policy specifically designed to get at the source of the problem of yield variability in dryland agriculture in India's SAT. Crop insurance is a contingency contract where participant farmers pay premiums and collect indemnities when yields fall below an insured level. In India, as in most developing countries, crop insurance is commonly administered as crop credit insurance, where the insurer covers a percentage of the loan for annual cultivation expenses of the participant farmer.

The track record of publicly funded crop insurance programs in both developed and developing countries in attaining efficiency and/or equity objectives is dismal. Empirical evidence on the benefits of crop insurance is sparse. Repeated findings that relatively few farmers demand crop insurance unless voluntary programs are heavily subsidized are probably the best indication that benefits as perceived by farmers are small (Nieuwoldt and Bullock 1985; Gardner and Kramer 1986).

In this section, we argue that farmers are reluctant to participate because crop insurance is not effective in protecting households from crop income risk even in highly uncertain, dryland production environments typical of the SAT, where, as we saw earlier in this chapter, yield risk is often three to four orders of magnitude greater than price risk. The argument is based on the modest and in most cases negligible risk benefits estimated from simulated crop insurance designs carried out on data from households in Aurepalle, Shirapur, and Kanzara from 1975/76 to 1983/84 (Walker, Singh, and Asokan 1986). The village study results point to some general principles or conditions that have to be satisfied if crop insurance is to generate sizable risk benefits. In particular, what defeats crop insurance in dryland agriculture is the recurring theme of area variability, which is largely conditioned by farmers' response to planting season rainfall.

Because crop insurance scores such low marks as an effective stabilization policy, two institutional alternatives, rainfall lotteries and rural public works, are briefly examined later in this section. Before addressing risk benefits conceptually and empirically, we review why risk benefits have remained a neglected theme in the literature and how crop insurance has evolved as a policy in India. That knowledge is essential to following the argument in the rest of the section.

Cost of Crop Insurance

The risk benefits of and the consequent demand for crop insurance have not attracted as much attention in the literature as the cost of providing insurance. Concentrating research effort on the supply side is justified because the fundamental problem with public sector crop insurance is that the costs to the exchequer are potentially high and those of an ill-conceived program can be catastrophic. In 1981, the Mexican government spent more than U.S. $600 million in subsidies on crop insurance that over time evolved into an income maintenance scheme for poor dryland cereal and grain legume producers (Bassoco, Cartas, and Norton 1986). In that same year, indemnities paid to farmers approached U.S. $300 million in a federal crop insurance program in Brazil (de Rezende Lopes and Leite da Silva Dias 1986). That program paid out about forty times more than it took in during its initial years of operation in 1975 and 1976.

Expenses on administration are often only a small component of total cost. Hidden costs are associated with moral hazard and adverse selection, which can be endemic in ill-designed crop insurance programs. Moral hazard is synonymous with farmers taking advantage of weaknesses in program design, while adverse selection means that participants in the program are not representative of the target population of interest. For example, farmers in the heavily subsidized Brazilian program found it profitable to plant upland rice with grass seed and claim indemnities on the failed upland rice which was not harvested. They had their pasture established courtesy of the government's subsidized crop insurance program (de Rezende Lopes and Leite da Silva Dias 1986).

Farmers on more marginal land within a designated region have often been more likely to participate in crop insurance (Walker 1982). Better farmers are adversely selected against, which invalidates the basis for actuarial calculations in a voluntary crop insurance program. Given the scope for moral hazard and adverse selection to manifest themselves, most practitioners recommend that programs evolve over time after an initial phase of experimentation characterized by learning by doing.

Crop Insurance in India

Until 1985, India had done better than most countries in crop insurance because the public sector had not invested that much in crop insurance and whatever investment had been made had been allocated to schemes that, for the most part, were financially sound.

The recent history of crop insurance in India is chronicled in Dandekar (1976,1985) and Agarwal (1980). That history is marked by the following events.

1. In 1965, the central government proposed a model crop insurance scheme. The state governments refused to participate in that scheme without substantial subsidization by the center.
2. In 1971, an expert committee was formed to evaluate the model scheme. It decided against crop insurance.
3. In 1972, an experimental crop insurance scheme was established to promote hybrid cotton production in selected areas of Gujarat.
4. In 1979/80, an innovative pilot crop insurance program along the lines suggested by Dandekar (1976) was initiated by the Government Insurance Corporation and the state governments in selected areas of Gujarat, Tamil Nadu, and West Bengal. That program was subsequently expanded to other states and commodities over time.
5. In 1985, a comprehensive crop-credit insurance scheme was introduced to financially help farmers in the event of crop failure, to restore the credit eligibility of farmers, and to support and stimulate production of cereals, pulses, and oilseeds (Seeta Prabhu and Ramachandran 1986).

The pilot insurance schemes, started in 1979, were financially healthy because assessing premiums and especially indemnities on a homogeneous area approach essentially eliminated problems of moral hazard and adverse selection (Dandekar 1976). Loss ratios, defined as indemnities paid divided by premiums collected, have only exceeded 1.0 in relatively few states, crops, seasons, and years (Dandekar 1985). Data in Dandekar's comprehensive appendix tables (1985: A-57, A-58) indicate that over five cropping years from 1979/80 to 1983/84 the total loss ratio was a respectable 1.10. Administrative costs were also less in a homogeneous area approach.

Placing crop insurance on a sound financial footing is a very large achievement, but the financial health of the insurer does not translate into voluntary participation by farmers. In contrast, the large crop-credit insurance scheme, introduced in 1985 and described by Seeta Prabhu and Ramachandran in 1986, is heavily subsidized. Although still administered on a homogeneous area approach, 150 percent of the amount loaned is insured, and the premium payments are nominal—2 percent of the amount insured for cereals and 1 percent for pulses and oilseeds. Additionally, small and marginal farmers receive a 50 percent subsidy on premium payments.

If results from the Akola villages in 1987/88 are indicative, farmers should find this scheme very attractive. In one of the first experiences with crop insurance in the study villages, farmers, borrowing from the cooperative sector to produce hybrid sorghum in Kanzara, received indemnities when regionally estimated yields were below average in 1987/88. Yields in Kanzara were normal or above average. Although many farmers do not know how much of the loan was paid as premiums on the insurance, the windfall indemnities have significantly increased the demand for cooperative credit in the village.

Risk Benefits with a Mean-Variance Approach

Stabilization policies like crop insurance can benefit producers in two ways (Newbery and Stiglitz 1981). They can increase mean income levels or reduce income variability. The former are referred to as transfer benefits, while the latter are usually called risk benefits. Transfer benefits arise largely from the level of program subsidies and the degree of specialization into riskier but more profitable technologies or crops as a result of participation in the program. Transfer benefits are very location specific and depend on commodity supply and demand elasticities. They often wind up in the hands of consumers.

Risk benefits of a stabilization policy are identified with how much farmers would be willing to pay to smooth fluctuations in income and consumption. How much they would be willing to pay depends on the conditions cited earlier in this chapter: (1) preferences for risk taking, (2) perceptions of how much participation in a crop insurance program would result in lessened household income variability, and (3) ability to adjust to income risk through transactions in credit and asset markets and changes in storage position. If farmers were risk averse, if they perceived that crop insurance could significantly reduce household income variability, if they could not cost effectively adjust to income risk, we would expect them to participate in a financially sound crop insurance program.

We focus on the second of the three components that condition participation (that is, the perceived consequences of enrolling in a stabilization program like crop insurance): household income variability. The conventional way to analyze variability consequences in the economics literature is to compare the CV of household income with and without participation in the program (Newberry and Stiglitz 1981). Large risk benefits are obtained when the CV with simulated program participation is substantially lower than the actual CV. In contrast, when we impose different program designs on household income streams and arrive at little or no change in income CVs we have every reason to expect that the risk benefits from and the consequent demand for an unsubsidized crop insurance program will be negligible. Few farmers would invest in an unsubsidized stabilization program if they did not believe that participation would have a measurable impact on dampening income variability.

To measure risk benefits derived from participating in a crop insurance program, we focus on the most common crops grown in each village. Those crops include irrigated paddy in Aurepalle and five dryland crops: rainy season sorghum and castor in Aurepalle, post-rainy season sorghum in Shirapur, and local cotton and hybrid sorghum in Kanzara. We include in the analysis those cultivators who grew the crop in at least five of the nine years. With the exception of hybrid sorghum in Kanzara, many of the sample farm households planted the crop each year but in varying area.

Descriptive information on the households cultivating the common crops is presented in table 8.5. Two points, brought out in other chapters, are worth reemphasizing. First, many of the so-called common crops were not actually that common, reflecting a diversified cropping pattern typical of dryland agriculture in India's SAT. The most common village cropping system is post-rainy season sorghum in Shirapur, which accounted for about 58 percent of gross cropped area in the village. Although hybrid sorghum is the second most common cropping system after local cotton in Kanzara, it was planted on average to only about 8 percent of gross cropped area. Second, yield variability on average was three to five orders of magnitude greater than price variability. Prices were remarkably stable over the period of analysis. Such stability is an essential ingredient for crop insurance to generate sizable risk benefits. Unfortunately, as we shall soon see, there are several other ingredients in the recipe.

To assess the range of risk benefits potentially offered by crop insurance, we investigate two contrasting designs. One is an individual ap-

Table 8.5. Descriptive information on the common crops sown in the study villages, from 1975/76 to 1983/84

Crop	Village	N: Farm Households[a]	N: Mean Years Cropped	Gross Cropped Area (%)	Coefficient of Variation (cv) (%)[b]: Household Income	Yield	Price
Irrigated paddy	Aurepalle	9	8.1	12	47	31	7
Castor	Aurepalle	23	7.6	34	45	68	22
Sorghum	Aurepalle	21	7.3	18	41	66	12
Sorghum	Shirapur	26	8.3	58	34	69	17
Cotton	Kanzara	26	8.2	51	33	44	15
Hybrid sorghum	Kanzara	18	7.2	8	34	66	13

Source: Walker, Singh, and Asokan (1986: table 2).

[a]Those that planted the crop for at least five years from 1975/76-1983/84.

[b]Simple means across those households that planted the crop for at least five years from 1975/76-1983/84.

proach, where the basis for both premiums and indemnity assessment is each farmer's yield; the other is a homogeneous approach with indemnity claims and premium charges based on village yields. We assume 75 percent yield coverage in both designs. Farmers are compensated when their yield falls below the 75 percent level of either their mean yield (in the individual design) or the village average yield (in the homogeneous area approach). Compensated yields are multiplied by the same year's price to exploit the potential stabilizing impact of negative yield-price covariances. Indemnity payments are then added to household income net of break-even premium costs. It is assumed that the government bears the full administrative costs of the program.

Our assessment is also based on the assumption that the household does not materially change its behavior in response to the program. Thus, the simulated results in table 8.6 show how much income stability could be achieved over and beyond whatever risk management alternatives the household availed itself of.

Risk benefits from each design are measured in two ways. In columns 3 and 5 of table 8.6, we present estimates of the mean percent reduction in the CV of household income with participation in the crop insurance program. The estimates in columns 4 and 6 are more formally grounded in economic theory and reflect what a household would be willing to sacrifice in terms of its mean income level to gain the reduction in household income variability derived from crop insurance. The risk benefits for each household is synonymous with the proportional risk premium, which is calculated by multiplying one-half the difference between the

Table 8.6. Simulated risk benefits from participating in alternative crop insurance designs

		Crop Insurance Design			
		Homogeneous Area		Individual	
Crop	*Village*	*Mean reduction in % in Household Income CV*	*Mean Proportional Risk Premium*[a]	*Mean Reduction in % in Household Income CV*	*Mean Proportional Risk Premium*[a]
Irrigated paddy	Aurepalle	4.24	0.85	3.93	0.80
Sorghum	Aurepalle	0.58	0.11	0.56	0.09
Castor	Aurepalle	4.04	0.99	3.05	0.64
Sorghum	Shirapur	1.10	0.32	1.66	0.25
Local cotton	Kanzara	-0.91[c]	0.05	1.21	0.15
Hybrid sorghum	Kanzara	-0.64[c]	0.10	-0.40[c]	0.03
Paddy, sorghum, castor[b]	Aurepalle	2.60	0.53	2.20	0.50
Cotton, sorghum[b]	Kanzara	1.55	0.15	1.65	0.18

Source: Walker, Singh, and Asokan (1986: table 3).

[a]% of mean household income from 1975/76-1983/84.

[b]For households that planted at least one crop in five or more years.

[c] Negative signs indicate that participation in the crop insurance design would have increased the mean CV of household income.

squared CVs with and without insurance by an index of risk aversion called the relative risk aversion coefficient. The value of the latter is often assumed to be around 1.0 (Newberry and Stiglitz 1981). The proportional risk premium is expressed as a percent of mean household income.

The results in table 8.6 are discouraging. For all common village crops, the risk benefits from crop insurance range from modest to negligible. Crop insurance is simply not an effective means to reduce income variability for the vast majority of farm households cultivating the crops most often grown in the study villages. Of the common cropping patterns, apparent risk benefits would be derived from insuring castor and paddy in Aurepalle. But insurance would only reduce household income variability by 3 to 4 percent; such a modest reduction would be worth only about 1 percent of mean household income.

Some risk benefits would also accrue to farmers participating in a multicommodity crop insurance scheme in Aurepalle, but even those gains are small compared to the benchmark of perfect net crop revenue stabilization. If net crop revenues could be stabilized at their mean level over the nine years, the risk benefits could be sizable, ranging from a 62 percent reduction in household income CV for paddy cultivators in Aurepalle to a 30 percent decrease for cotton growers in Kanzara. When we estimate and compare mean proportional risk premiums from perfect crop revenue stabilization with those from the simulated crop insurance designs in columns 4 and 6 in table 8.6, we find in general that enrolling in the simulated crop insurance schemes exploits relatively little of the potential risk benefits derived from perfect crop revenue stabilization. The mean proportional risk premium for multiple commodity crop insurance in Aurepalle is only about 9 percent of the estimated mean proportional risk premium from perfect crop revenue stabilization. Multiple crop insurance in Kanzara only taps about 5 percent of those potential risk benefits. With the exception of castor in Aurepalle (at 17 percent), the risk benefits from single commodity crop insurance are less than 10 percent of those from perfect crop income stabilization. Single or multicommodity crop insurance does not make much of a dent in crop revenue instability.

The very modest reduction in income CVs in table 8.6 indicate that few farmers would be willing to participate in the alternative crop insurance designs. One would have to assume much higher levels of risk aversion, far surpassing those commonly assumed in the literature, to generate significantly higher levels of participation. Additionally, if farmers had to bear the administrative costs, usually estimated at 6 percent of insured yield for individually designed programs operating in the world today (Hazell and Valdes 1984), participation would be severely curtailed.

Risk Benefits and Income Shortfalls

The preceding analysis was based on a mean-variance approach. Income variability was measured from the continuous perspectives of CVs. Would the outcome have been more favorable to crop insurance if we used a bounded rationality framework in which risk benefits are assessed in discontinuous terms like disaster levels of income and minimum probabilities? While there are almost a limitless number of threshold levels of income and frequencies from which to choose, we use as a benchmark the threshold-frequency combination described in chapter 4: the probability that a household would suffer a shortfall in income (in at least one of nine years) below 50 percent of its median income. Could participation in crop insurance have prevented households from suffering such sharp shortfalls in income? The answer is no: crop insurance would not have made much difference (Walker, Singh, and Asokan 1986). Without crop insurance, the total number of village by crop shortfalls in household income (across the three villages and the eight common cropping systems in table 8.5) was sixty-three. With crop insurance, fifty-one of those shortfalls still occurred for the farmers cultivating those cropping systems. This result is consistent with the realization that yield risk was only one of several factors contributing to such shortfalls in household income (chapter 4).

Area Variability and Covariate Sources of Risk

Why doesn't crop insurance in general and schemes based on a homogeneous area approach in particular generate larger risk benefits in these dryland farming communities? Too many necessary and sometimes conflicting conditions have to be satisfied for crop insurance to achieve the objective of stabilizing farm household income. One way to point out those conditions is to outline the features of an environment conducive to farm households receiving significant risk benefits from insurance. The ideal region would be characterized by the following:

1. Crop income should loom large in household income.
2. Farm households should specialize in a few crops.
3. Output prices should be stable to ensure that price variability does not unduly influence revenue variability directly or indirectly through fluctuations in areas.
4. Crop supply should not depend heavily on agroclimatic conditions so that the link between weather-induced fluctuations in area and crop income could be broken.
5. Yields from the insured crops should be exposed to at most a few and not multiple sources of risk so that indemnity assessment based on a homogeneous area approach could be efficient in stabilizing income for most farmers in the region.

The first three conditions are self-evident and do not warrant further comment. Conditions 4 and 5 are more subtle. An understanding of them is important, because regions where condition 4 obtains are unlikely to overlay with geographic areas where condition 5 is satisfied.

Condition 4 addresses area variability, which severely erodes the capacity of crop insurance to generate risk benefits in uncertain dryland production environments. When we calculate the CV of area sown for each household as we did for yields and prices in table 8.5, we find that mean area variability exceeds yield variability for each common cropping system.

A large share of area variability in dryland agriculture stems from decisions taken by farmers to cope with agroclimatic risk. Examples are not hard to find; several were discussed in chapter 3 for the common cropping systems in the study villages. Planned area for a crop often deviates markedly from actual area sown. Analysis of more aggregate data from SAT districts also suggests that relatively more area is planted to hardier coarse grains in low rainfall years (Bapna, Binswanger, and Quizon 1984). The role of area variability has also not gone unnoticed by economic historians. McAlpin (1983) found that year-to-year changes in acreage planted contributed the lion's share to variation in an index she constructed to measure the quality of the agricultural year in the erstwhile Bombay presidency from 1886/87 to 1919/20.

Perhaps the most poignant example of area variability in dryland agriculture occurs in the hard rock production regions, where area sown depends on surface water collected in tanks and on groundwater stored in dug wells. If not enough water is available, crops, usually paddy, are often not planted, which is what happened in Dokur in 1985 to 1987 during consecutive drought years. Similarly, Ramasamy et al.'s (1986) finding that paddy yields in their North Arcot study villages in the dry early 1980s in Tamil Nadu did not differ markedly from yields in normal years illustrates that drought often manifests itself in reductions in area more than in shortfalls in yield.

To address area variability in dryland agriculture with crop insurance, one needs to extend Dandekar's recommendation that the basis for indemnity payments with a homogeneous area approach should be a multicrop yield index. That recommendation should be widened to cover both yield and area components. To derive such a multicommodity production index that is actuarially sound and administratively feasible would be a challenging, even daunting, task.

Subsidized crop insurance programs that have tried to cope with area variability by insuring failed plantings or ex-post area sown have been fraught with moral hazard problems and recorded high loss ratios. The U.S. crop insurance program in the early 1940s was one such case (Gardner and Kramer 1986). For crop insurance to yield risk benefits, planned area, which is the basis for insurance, should coincide reasonably well with actual area sown to the insured crop.

In other words, condition 4 says that crop insurance will work better in the more stable production regions where area variability caused by climatic risk is less. Condition 5 implies the opposite. In those more assured production environments, there is not a dominant or monolithic source of risk like drought that affects crop yields in most farmers' fields in roughly the same way within the same cropping year; that is, in the more assured production regions, the sources of risk are potentially less covariate because biotic stresses such as insect pests and disease play a more prominent role. Less covariate sources of risk means that indemnities based on a homogeneous area approach will not stabilize and in some cases may even destabilize income (Roumasset 1979). For example, for about 35 percent of the local cotton growers from the respondent households in Kanzara, individual farmers' yields were inversely correlated with average yields within the same village from 1975/76 to 1980/81 (Walker and Jodha 1986). Moreover, if the sources of risk are not that covariate within the homogeneous regions, farmers will rarely be indemnified.

Extending the same line of reasoning with regard to multicommodity crop insurance schemes, if the sources of risk are not that covariate across crops, then farmers can self-insure through crop diversification. We saw in the last section that in the more rainfall-assured Akola region, where production risk arises from several physical and biotic stresses, crop diversification was effective in significantly reducing crop income variability. In the more rainfall-unreliable Mahbubnagar and Sholapur regions, where production risk stems mainly from drought, a single covariate source of risk, more diversified holdings have about the same level of crop income variability as less diversified farms. Therefore, absence of covariate risks in the more stable production environments has two implications for crop insurance based on a homogeneous area approach: (1) the timing of indemnities will not coincide well with years of low crop income for some (and most likely many) farmers in the region and (2) the effectiveness of self-insurance through crop diversification will reduce the demand for multicommodity crop insurance.

Conditions 4 and 5 clearly conflict. To satisfy condition 4 we need relatively assured production regions. To meet condition 5 we require drought-prone regions. Suppose we map those five necessary conditions and delineate geographic areas where they are satisfied in India's semiarid tropics. We believe that the intersecting set either in geographic area or number of households would be very small.

Rainfall Lotteries

If crop insurance does not deliver the goods in terms of risk benefits, what other institutional alternatives are available? Rainfall lotteries are one alternative that on paper appear to hold more promise than crop insurance as an institutional means to cost effectively diminish rural household income variability in India's SAT. Rainfall lotteries or insurance are not a new idea (Bardsley, Abey, and Davenport 1984), but to our knowledge there are few if any cases where they have been tried through private or public sector finance.

Rainfall lotteries could be patterned along the lines suggested by the Australian Industries Assistance Commission in their 1978 report on rural income fluctuations (Lloyd and Mauldon 1986). Rainfall for the monsoon season or even for a critical month in the season could be divided into five or ten intervals representing discrete events. Households would be free to buy lottery tickets on those events at the start of the rainy season. Payments would be based on rainfall data from the nearest rain gauge, usually located in a taluka or *tehsil* headquarters.

Rainfall lotteries potentially offer several advantages over crop insurance in India's SAT. They would be a fair betting system and (as envisaged by Dandekar [1976] for crop insurance) would be open to all households in the village. If landless labor households felt the demand for their labor was markedly reduced in low rainfall years, they could hedge their future labor income by purchasing tickets on the lowest or what they perceived to be the most adverse rainfall events. A lottery format would also allow farmers to protect their income from nonlinearities between rainfall and yield. Too much rain is often as damaging to crop income in the semi-arid tropics as too little rain. With rainfall lotteries, farmers could guard against unfavorable events associated with too little or too much rainfall.

Although rainfall is more covariate across space than yield, the insurer would likely be less exposed to risk because, with both hedgers and speculators in the market, offsetting positions would be held. Also, in a country as large as India, the monsoon is not that covariate across regions. In most years, rainfall is high in some regions, low in others. The geographic coverage for insuring rainfall would be much broader than for insuring yields of specific crops that are planted in well-defined regions. Both the lottery format and the more extensive geographic coverage should ensure that a rainfall insurer would be less exposed to risk of catastrophic loss in India's SAT than a crop insurer. The size of the country makes rainfall lotteries a more attractive alternative in India than in smaller countries of the semi-arid tropics.

Rainfall appears to be more removed from income than yield; however, in the lower and more variable rainfall dryland agricultural regions, rainfall may be a sounder basis for measuring fluctuations in crop revenues than yield. In those regions, rainfall should be positively covariate with cropped area. Deviations from normal rainfall at sowing also induce farmers to plant less remunerative crops. Hence, in the drier, less assured regions, rainfall may explain more of the variation in crop revenue variability through its combined effect on area and yield variability than the pure impact of yield variability.

A number of other points favor rainfall lotteries over crop insurance. In principle, rainfall is much more observable than yield and should be easier to measure. Participants in a self-funded rainfall lottery should be in a much better position to agree on what rainfall events obtained compared to farmers enrolled in a crop insurance program that relies on yield assessments based on area sampling frames. Rainfall lotteries should also be relatively free from incentive problems related to moral hazard and adverse selection. They should also be administratively cheaper than crop insurance. Finally, the actuarial basis for rainfall insurance is much firmer than for crop insurance. Rainfall records are extensive throughout much of India.

Rainfall lotteries also share some of the problems of crop insurance. Participation by the poorest households could be severely limited or even curtailed by liquidity constraints. Designing the lottery to correspond to rainfall events highly associated with crop income and village labor demand would be a challenging, location-specific task. Installing a rain gauge in every village would maximize demand for rainfall insurance, but this would also lead to increased scope to tamper with rainfall data. One could imagine a situation where all villagers collude, bet on the same event, and bribe officials to report fraudulent rainfall data so that that event is obtained.

Initial experience with a small simulated rainfall lottery in Shirapur from 1986 to 1988 was not that positive (Bakker 1989). Farmer choices in the lottery were dominated by speculative demand. Few participants viewed the lottery as an opportunity to hedge against adverse rainfall events. Participation was also constrained by the lack of liquidity. Specific rainfall events could not be identified that would explain much of the interhousehold variation in within-household income variability from 1975/76 to 1983/84. With hindsight, Shirapur was probably not the best of all possible worlds to monitor households' reaction to a rainfall lottery because the marked presence of and activity from the MEGS near Shirapur probably reduced the demand for rainfall insurance. Nevertheless, based on this experience, we are not optimistic that participation in a rainfall lottery could generate sizable risk benefits for participants. Moreover, rural public relief measures are usually triggered on rainfall assessments, thereby making rainfall-based insurance (to some extent) redundant. Demand for such insurance would be particularly reduced in regions where politicians are quick to appeal for state and central government assistance at the slightest indication that the monsoon is capricious (Morris 1974).

Rural Public Works

Rural public works programs, often on a massive scale, have been the main institutional response to times of scarcity in India since 1880, when the Famine Commission issued its report and when the famine codes were promulgated (Dreze 1988). Gratuitous relief for those unable to work played a secondary role and complemented public works.

The great advantage of rural public works is their self-targeting ability to select for the poorest, provided the wage is set low enough to self-select for those in need but not too low to jeopardize their subsistence. Other forms of self-targeting to relieve famine were tried in the nineteenth century and found wanting compared to the option of labor in public works schemes. They included "(1) the distance test: relief is provided . . . in far-apart places, on the assumption that only those in greatest need will take the trouble of traveling long distance to avail themselves of it; (2) the residence test: beneficiaries are required to reside at the place of relief; (3) the test of cooked food: relief is based on the distribution of cooked meals" (Dreze 1988: 28-29).

In the 1980s, real wages for piece-rate work on the MEGS have increased over time and are probably now higher than what is socially desirable (Subbarao 1987b). The MEGS has gradually evolved from a slack season work program into a regular employment program (Subbarao 1987b). For example, a small minority of laborers, particularly women, specialized in MEGS employment in Shirapur from 1979/80 to 1983/84 when detailed data were maintained on participation in the MEGS. They received seasonal wages that were generally higher than those reigning in the village daily-rated labor market.

Nevertheless, the self-targeting character of rural public works was clearly visible in the Maharashtra study villages in the early 1980s. Wealth in the form of total assets was strongly and inversely related to participation in the Maharashtra Employment Guarantee Scheme (table 8.7). The size of that relationship was particularly large for women: as wealth increased, women's participation fell off more sharply than men's in both Shirapur and Kanzara. Between the two villages, the effect of wealth on participation was considerably stronger in Kanzara, where farm employment opportunities were more abundant.

Still, rural public works featuring earnings based on piece-rate performance, largely in moving earth, are not everyone's cup of tea. For example, in Shirapur several casual laborers of both sexes reported many days of involuntary unemployment and no or negligible participation in the MEGS. By and large, these people comprised the old, the very young, the disabled, or others who could not perform rigorous manual labor. But among the able-bodied, opportunities to participate in the MEGS were widely available. As long as the household work force contained one able-bodied member, that household could benefit from the MEGS.

While the self-targeting nature of rural public works programs such as the MEGS has been numerically documented in several studies (Dandekar and Sathe 1980), the elusive issue of risk benefits (i.e., how effective the MEGS has been in smoothing income variability of participants) has not received much empirical attention.

Table 8.7. Elasticities from a Tobit analysis of effect of wealth on days of participation in the MEGS in Maharashtra villages, 1979 to 1983[a]

	Shirapur		*Kanzara*	
Variable	*Male*	*Female*	*Male*	*Female*
Total assets	-0.49**[b]	-2.86**	-3.17**	-4.40**
	(-4.14)	(-8.70)	(-5.44)	(-3.09)
Ln likelihood function	-1,199	-932	-767	-309
N[c]	801	1,020	660	822

[a]Year and season dummies were also included but are not reported as they were rarely significant.
[b]t values in parentheses. ** indicates statistical significance at the 0.01 level.
[c] Seasonal observations for each potential labor force participant residing in the village from the household panel during the kharif, rabi, and summer seasons.

Some quantitative, although fragmentary, evidence on the potential for flexible, local public works programs like the MEGS to generate risk benefits comes from the study villages. That evidence is based on comparing levels of household income variability in drought-prone Shirapur and Aurepalle. Landless labor households that relied almost entirely on earnings in the daily agricultural labor market in Shirapur and Kanzara, where the employment guarantee scheme had operated since 1977, had about 50 percent less variable income streams than those in Aurepalle, where rural public work opportunities were not locally available. As pointed out in chapter 4, only in Shirapur, where the supply of rural public works was greatest, was labor's share in income inversely and significantly associated with the CV of net household income, suggesting that a considerable number of the respondent households relied on off-farm earning opportunities to smooth fluctuations in income. Nonetheless, these results should be interpreted with caution, because there are only eight or nine households in each village by farm-size category. Moreover, differences in village ecologies other than the availability of rural public works employment and other off-farm employment opportunities also conditioned the degree to which shortfalls in income could be compensated for by labor market earnings.

Increased participation in response to natural hazard is the most visible sign of potential risk benefits from locally available rural public works programs. Evidence on year-to-year fluctuations in participation rates suggests that the MEGS has been effective in conferring risk benefits on participants in some localities hit by drought and other events that adversely affect production. The ability of the scheme to respond in times of need is supported by the following examples:

> cultivators in Western Maharashtra and Marathwada (central districts) flocked to EGS sites after sowing operations were disrupted by lengthy dry spells during the 1979 monsoon; attendance rose sharply and remained high in Vidarbha (eastern portion of the state) when August flooding destroyed the paddy crop in many localities. Similarly, a poor rabi crop due to insufficient soil moisture was reflected in unusually high EGS attendance during April-July 1983; flooding in Marathwada resulted in relatively high participation levels from August 1983 onward. (Lieberman 1984: 7)

Conclusions

The main findings in this chapter can be summarized as follows. Intuitively and empirically, we could cite only a handful of cases where risk played a prominent role in the adoption of improved practices, technologies, or cropping systems in the study villages. Examples of a transparent conflict in risk and expected profitability arose in the choice of rainy season cropping systems in Aurepalle and Kanzara and in the decision to dig a well in the Mahbubnagar villages. But those examples were in the minority, as dominance of one practice, technology, or cropping system over another was a more likely outcome.

Thus, intermediate to moderate levels of farmer risk aversion, estimated in the experimental games, often did not have a direct bearing on decisions on technology choice because tradeoffs between risk and expected profitability were nonexistent or negligible. The more subtle, indirect effects leading to reduced availability of credit and scope for maneuver in production relations may be more important in India's SAT than the overt consequences of risk aversion (Binswanger and Sillers 1983).

Two general regional aspects of production risk were highlighted in this chapter. Compared to irrigated agriculture, yield risk is likely to loom proportionally larger in dryland agriculture. That finding from district data was not surprising, but the result from farm-level data was unexpected: even within assured irrigated areas of India's SAT, such as well-irrigated Dokur, farmers were much better at predicting harvest prices than yields for their irrigated crops. The ability of farmers to forecast prices, especially for paddy, again attests to the stability of food grain prices in the study villages in the early and mid 1980s.

The other general geographic feature of production risk examined in this chapter pertained to interregional differences in farmers' effectiveness in dealing with crop income risk. Again, not surprisingly, we found that both crop diversification and intercropping worked better at diffusing production risk in the more rainfall-assured Akola villages, where the sources of yield risk are less covariate, rainy season cropping is more widely practiced, and the growing season is longer than in the other study villages, particularly the drought-prone Sholapur villages.

The recognition that yield risk is pronounced in dryland agriculture and that the efficacy of farmers' self-insurance increases with the length of the growing season raises the question of the effectiveness of public policy interventions to assist farmers to adjust to production risk in the resource-poor Mahbubnagars and Sholapurs. More specifically, could crop insurance protect farm households from suffering fluctuations or shortfalls in income conditioned by production risk? Based on alternative simulated designs, we found that crop insurance would have conferred little if anything in the way of risk benefits on the cultivator households in the study villages. What mainly defeats crop insurance in the resource-poor regions of India's SAT is area variability, discussed in chapter 3. Indeed, crop insurance was most effective in reducing income variability to well-irrigated paddy producers in Aurepalle. Well-irrigated paddy loomed large in household income and was not characterized by as marked year-to-year fluctuations in area as were the common dryland crops.

Our disenchantment with crop insurance is not without precedent. In India, the 1971 expert committee chaired by Dharm Narain concluded "that in the context of [the] paucity of resources for planned development, a recurring expenditure on the administration of [the] crop insurance scheme is not preferable to the direct utilisation of funds for raising agricultural productivity and reducing crop yield variability" (cited in Agarwal 1980: 100). More recently, in Australia, where aggregate cereal production variability is two to three orders of magnitude greater than in India, the Industries Assistance Commission came to the same conclusion: "The Commissions's preferred option is for the Government not to provide assistance to increase the availability of crop and/or rainfall insurance" (Australia: Industries Assistance Commission 1986: 42).

Our pessimism about crop insurance does not preclude the possibility that a new institutional innovation could improve the odds that public assistance could directly and cost effectively contribute to risk management in resource-poor dryland agricultural regions in India's SAT. For example, insuring against the event that large village tanks, such as the one in Dokur, do not fill for rainy season cropping could be one candidate for insurance research. But for now and into the foreseeable future it is difficult to improve on the main recommendation of the 1880 Famine Commission that self-targeting public works " is the safest and most efficacious form of State help" (cited in Dreze 1988: 33).

9 Nutritional Status

Adequate nutrition is both an end of and a means to economic development. In the words of Berg, it "is now widely accepted as part of the purpose of development and need not be justified as a means of development" (1981:14). Improved nutrition can reduce child mortality and increase life expectancy, which in turn can lead to increased receptivity to family planning, resulting in diminished fertility and population growth. Nutritional deficiencies can also dampen productivity, education attainment, and mobility, thereby eroding income-earning opportunities.

That there is a pernicious and pervasive health and nutrition problem at the aggregate level in developing countries is now well recognized, though its extent is debated. Mellor and Johnston (1984) quote figures of between 0.4 and 1.1 billion people suffering from protein-energy malnutrition (PEM) in the 1960s and 1970s. Pinstrup-Andersen (1981) estimates that 0.4 billion people live close to minimum subsistence, with between 4 and 5 million dying annually from starvation and malnutrition. Using estimates of population in the so-called vulnerable groups, mainly preschool children and pregnant and lactating women, Poleman (1981) suggests that about 0.3 billion people are at nutritional risk. His estimate is close to the 0.46 billion calculated by FAO in their Fourth World Food Survey. A comparable estimate in the Fifth World Food Survey for 1979 to 1981 was slightly higher at 0.49 billion (Quance 1988). Upton (1983a) maintains that poverty-related undernutrition affects 10 to 15 percent of the populations of developing countries, considerably less than the 35 to 60 percent cited by Berg (1981), Dandekar and Rath (1971), and Knudsen and Scandizzo (1982).

From a development perspective, the challenge is to better understand the processes by which villages, families, and individuals form and express their desires for health improvements and food, how they acquire and allocate them, and the factors which condition this behavior and hence determine the health and nutritional status of individuals (Kennedy and Pinstrup-Andersen 1983). Policies and programs built on a sound understanding of the microlevel determinants of health and nutritional status can help ensure that increased food supplies reach those most in need in a cost-effective manner.

The dearth of nutrition studies at the level of the household is widely acknowledged (Timmer, Falcon, and Pearson 1983; Chambers 1982; Schofield 1979). Much less research has focused on the nutritional and health status of the individual, not only in developing but also in the developed countries. Investing in understanding the nutrition and health of individuals could help explain why the performance of many nutrition interventions often has not measured up to expectations. Examples include supplementary feeding of children, income transfers, food fortification, nutrition education, and food subsidies.

This chapter is based on data, collected in the late 1970s, on the nutritional status of individuals in the six study villages. These voluminous data have been subjected to considerable analysis; the results are reported here in five sections. We set the scene by presenting the central tendencies of the nutrition and health data to place the estimated health and nutritional well-being of these SAT villagers in a wider Indian and world perspective. Next, we point out aspects of village environmental health and regional food preferences that influence nutritional status. Then, we examine how nutritional status differs by gender and season, two characteristics that are often mentioned as partially determining the nutrition and health status of rural villagers in developing countries.

In the second section, we assign the total variation in nutrient intake and weight-for-height, an anthropometric index of nutritional status, among individuals to interseasonal, intervillage, interhousehold, and intrahousehold differences to establish the relative importance of where one should look initially to understand variation in nutrition and health outcomes. In the third section, we discuss the determinants of nutritional status of individuals. A major issue addressed in that discussion is the extent to which income growth can be relied upon to enhance nutrient intakes in these poor regions of India. Intrahousehold disparities in nutritional status are the subject of the fourth section. Evidence on changes (since the late 1970s) in nutritional status in one of the villages is presented in the fifth and last analytical section. We conclude by drawing implications for health and nutritional policy. Nutritional implications pertaining to agricultural research and technological policy are deferred to chapter 10.

General Features

The nutritional status of villagers was evaluated from three sources of information: (1) twenty-four-hour dietary recalls of individual food intake in the sample households, (2) anthropometric measurements, and (3) the extent of evident clinical malnutrition and deficiency symptoms. Data were gathered four times during a sixteen-month period commencing in

October 1976 by an interdisciplinary team consisting of nutritionists, medical staff, home scientists, and economists.

The combined nutrient value of all foods was calculated for each of the 1,200 members of the 240 respondent households and expressed as a percentage of Indian recommended daily allowances (RDAs) in each of seven age-sex groups. The nutrient values of diets and RDAs were taken from Gopalan, Sastry, and Balasubramanian (1971). See Ryan et al. (1985) for more information on the methods used.

Weight-for-age, based on the Gomez et al. (1955) classification, was used to measure malnutrition in preschool children; weight-for-height was the anthropometric measure of nutritional status for older children and adults. According to the Gomez classification, less than 60 percent of standardized weight-for-age is associated with third-degree malnutrition, between 60 and 75 percent with second-degree malnutrition, and between 75 and 90 percent with first-degree malnutrition (Gomez et al. 1955). Weight-for-height is often considered a more appropriate index of nutritional well-being than either weight-for-age or height-for-age (Seoane and Latham 1971).

Incidence of Deficiencies

Across the six study villages, the primary deficiencies in diets were ascorbic acid (vitamin C), beta-carotene (precursor of vitamin A), calcium, riboflavin, and energy (figure 9.1). From the means and standard deviations of the %RDAs in figure 9.1, we see that the mean intake was less than half the Indian standards for beta-carotene and ascorbic acid, less than three-quarters of the standards for calcium and riboflavin, and below the standards for energy. These sample averages exceeded the standards only for protein, iron, and thiamine.

Because of person-to-person variation in RDA and the notion of individual self-regulation of requirements or homeostasis, nutritionists are reluctant to use a single-valued RDA for a reference individual as the criterion for determining nutritional adequacy of diets. Some argue that the critical level of RDA should be established two or three standard deviations below the RDA for a reference individual (Sukhatme 1982; Sukhatme and Margen 1978). Ryan et al. (1985) used 50 percent RDA as an approximation.

The proportions consuming less than 50 percent of RDA for calories ranged from 11 to 15 percent for children (one to twelve years), 2 to 9 percent for males over twelve, and 3 to 8 percent for females older than twelve across the six study villages. These estimates are similar to the figures of 10 to 15 percent cited by Lipton (1983a) and Seckler (1979) as the proportion of the Indian population likely to be too poor to avoid serious risk of undernutrition. They are much lower than the 40 to 60

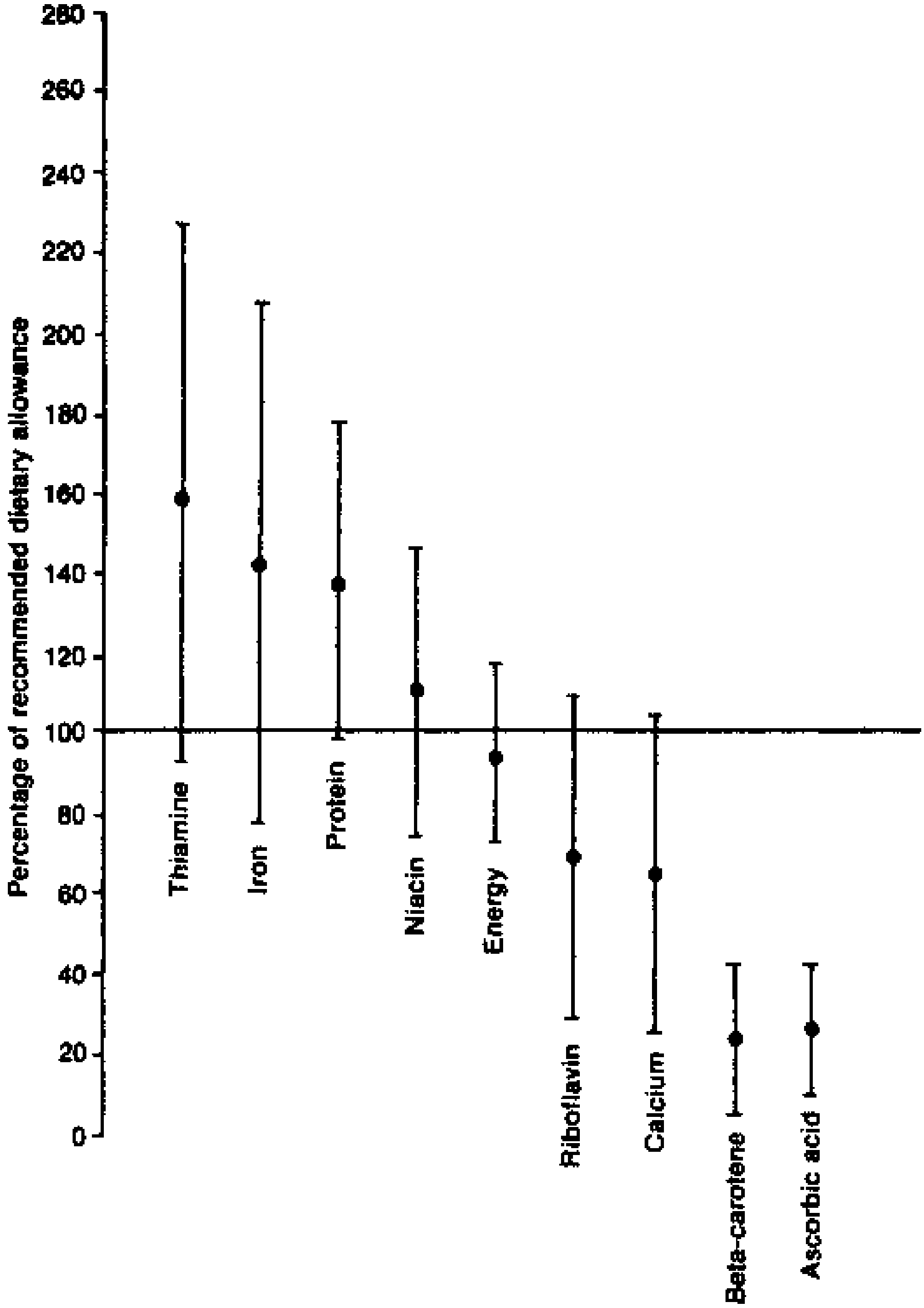


Figure 9.1 Means and standard deviation of energy and nutrient intake among individuals in the study villages from 1976 to 1978

percent estimates of Dandekar and Rath (1971), Reutlinger and Selowsky (1976), and Mellor and Johnston (1984).

Severe cases of malnutrition among preschool children, as measured by less than 60 percent standardized weight-for-age on the Gomez scale, ranged from 2 to 7 percent across seasons and villages. Those estimates are consistent with results from other studies in India. Poleman (1981) cites six surveys in India involving more than 32,000 children where the median incidence of severe malnutrition measured by weight-for-age on the Gomez scale was 2.6 percent, with a range of 1.1 to 20 percent. The Indian Council of Medical Research (ICMR 1974) found the incidence of kwashiorkor (protein deficiency) in India to be 1 percent and marasmus (severe wasting) 2 percent.

No clinical signs of protein-energy malnutrition (PEM) were observed in the Maharashtra villages. In the two Andhra Pradesh villages, PEM was observed in 5 percent (or 11) of the 226 preschool children clinically examined; the sexes were equally represented. All the affected children had less than 60 percent weight-for-age (third-degree malnutrition). Major dietary protein deficiencies were not evident. The sulfur-amino acids, methionine and cystine, were in adequate supply in all age-sex groups.

Calorie deficiencies were most pronounced among one-to-three-year-old children, which is in line with Prahlad Rao, Singh, and Swaminathan (1969). As age increased, calorie deficiencies declined slightly. Beta-carotene and ascorbic acid were severely deficient in all age-sex groups. Thiamine was deficient in the diets of all the Andhra Pradesh villagers and in the food consumption of the one-to-three-year-old children in the Maharashtra villages. Children in all the villages were consuming insufficient riboflavin; so were some youths and adults.

Clinical symptoms of vitamin A and vitamin B-complex deficiencies were evident in preschool children in all the villages. The range (across the six villages) was 4 to 29 percent for symptoms of vitamin A deficiency and 4 to 41 percent for vitamin B-complex deficiency. Often both deficiencies were present. They were most visible in Aurepalle and least noted in the two Akola villages. Their incidence was much greater than was reported by the Indian Council of Medical Research (ICMR 1974) in a study of eighteen thousand preschoolers in six urban areas. In Hyderabad and Pune (two cities in India's SAT) the frequency of symptoms of vitamin A deficiency was 5.0 and 4.6 percent, respectively; comparable figures for symptoms of vitamin B-complex deficiency were 7.6 and 3.3 percent. These rural-urban differences highlight the need for enhancement of intake of foods rich in vitamins in rural areas of India's SAT.

About 8 percent of individuals fell below 70% of their age-sex weight-for-height standards. That figure approaches those cited by Seckler (1979), who estimates that truly malnourished individuals in India, as measured by weight-for-height (not weight-for-age, as is commonly done), number between 10 and 20 percent.

Village Environmental Health

Anthropometric indicators of nutritional status may be as much or more influenced by nonnutritional health considerations as by food consumption (Bidinger, Nag, and Babu 1986a). Poor sanitation, hygiene, and public health infrastructure are most likely largely responsible for why our findings on energy and nutrient intake are often incongruent with results based on anthropometry. For example, both children and adults in Dokur had significantly higher caloric intakes than villagers in Aurepalle in the same age groups. But superior energy consumption did not translate into marked advantage in weight-for-height and weight-for-age or into a reduced incidence of signs of PEM.

Several special purpose surveys on aspects of environmental health were undertaken to complement the dietary recalls, the anthropometric measurements, and the clinical exams (Bidinger 1983). In the late 1970s, sanitation was inadequate in all the study villages. All the villages and many of the household cooking areas were infested with flies and mosquitoes. Many households also had litter, debris, and/or animals within their compound. Only about 15 percent of the respondent homes in the 1977 survey of household environmental health were considered to satisfy good conditions of household cleanliness.

Turning to drinking water, the results of a bacteriological examination of samples from 46 of the 101 domestic wells in the six villages in 1977 showed a high degree of contamination, not only by coliform bacteria in general but by *Escherichia coli* in particular. The presence of *E. coli* indicates fecal contamination, which may be responsible for the transmission of serious diseases.

None of the villages has a trained physician (M.B.B.S.). A homeopathic doctor who used plant material and minerals for medicinal purposes lives in Kalman. Residents of Aurepalle and Dokur have access to registered medical practitioners who are trained in ayurvedic (or Indian) medicine and to a much lesser extent in the use of allopathic (or Western) drugs.

Distance to the nearest government-operated primary health center ranged from 4 km for Kanzara to 13 km for Dokur. The public health centers serving the study villages were poorly staffed and equipped. Although some were better stocked than others, frequently the only medicines available were aspirin, calcium lactate, and penicillin.

Because of these conditions, sickness is no stranger to the villages. Based on weekly interviews on a forty-household sample of 349 people in Dokur in 1982/83, Bidinger, Nag, and Babu (1986a) found that the incidence of illness (i.e., the proportion of individuals with morbid signs) ranged from a weekly low of 14 percent to a weekly high of 28 percent during the fifty-two-week period of analysis.

Food Consumption

Another trait shared by residents of the six study villages was the dominance of cereals in supplying energy and nutrients in the diet. In most of the villages, the bulk of thiamine, iron, protein, niacin, and riboflavin was derived from cereal consumption (figure 9.2). The lack of diversity in the sources of some of the micronutrients such as riboflavin cannot be regarded as a good thing. For example, both children and adults in Au-

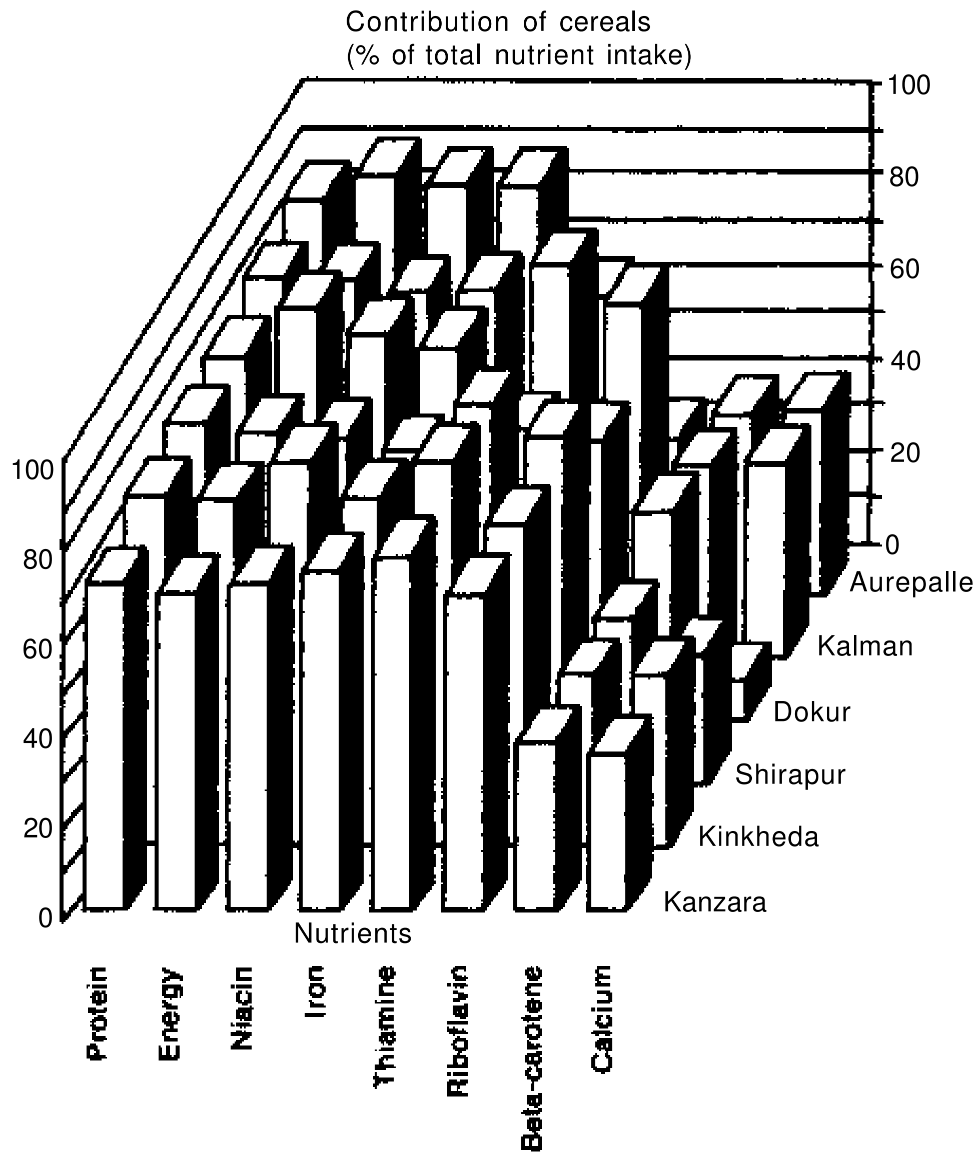


Figure 9.2 Importance of cereals in energy and nutrient intake by village and nutrient

repalle, where milk and milk products such as buttermilk loomed larger in the diet, had significantly higher riboflavin intakes than residents of the other villages characterized by a higher contribution of cereals in the source composition of riboflavin.

Gender

Convention dictates that women's health and nutritional status are inferior to men's (Agarwal 1986). Two material reasons are often put forward to explain the apparent discrimination against women: (1) they are of little social security value to their parents because they leave home after marriage and (2) sons have better income-earning opportunities (Rosenzweig and Schultz 1982).

A clear case of sex discrimination in nutritional and health position was documented by Chen, Hug, and D'Souza (1981) in rural Bangladesh, where female mortality was much greater in 1978, especially among preschoolers. In that study, a higher proportion of girls (14 percent) were malnourished than boys (5 percent), as measured by their weight-for-age and also their heigfat-for-age (27 percent versus 17 percent). Preschool boys met about 8 percent more of their energy RDAs than preschool girls. Although gender differences in infection rates were not significant, boys were taken to medical treatment centers with much greater regularity than girls. In contrast, Upton's (1983b) interpretative review of the empirical evidence supports the view that, apart from Bangladesh and northern India, women seldom receive a smaller proportion of their RDAs of calories than men.

Across the six villages, evidence for a gender bias within age, season, and farm-size groups was not persuasive. Transparent differences between males and females falling below the 50 percent RDA standard did not emerge (figure 9.3). Only eleven of the forty-eight energy and nutrient (protein, calcium, iron, beta-carotene, thiamine, riboflavin, niacin, and ascorbic acid) by season (surplus and lean) by farm size (landless and small farm, medium farm, and large farm) comparisons between the sexes were statistically significant. In seven of the eleven, proportionally more males fell below 50 percent RDA than females. Also, relatively more women met 80% of their RDAs than men (Bidinger 1983).

Focusing on children, more boys than girls of preschool (one to six years) and school age (seven to twelve) were poorly nourished on a standard of weight-for-age. Few of these children had second- or third-degree malnutrition on a weight-for-height index. Those that did mainly came from the Akola villages, where 7 of the 35 one-to-three-year-olds and 23 of the 216 adolescents (ten to eighteen years) failed to achieve 75 percent of their weight-for-height. Of these children, 12 were girls and 18 were boys.

Seasonality

Based mainly on research and experience in Africa, the role of seasonality in conditioning nutritional and health outcomes was highlighted in the 1970s. In particular, the wet season is purported to be the period when malnutrition and illness are at their peak in tropical developing countries (Schofield 1974, 1979; Longhurst and Payne 1979; Chambers 1982). Malaria, diarrhea, and skin diseases are generally more prevalent at that time. Their effects are also more debilitating because the wet season is also when staple food supplies and intakes are dwindling and when labor demand and energy expenditure are rising.

The wet season in the six villages is generally from mid-June through September and, with the exception of the Akola villages toward the end of the rains, it represents a period of lean food availability (table 9.1). Other lean periods occur in the cold dry season in the Sholapur villages because of the practice of monsoon fallowing and post-rainy season cropping and in the hot dry summer season in Aurepalle. With those two

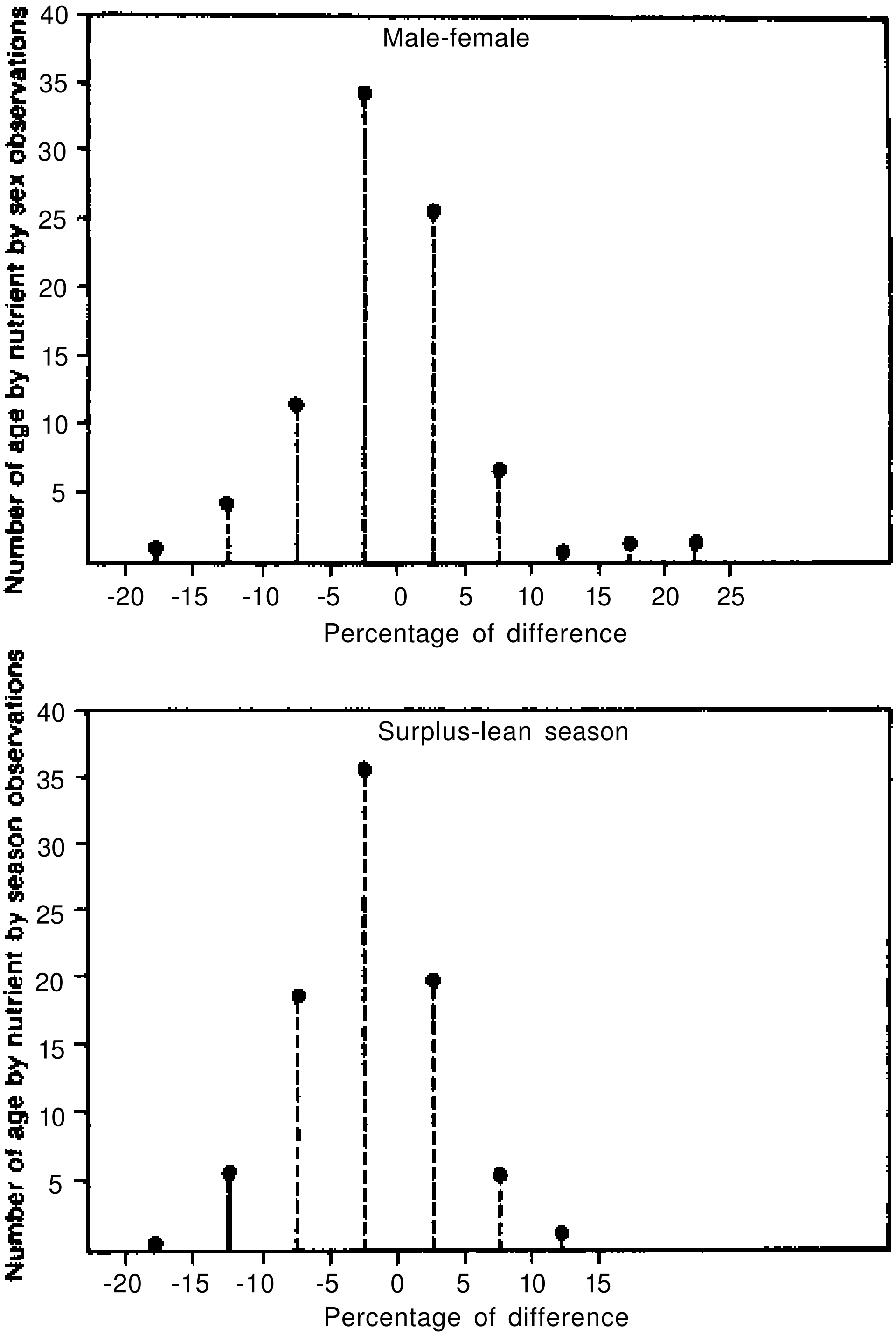


Figure 9.3 Frequency of differences between sexes and seasons in the incidence of less than 50 percent RDA consumption of nutrients by age, sex, season, and nutrient categories

Note: **Age categories are 1-3, 4-6, 7-12,13-18, and above 18 years; seasons are surplus and lean; nutrients categories include calories, protein, calcium, iron, beta-carotene, thiamine, riboflavin, niacin, and ascorbic acid.**

exceptions, the cold and dry season from November to February and the hot and dry season from March to May are times of seasonal food grain surplus. Contrary to expectations, mean per capita intakes of energy and nutrients did not show a marked depression in the wet season (figure 9.4). Indeed, more of the village by nutrient seasonal patterns in figure 9.4 fit an inverted U-shape than the expected dip in the wet season.

Table 9.1. Availability of food grains and demand for labor in six villages

	Season					
	Cold and Dry[a]		*Hot and Dry*[b]		*Wet*[c]	
Village	*Food Grain Availability*	*Labor Demand*[d]	*Food Grain Availability*	*Labor Demand*	*Food Grain Availability*	*Labor Demand*
Aurepalle	Surplus	Peak	Lean	Slack	Lean	Peak
Dokur	Surplus	Peak	Surplus	Slack	Lean	Peak
Shirapur	Lean	Slack	Surplus	Slack/peak	Lean	Peak
Kalman	Lean	Peak	Surplus	Peak	Lean	Slack
Kanzara	Surplus	Peak	Surplus	Peak/slack	Lean/surplus	Peak/slack
Kinkheda	Surplus	Peak	Surplus	Peak/slack	Lean/surplus	Peak/slack

[a] November-February.

[b] March-May.

[c] June-October.

[d] As determined by labor opportunity costs (wages x probabilities of employment) from 1975 to 1977 described in chapter 5.

Seasonal differences in meeting 50 percent RDA in the age by sex by nutrient group comparisons were also not pronounced. They were unimodally distributed around zero in the lower panel of figure 9.3.

Intakes of thiamine, ascorbic acid, sulfur-amino acids, protein, and calories were subject to the greatest extent of seasonal variability, while consumption of beta-carotene and lysine fluctuated the least. In seasons when proportionally more pulses and coarse grains were consumed, the extent of thiamine, riboflavin, and beta-carotene deficiencies declined. Drought-prone and poor Aurepalle seemed to be subject to greater seasonality in nutrient intake; seasonality was least in highly irrigated Dokur. The Maharashtra villages showed only a moderate degree of seasonality.

In Aurepalle and in the Sholapur villages, nutrient intakes in the surplus food grain seasons were either equal to or in excess of the levels in the lean season. In contrast, in Akola and to a lesser extent in Dokur, the lean food grain availability season during the monsoon was a time of considerably improved overall nutrient intake, or, at worst, a situation similar to the surplus season. Both regions have a significant degree of cash cropping (cotton in the Akola villages and rice in Dokur), which may cushion the effects of seasonality in the production of the major food grains. The lean season in the Akola villages falls in June and July, when landless laborers can find employment with relative ease and when farmers receive payments for the previous cotton harvest.

Some subtle effects of the variation in regional ecology on seasonal nutrition outcomes were also observed. In Dokur and in the Akola villages, a person's intake of calories measured as a proportion of his or her RDA relative to others in the village was more stable across seasons

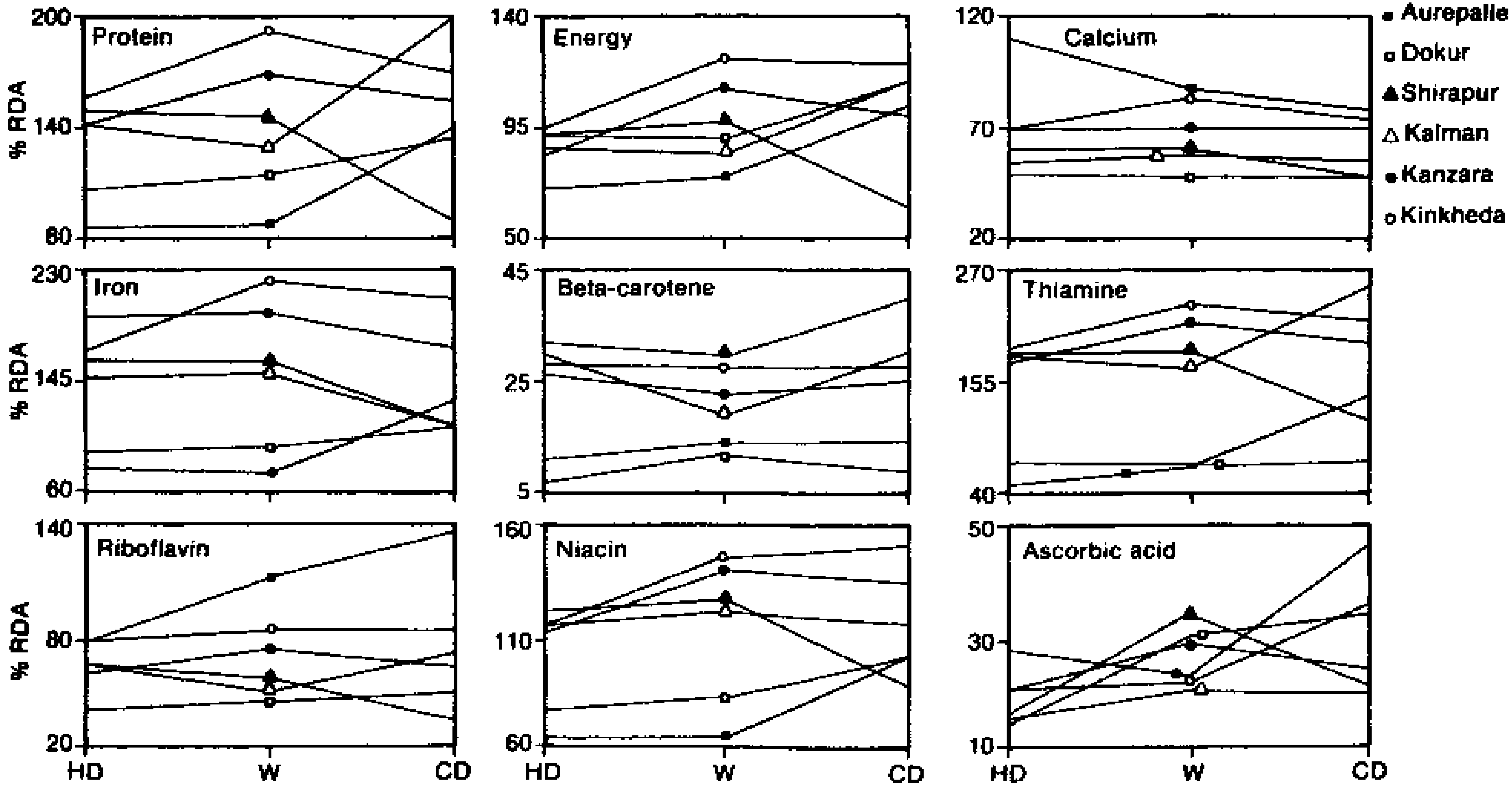


Figure 9.4 Nutrient intake in the hot dry (HD), wet (W), and cold dry (CD) seasons by village from 1976 to 1978

than in the other three villages. In other words, the rank correlation coefficients between villagers' lean and peak seasonal positions on the %RDA scale were higher and generally statistically significant in Dokur, Kanzara, and Kinkheda. Few correlations were statistically significant in Aurepalle, Shirapur, and Kalman. Access to irrigation and/or assured rainfall led to longer-lasting relative energy status compared to more drought-prone environments such as Aurepalle and the Sholapur villages, where it was harder to identify individuals with endemic energy deficiencies that linger across seasons. However, rank correlation coefficients were all low, with most ranging between 0.1 and 0.2 and none above 0.5 (Ryan et al. 1985). When rankings were estimated by pooling all individuals, ignoring age, gender, and village differences, the correlations were much higher.

Turning to households within villages, one can list several reasons why the poorer segments of the population are expected to be susceptible to greater seasonal variation in nutritional status (Lipton 1983a, 1983b). But we found no systematic tendency for those from landless and small farm households to be subject to a greater degree of seasonality in energy and nutrient intake than members of medium and large farm households. Only in the Akola villages was the incidence of seasonal differences more pronounced for landless labor and small farm households than for other farm-size groups. For Kanzara and Kinkheda, nutrient intakes, when statistically significant between the lean and surplus seasons, were always higher in the lean season. The Akola case suggests that having cash in one's hand in a lean food grain availability period can confer a relative seasonal advantage in energy and nutrient intake to poor households.

The incidence of mild to severe malnutrition also did not display a marked seasonal pattern. Only Dokur conformed to the conventional wisdom that malnutrition, based on the Gomez classification of weight-for-age, was higher in the lean season. But even in Dokur the incidence of illness was not unimodally distributed around the wet season. Seasonal peaks in illness exceeding 20 percent for shorter periods of six or more weeks occurred in each of the three seasons in table 9.1 (Bidinger, Nag, and Babu 1986a). Nor did we find significant differences in the weights of adults between seasons. The proportion of villagers falling below 70 percent of their age-sex weight-for-height was higher in the surplus food grain season. Again, the differences were small: 9.3% in the surplus season compared to 6.6 percent in the lean season.

Given the discussion in chapter 4 on the flatness of cereal prices for consumers during the period of analysis from 1975/76 to 1984/85 and the description of the active village markets for consumption credit in chapter 7, the findings of relatively limited seasonality in nutritional status and the absence of a consistent seasonal pattern across the study villages are not that surprising. Bidinger, Nag, and Babu (1986a) during their fifty-two-week nutrition and health study in Dokur also attributed the lack of seasonality in caloric intake to the active market in consumption credit, which often took the form of cooked food, mainly rice, and had overtones of a patron-client relationship.

Moreover, the critical seasonal correspondence between food grain availability and energy expenditure—lean with peak labor demand and surplus with slack labor demand—is not one to one in table 9.1. Considerable energy is expended in the surplus season. Tasks such as harvesting, threshing, and carrying of produce are generally more demanding of physical effort. The anthropometric estimates indicate that much of any additional food intake in the surplus seasons may be dissipated in increased energy expenditure.

Finally, an emphasis on seasonal energy requirements and food-grain availability could be tempered by seasonal interactions with other deficient nutrients, particularly vitamins. Vegetable production, the main source of ascorbic acid intake, is both inadequate and subject to substantial seasonal variation in all the villages. The surplus food grain seasons were generally those when vegetable consumption was reduced, especially for children. The need for some B vitamins increases with a rise in the intake in food grains. Deficiencies can result if diets do not contain adequate amounts of "protective foods" such as fruits and vegetables. Such imbalances may be more frequent in the surplus season even though, as Chambers (1982), Longhurst and Payne (1979), and Schofield (1974) point out, in these surplus (i.e., dry) seasons, total food availability may be better.

Sources of Variation

Recently, the distribution of nutrient and energy intakes and health status within the household have been the subjects of more discussion and debate if not greater analytical scrutiny (Haaga and Mason 1987; Harriss 1987). Nutrient imbalances or maldistribution within the household are referred to as a stage 2 nutrition problem (Timmer, Falcon, and Pearson 1983). They require intervention strategies of a different type to those designed to alleviate stage 1 deficiencies at the household level.

To ascertain the relative importance of these two types of nutrition imbalances, we split the total variation in nutritional adequacies (in %RDA) and in weight-for-height into four component sources; (1) intra household, (2) interhousehold, (3) intervillage, and (4) interseason effects.

The results of the partitioning of the total sums of squares are displayed for children (one to twelve years), younger and older adults above age twelve, and all family members in figure 9.5. These results are given as a proportion or share of each source's contribution to total variation.

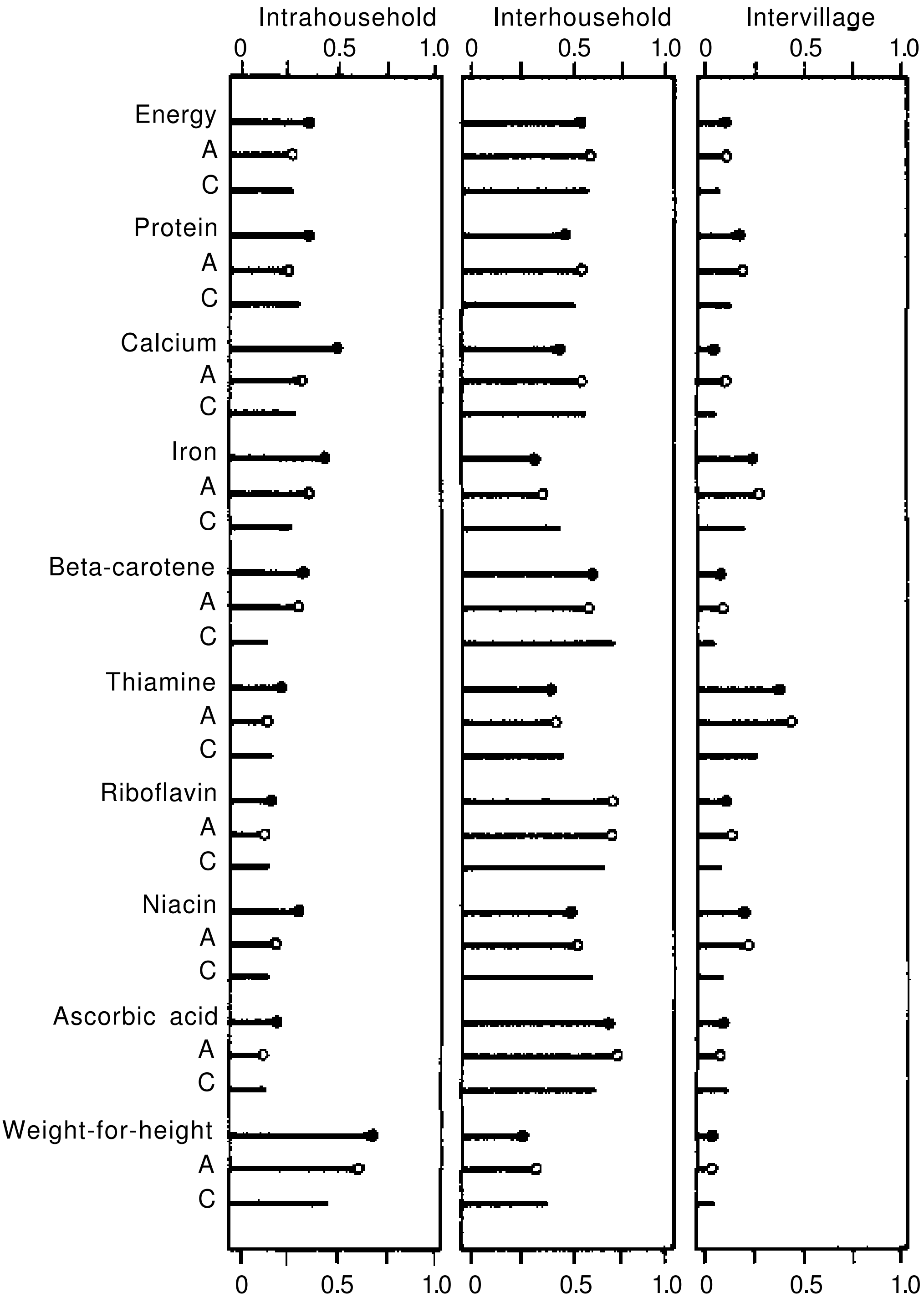


Figure 9.5 Proportion of total variation in standardized nutrient and anthropometric measures contributed by intrahousehold, interhousehold, and intervillage differences for all individuals, adults (A) and children (C)

Because seasonality's share never exceeded 0.01 for any nutrient or energy or for weight-for-height, only the first three components of the decomposition analysis are presented in figure 9.5.

For both adults and children, interhousehold variation was the dominant contributor to the total variation in energy and nutrient intakes. Next in importance was intrahousehold variation, except for thiamine for adults and children and niacin for adults, where intervillage variation loomed large. On average, across the eight nutrients and energy, interhousehold differences contributed about half the total variation, intrahousehold disparities about one-third, and intervillage variation about one-sixth.

Intrahousehold variation was a more important source of the total variation in weight-for-height than of the total variation in nutritional adequacies based on dietary intake. That difference is perhaps to be expected because individual disparities in genetic endowment are more obviously manifested in anthropometric measurement than in data on dietary intake.

The interpretation of the information in figure 9.5 leaves something to be desired in providing a perspective on the relative size of these effects because few if any studies are available for comparative analysis. Nonetheless, intrahousehold distribution of energy and nutrients is clearly important, but as we shall see in the next section systematic village differences and their associated explanations are transparent, interhousehold differences and the reasons why they exist are somewhat discernible, while systematic intrahousehold differences are much harder to detect and even more difficult to explain.

Determinants of Energy and Nutrient Intakes

The determinants of energy and nutrient intake for one-to-twelve-year-old children and adults (older than eighteen) were examined with multiple regression analysis. Within each of those age groups, individual nutrient and energy intake were regressed on personal, household, seasonal, and village characteristics. Data on the dependent and independent variables are described in table 9.2. Energy and nutrients with a mean intake level less than 100 percent of RDAs in figure 9.1 were analyzed. Protein was also included in the analysis. The determinants of the other nutrients (iron, thiamine, and niacin) and of anthropometric status (weight and height standardized for age) are reported in Bidinger (1983) and Ryan et al. (1985). The regression results for the determinants of those nutrients and energy are presented in table 9.3 for children and table 9.4 for adults. We also draw on some recent work (using the same data base) by Behrman (1987, 1988) and Behrman and Deolalikar (1987, forthcoming) to flesh out the discussion of determinants.

Personal Characteristics

For children, the regression results in table 9.3 support our earlier finding from tabular analysis that differences in nutrient intake between boys and girls were not marked. Indeed, other things being equal, girls consumed more energy, protein, riboflavin, and beta-carotene than boys, but those differences were not statistically significant.

Turning to adults, the results in table 9.4 show that, *ceteris paribus,*

Table 9.2. Means and standard deviations of the dependent and independent variables in the regression analysis of the determinants of nutrient intake

	1-12-year-old Children[a]		Adults (over 18 Years)[b]	
Variables	*Mean*	*Standard Deviation*	*Mean*	*Standard Deviation*
Dependent				
Energy ('000/kcal)	1.54	0.64	2.53	0.83
Protein (gm)	43.32	20.40	70.23	27.40
Calcium (mg)	241.12	173.84	370.68	300.69
Beta-carotene (mg)	424.49	617.78	723.18	843.29
Riboflavin (mg)	0.57	0.47	0.98	0.84
Ascorbic acid (mg)	9.03	9.80	13.73	13.82
Explanatory				
Males[c]	0.57	—	0.53	—
Females[c]	0.43	—	0.47	—
Age (years)	7.30	3.06	39.54	13.50
$(Age)^2$	62.56	43.69	1,745.28	1,168.43
Birth order *(N)*[d]	2.71	1.48	—	—
Nonnutritional morbidity symptoms	0.26	0.44	0.32	0.47
Nutritional morbidity symptoms	0.35	0.48	0.21	0.41
Mean per capita consumption expenditure (' 000/Rs)	0.35	0.12	0.39	0.19
Family size *(N)*	8.37	3.27	7.78	3.42
Landless labor and small farm size[c]	0.43	—	0.46	—
Medium farm size[c]	0.24	—	0.24	—
Large farm size[c]	0.33	—	0.30	—
Education of mother/female household head	0.20	0.40	0.15	0.36
Mother's participation rate (ratio)[d]	0.30	0.32	—	—
Caste 1 (high)[c]	0.43	—	0.40	—
Caste 2[c]	0.16	—	0.21	_
Caste 3[c]	0.25	—	0.25	—
Caste 4 (low)[c]	0.16	—	0.14	_
Lean season[c]	0.52	—	0.50	—
Surplus season[c]	0.48	—	0.50	—
Aurepalle[c]	0.17	—	0.13	—
Dokur[c]	0.14	—	0.18	—
Shirapur[c]	0.19	—	0.19	—
Kalman[c]	0.23	—	0.20	—
Kanzara[c]	0.14	—	0.16	_
Kinkheda[c]	0.13	—	0.14	—

[a]Based on 938 observations.

[b]Based on 1,796 observations.

[c]For dummy variables, proportions in each category are reported.

[d]In the adult regressions, birth order and participation rate of mother were excluded because they were not relevant in the analysis of the determinants of nutrient intake.

Table 9.3. Determinants of individual nutrient intakes for 1-12-year-old children[a]

Explanatory Variables	Energy	Protein	Calcium	Beta-carotene	Riboflavin	Ascorbic Acid
	Dependent Variables					
Individual characteristics						
Male	0.01	0.45	-6.67	60.78	0.02	-0.79
	(0.22)	(0.41)	(-0.64)	(1.54)	(0.69)	(-1.30)
Age (years)	0.19**[b]	4.86**	5.29	15.13	0.08**	1.19*
	(7.04)	(5.82)	(0.66)	(0.50)	(3.63)	(2.56)
$(Age)^2$	-o.or*	-0.16**	-0.13	0.15	-0.003	-0.04
	(-3.60)	(-2.68)	(-0.24)	(0.07)	(-193)	(-1.13)
Birth order	-0.01	-0.16	-2.19	-8.78	0.004	-0.12
	(-0.37)	(-0.41)	(-0.59)	(-0.63)	(0.44)	(-0.54)
Nonnutritional morbidity symptoms (present = 1)	0.02	-0.00	10.29	-25.11	0.05	0.36
	(0..57)	(-0.00)	(0.82)	(-0.53)	(1.32)	(0.49)
Nutritional morbidity symptoms (present = 1)	0.07	2.79*	-1.68	86.14*	-0.02	0.21
	(1.71)	(2.32)	(-0.15)	(1.99)	(-0.56)	(0.31)
Household characteristics and endowments						
Mean per capita consumption expenditure ('000/Rs)	0.79**	22.04**	372.69**	799.95**	0.40*	11.03**
	(3.56)	(3.20)	(5.66)	(3.22)	(2.22)	(2.87)
Family size *(N)*	-0.01	-0.01	-6.39**	22.70**	-0.02*	0.02
	(-1.25)	(-1.25)	(-2.94)	(2.77)	(-2.55)	(0.17)
Medium farm size	0.09	3.66*	4.53	-22.29	0.11**	1.24
	(1.69)	(2.31)	(0.30)	(-0.39)	(2.59)	(1.40)
Large farm size	0.08	3.79*	5156**	211.75**	0.14**	3.25**
	(1.60)	(2.32)	(3.31)	(3.61)	(3.39)	(3.58)
Education of mother/female household head (educated = 1)	0.03	1.33	38.46*	48.47	-0.04	0.06
	(0.56)	(0.76)	(2.29)	(0.77)	(-0.84)	(0.06)
Mother's participation rate (ratio)	-0.04	-2.35	-26.07	170.47*	-0.01	4.97**
	(-0.59)	(-0.99)	(-1.15)	(1.99)	(-0.22)	(3.76)
Caste 2	0.07	2.92	-7.92	140.93*	-0.11*	-2.02
	(1.05)	(1.52)	(-0.43)	(2.03)	(-2.20)	(-1.89)
Caste 3	0.09	3.82*	1.18	90.92	-0.04	-1.36
	(1.93)	(2.49)	(0.08)	(1.64)	(-0.93)	(-160)
Caste 4	-0.01	2.06	-16.70	247.38**	-0.13*	0.29
	(-0.16)	(0.93)	(-0.79)	(3.09)	(-2.23)	(0.23)

[a]Based on 938 observations

[b]* and ** indicate significance at the 0.05 and 0.01 levels, respectively.

Table 9.3. *continued*

Explanatory Variables	Dependent Variables					
	Energy	Protein	Calcium	Beta-carotene	Riboflavin	Ascorbic Acid
Seasonality						
Surplus	0.01	0.39	-4.62	-47.11	0.08**	0.74
	(0.17)	(0.34)	(-0.42)	(-1.14)	(2.74)	(1.16)
Village						
Dokur	0.22**	2.98	-35.88	-84.69	-0.50**	-5.30**
	(3.25)	(1.40)	(-1.76)	(-1.10)	(-9.00)	(-4.46)
Shirapur	0.01	7.20**	-28.26	218.38**	-0.39**	-8.39**
	(0.19)	(3.14)	(-1.29)	(2.64)	(-6.49)	(-6.56)
Kalman	0.18**	13.70**	3.05	185.71**	-0.31**	-8.42**
	(2.94)	(7.12)	(0.17)	(2.68)	(-6.30)	(-7.86)
Kanzara	0.24**	13.73**	40.43	48.61	-0.26**	-6.50**
	(3.05)	(5.68)	(1.75)	(0.56)	(-4.14)	(-4.83)
Kinkheda	0.46**	19.93**	32.45	208.58**	-0.20**	-8.36**
	(6.63)	(9.21)	(1.57)	(2.68)	(-3.60)	(-6.93)
Intercept	0.11	-1.38	127.47	-495.62	0.36	2.77
$\bar{R}^2$	0.33	0.36	0.20	0.10	0.19	0.14
SEE	0.52	16.29	155.77	587.26	0.42	9.08
F ratio	23.21	26.36	11.96	5.76	11.60	8.40

men consumed 9 gm more protein daily than women, 290 kcal more energy, 28 mg more calcium, 158 mcg more beta-carotene, and 0.16 mg more riboflavin. The added consumption of protein, energy, and riboflavin by men cannot be termed discriminatory as the gap is less than the differentials in RDAs (Gopalan, Sastry, and Balasubramanian 1971).

Table 9.4. Determinants of individual nutrient intakes for adults[a]

Explanatory Variables	Dependent Variables					
	Energy	Protein	Calcium	Beta-carotene	Riboflavin	Ascorbic Acid
Individual characteristics						
Male	0.29**[b]	8.98**	28.07*	157.71**	0.16**	0.97
	(7.85)	(7.79)	(2.15)	(4.22)	(4.54)	(1.54)
Age (Years)	0.02*	0.39	10.80**	37.19**	0.01	0.16
	(2.35)	(1.65)	(4.02)	(4.84)	(1.34)	(1.27)
$(Age)^2$	-0.00**	-0.01*	-0.12**	-0.42**	-0.00	-0.002
	(-2.72)	(2.15)	(-3.91)	(-4.74)	(-1.32)	(-1.05)
Nonnutritional morbidity symptoms (present = 1)	-0.01	0.19	-3.82	-7.73	0.06	0.68
	(-0.25)	(0.13)	(-0.24)	(-0.17)	(1.41)	(0.88)

Table 9.4. *continued*

	Dependent Variables					
Explanatory Variables	*Energy*	*Protein*	*Calcium*	*Beta-carotene*	*Riboflavin*	*Ascorbic Acid*
Nutritional morbidity symptoms (present = 1)	-0.11* (-2.35)	-3.71* (-2.51)	-9.64 (-0.58)	-54.65 (-1.14)	-0.17** (-3.74)	-0.56 (-0.70)
Household characteristics and endowments						
Mean per capita consumption expenditure ('000/Rs)	-0.14 (-1.14)	-4.93 (-1.32)	145.98** (3.44)	323.07** (2.66)	0.13 (1.12)	7.27** (3.55)
Family size *(N)*	-0.03** (-3.97)	-0.69** (-3.37)	-2.24 (-0.96)	11.97 (1.81)	-0.01 (-1.84)	-0.33** (-2.96)
Medium farm size	0.14** (2.93)	5.40** (3.56)	-35.51* (-2.06)	-64.15 (-1.30)	0.08 (173)	-0.80 (-0.96)
Large farm size	0.23** (4.50)	7.24** (4.49)	29.49 (1.62)	55.16 (1.06)	0.29** (5.78)	2.84** (3.22)
Education dummy of female household head (educated = 1)	-0.05 (-0.90)	-1.28 (-0.74)	-14.35 (-0.73)	149.43** (2.65)	-0.15** (-2.73)	1.18 (1.24)
Caste 2	0.05 (0.94)	-0.10 (-0.06)	-11.01 (-0.56)	38.43 (0.68)	-0.18** (-3.31)	-1.63 (-1.72)
Caste 3	0.001 (0.02)	-0.19 (-0.12)	39.06* (2.14)	96.34 (1.84)	-0.06 (-120)	-1.42 (-1.62)
Caste 4	-0.12 (-1.77)	-2.57 (-1.21)	-72.39** (-3.00)	161.07* (2.33)	-0.26** (-3.99)	-0.20 (-0.18)
Seasonality						
Surplus	-0.06 (-1.54)	-0.16 (-0.13)	-72.83** (-5.13)	159.02** (3.92)	0.10* (2.45)	1.17 (1.70)
Village						
Dokur	0.26** (3.74)	3.94 (1.78)	-326.61** (-13.05)	-92.50 (-1.29)	-1.06** (-15.41)	-4.57** (-3.79)
Shirapur	-0.10 (-1.28)	11.83** (4.96)	-365.28** (-13.52)	528.35** (6.83)	-1.01** (-13.65)	-8.78** (-6.73)
Kalman	0.10 (1.29)	20.26** (8.57)	-361.35** (-13.49)	599.26** (7.82)	-0.91** (-12.34)	-10.17** (-7.87)
Kanzara	0.45** (5.56)	28.68** (11.29)	-230.67** (-8.01)	308.38** (3.74)	-0.65** (-8.30)	-7.10** (-5.11)
Kinkheda	0.62** (7.82)	30.93** (12.38)	-223.54** (-7.90)	463.22** (5.72)	-0.60** (-7.69)	-7.03** (-5.15)
Intercept	2.11	49.75	412.98	-776.90	1.47	15.04
$\bar{R}^2$	0.14	0.22	0.17	0.13	0.20	0.08
SEE	0.77	24.19	274.12	784.66	0.75	13.22
F ratio	16.66	27.66	20.20	15.65	24.34	9.77

[a] Based on 1,796 observations.
[b]* and ** indicate significance at the 0.05 and 0.01 levels, respectively.

Because the RDAs for calcium and beta-carotene are the same for men and women, men did disproportionately consume calcium and betacarotene. Men's estimated advantages of 28 mg calcium and 158 mcg beta-carotene were equivalent to 8 and 22 percent of adults' mean calcium and beta-carotene intakes, respectively. Thus, with the exception of beta-carotene for adults, the case for a gender bias favoring males in nutrient intake relative to requirements is not compelling.

In general, the most important personal characteristic in explaining the variation in energy and nutrient intake across individuals was age. For children, age should be curvilinearly related to intake because RDAs increase with age, although usually at a decreasing rate. That expectation was fulfilled for energy, riboflavin, ascorbic acid, and protein but not for calcium and beta-carotene, the two nutrients for which differences in personal traits accounted for little if any of the variation in nutrient intake (table 9.3). For adults, a curvilinear relationship is evident for energy and the five nutrients in table 9.4 and is statistically significant for energy, calcium, and beta-carotene.

How are calcium and beta-carotene different from energy and the other nutrients in that their consumption is not strongly associated with age for children? Unlike energy and the other nutrients, calcium and beta-carotene are not supplied through the staple diet. Mangos and other seasonal fruits and vegetables are the source of a substantial share of the beta-carotene intake. All children like to eat mangos when they come into season. Mangos are usually divided equally among children within the household (P. Bidinger, personal communication 1987). The same preferences apply to milk in tea, which is equally relished and equitably allocated in cups within the household.

The corollary question of why a marked curvilinear relationship between age and calcium and beta-carotene intake manifests itself during adult life is not so easily answered. One plausible explanation is that the intake of these two nutrients is derived from sources consumed outside the household. For example, for adults milk is consumed from tea taken in tea stalls. Such consumption does not have to be shared with other members of the household.

Birth order is another readily observed dimension of a child's endowment. Do parents allocate food in ways that favor the earlier born in energy and nutrient intake? Judging from the lack of significance on the coefficients on birth order in table 9.3, the answer to that question is no. We return to the issues of gender and birth order biases later in this chapter when the intrahousehold allocation of nutrients is examined.

Household Characteristics and Endowments

Income Malnutrition is often viewed by economists as an income problem. For example, the World Bank's *World Development Report* (1981) singles out policies that raise the income of the poor as the most efficient in the longer term to improve nutritional well-being. Optimism about the strong nexus between income and nutrition arises from sizable responses in energy and protein intake to changes in income or expenditure estimated in several empirical studies. For example, the expenditure elasticity for calorie consumption per capita in rural India, using National Sample Survey data, is around 1.0 for people in the lowest income households (less than Rs 36 per capita per month in 1976/77 prices) and falls to 0.44 for those in the highest income bracket (more than Rs 150 per capita per month) (Radhakrishna and Shah 1981).

Several recent studies and synthetic reviews (Wolfe and Behrman 1983; Behrman and Wolfe 1984) have questioned the prevailing view that augmented income will automatically result in improved nutrition. Mixed results are also common, with one income concept explaining variation in nutrient intake while another measure fails to explain such variation. Kumar's (1978) study of child nutrition in rural Kerala found that total household income had little effect on nutritional status, but per capita income was a more important determinant, both statistically and behaviorally. In two studies in the United States reviewed by Davis (1982) where child nutrition was examined, neither income nor expenditure influenced nutritional status, although in one case assets did.

Income effects can also vary by age group and nutrient. In the Morinda study in the Punjab, the income effects on the food consumption of children were less pronounced than for the whole population (Prahlad Rao 1980). Except for energy, Adrian and Daniel (1976) discerned a significant relationship between household disposable income and consumption of major nutrients in the United States. Nonetheless, all elasticities were very small, ranging from 0.05 for calcium to 0.3 for vitamin C. In a study of schoolchildren in Washington state in the United States, Price et al. (1978) found that more wealth increased the consumption of calcium, riboflavin, and vitamin C but not of protein, energy, and other nutrients. Monetary income had no influence on the nutritional intakes of the 728 children studied. Different income sources also may have a differential impact on nutrition. It has been suggested (without yet much empirical support) that total household income may not be as significant a factor as mother's income in determining the status of children's nutrition (Safilios-Rothschild 1980).

Earlier regression analyses of the nutrient intake data in the six study villages showed that the link between income and nutrition was tenuous. Net household income did not have a significant effect on children's consumption of eight of the nine nutrients analyzed by Ryan et al. (1985). Calcium was the exception. Wealth also did not significantly affect the energy intakes of one-to-six-year-olds in the same villages (Bidinger 1983).

Alternative empirical explanations were advanced for those counterintuitive results. First, Ryan et al. (1985) and Bidinger (1983) focused on individual children, whereas most studies reporting a positive relationship between income and protein-calorie consumption were based on the household as the unit of observation. Income effects on food consumption may also be less for children than for adults (Prahlad Rao 1980). Second, most other studies had failed to adjust for the effects of other agroclimatic, demographic, and socioeconomic variables on nutrient consumption before attempting to explain residual variation as a function of income. Third, the measure of income used by Ryan et al. (1985) was net household income, defined as annual gross household income less the cost of crop production, maintenance of livestock and machinery, raw materials, opportunity cost of family labor and owned bullocks, and interest paid on borrowed capital derived from data collected by resident investigators at three-to-four week intervals. In contrast, the standard practice is to use gross household income, often estimated from data gathered in a single interview survey.

To further explore the link between income and nutrition, we examine two hypotheses that could account for our thus far counterintuitive results: (1) "permanent" or mean consumption expenditure over several years looms larger than annual household income as a determinant of nutritional status in India's SAT, where household income fluctuates considerably (chapter 4) and (2) energy and nutrient intake in response to changes in household expenditure are much smaller than food consumption because prices paid per unit of nutrient and income are positively associated (i.e., people even in these low income households display a strong preference for better quality and higher status food as income rises) (Shah 1983).

To test the first hypothesis, the equations in table 9.3 and 9.4 were fitted using mean per capita annual household consumption expenditure across two cropping years, 1975/76 and 1976/77, to determine if, unlike income, consumption expenditure (smoothed for interyear variability) influenced energy and nutrient intake. For children, per capita consumption expenditure and intakes of energy, protein, and the four deficit micronutrients were positively and significantly related (table 9.3). For adults, calcium, beta-carotene, and ascorbic acid intakes were significantly and positively associated with per capita household consumption expenditure (table 9.4).

In contrast to Prahlad Rao's 1980 study, the size of these expenditure effects on nutrient intakes was considerably larger for children than for adults (table 9.5). Hence, rising consumer expenditure appears to translate much more directly into enhanced nutritional intake for children than for adults. Still, even for children the nutrient demand elasticities

Table 9.5. Elasticities of individual nutrient consumption with respect to per capita consumption expenditure and family size

	Elasticities[a]	
Age Group and Nutrient	*Per Capita Consumption Expenditure*	*Family Size*
1-12-year-old children		
Protein	0.16**[b]	-0.07
Energy	0.18**	-0.06
Calcium	0.56**	-0.22**
Beta-carotene	0.51*	0.37*
Riboflavin	0.25*	-0.29*
Ascorbic acid	0.44**	0.02
Adults		
Protein	-0.03	-0.08**
Energy	-0.02	-0.08**
Calcium	0.15**	-0.06
Beta-carotene	0.18**	0.12
Riboflavin	0.05	-0.08
Ascorbic acid	0.21**	-0.19**

[a]Calculated at the arithmetic mean of the consumption expenditure, family size, and nutrient intake variables listed in table 9.2.

[b]* and ** denote statistically significant t values at the 0.05 and 0.01 levels, respectively.

in table 9.5 are less than those commonly cited in the literature, supporting a strong linkage between income and nutrition (Poleman 1981).

To test the second (i.e., the food quality) hypothesis, the responsiveness of household food and nutrient intakes to changes in household consumption expenditure was evaluated for six food groups—cereals, meat, milk, pulses, sugar, and vegetables—and for energy and eight nutrients—protein, ascorbic acid, calcium, beta-carotene, iron, niacin, riboflavin, and thiamine (Behrman and Deolalikar 1987). A double logarithmic functional form was chosen to generate readily interpretable constant elasticity relationships between household expenditure and food and nutrient intakes. Binary variables for villages and cropping years were included to control for village endowments and year effects. Additionally, the time series nature of the panel data was exploited by first differencing between crop years, which eliminated fixed household effects.

All the estimated food expenditure elasticities in figure 9.6 were statistically significant and did not differ significantly from unity. A proportional change in household expenditure was accompanied by a similar proportional increase in the quantity of food consumed. In contrast, none of the estimated nutrient elasticities in figure 9.6 were positive and statistically significantly different from zero.

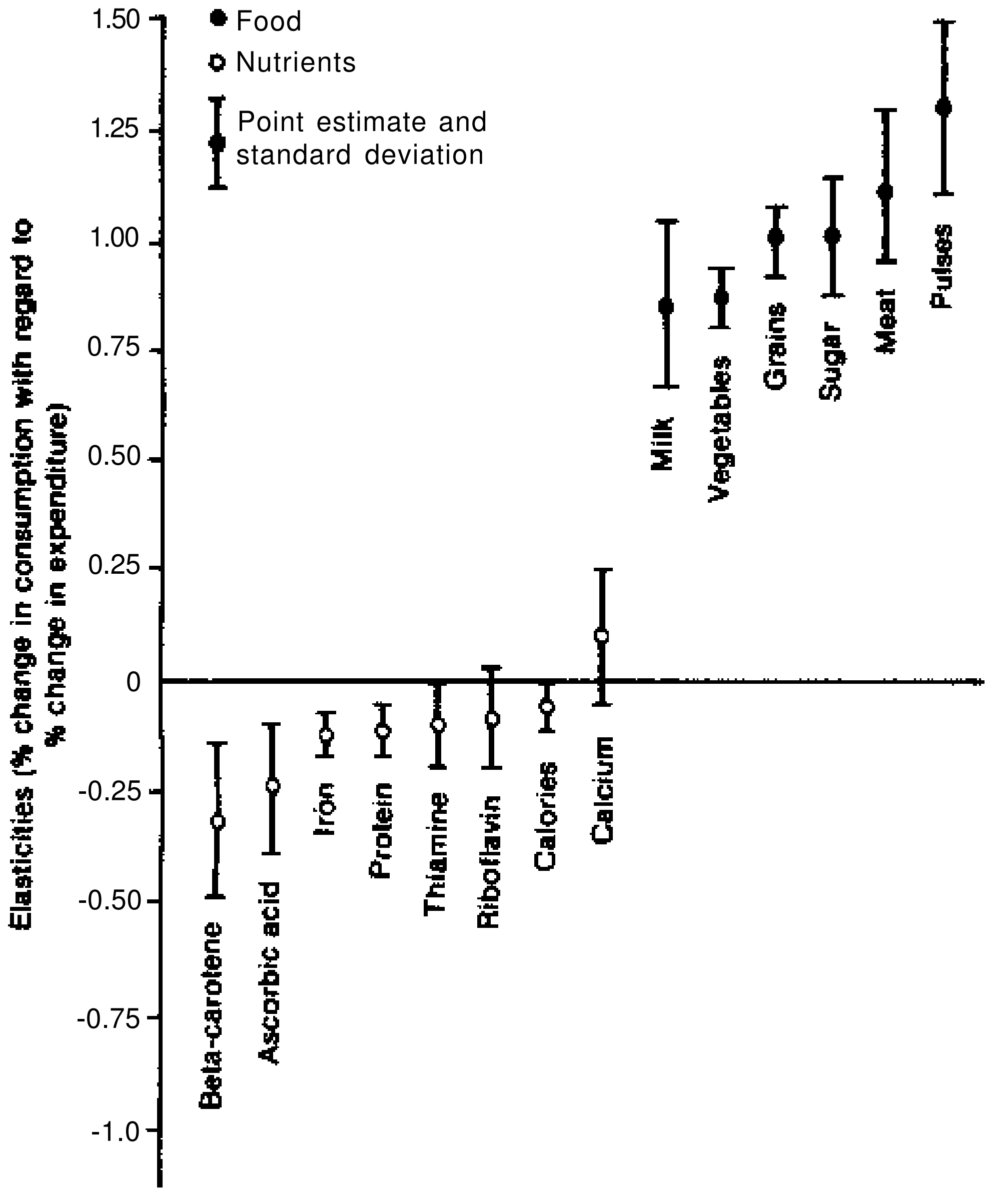


Figure 9.6 Estimated food and nutrient household expenditure elasticities in three ICRISAT study villages, 1976/77 and 1977/78

The estimates in figure 9.6 corroborate our earlier finding that in these poor villages in India's SAT increases in annual income do not result in substantial improvements in nutrition. Food expenditures rise substantially, more or less proportionally to income, but the marginal increments in food purchases are not devoted primarily to obtaining more nutrients. Instead, people choose to pay proportionally more for nutrients as their income rises, apparently to purchase other desirable food attributes. Even in these very poor villages the following generalization encapsulates the reality of consumption expenditures and food preferences: people buy and eat food because it tastes good or has status, not because it supplies nutrients.

The lack of relationship between income and nutritional status further undermines the relevance of the "efficiency theory of wages" for these villages. According to the theory, by increasing wages above "equilibrium" levels employers are able to obtain output increases more cost effectively than by employing more workers at a lower (equilibrium) wage. Added wages and incomes are translated into enhanced nutritional status, which in turn results in improved worker efficiency and effort. Without the first linkage, the theory cannot hold.

Household Size Studies reported by Prahland Rao (1980) and the World Health Organization (WHO 1976) show that severe malnutrition is more prevalent in larger families. Fears that larger household size would be accompanied by deleterious consequences for children's nutrient intake only appear to be justified for calcium and riboflavin (table 9.3). The negative effects of household size were more marked for adults, particularly for energy, protein, and ascorbic acid, but the size of these effects was small (table 9.5).

Farm Size Several writers, including Schofield (1979), Fleuret and Fleuret (1980), and Kumar (1978), have cited the beneficial consequences of landholdings on the nutritional status of owners/operators and/or their children. Our results in table 9.3 and 9.4 are consistent with this view: in general, for both children and adults, members of households with larger landholdings had higher energy and nutrient intakes than individuals from landless and small farm households. At the mean levels of the other variables, changing from a landless labor or small farm household to a household with a large landholding was accompanied by a 59 percent increase in children's beta-carotene consumption. Ascorbic acid intake went up by 44 percent, riboflavin by 30 percent, calcium by 23 percent, and protein by 9 percent. Similar upward shifts in adults' consumption were 27 percent for riboflavin, 18 percent for ascorbic acid, 12 percent for protein, and 8 percent for energy. In contrast to these results on energy and nutrient intake, farm size was not an important variable in explaining the variation in anthropometric indices such as the height of children (Ryan et al. 1985).

Much of the farm-size disparities in the intake of calcium, riboflavin, and even beta-carotene are derived from interhousehold differences in milk consumption. For the large farm group, milk and milk products contributed 50 percent to total calcium intake, 35 percent of riboflavin intake, and 20 percent to beta-carotene intake. Comparable shares for the landless labor and small farm groups were 30 percent for calcium, 15 percent for riboflavin, and 7 percent for beta-carotene as cereals figured more prominently as sources of those micronutrients. Twelve of the sixty large farm households across the six villages owned a buffalo and twenty-one owned cows in 1977; only one of the sixty landless labor households had a buffalo in 1977, and only two owned a cow. Apparently, and after accounting for the effects of variation in income, ownership of a milch animal, particularly a buffalo, did confer some additional nutritional advantage in micronutrient status.

To a lesser extent, the species composition of vegetables in the diet also varied between landless households and large farm households. Although vegetables' share in the micronutrient intake of landless labor and large farm households was roughly the same, landless labor families consumed more uncultivated greens while large farm families ate more cultivated vegetables, especially on small plots irrigated from dug wells.

Differences in the consumption of energy, protein, and ascorbic acid between landless labor and small farm households on the one hand and large farm households on the other are harder to explain because dietary composition of those nutrients did not vary markedly between the two groups. Differences in intake were primarily related to considerations of quantity and not of kind.

Mother's Education and Employment Among economists, the effects of mother's education on the nutritional well-being of her children have received considerable analytical scrutiny (Behrman and Wolfe 1984; Blau 1981; Davis 1982). Table 9.3 shows that educated mothers, who represent only 20 percent of the sample, had a beneficial impact on children's consumption of foods such as milk that are high in calcium.

The consequences of labor market participation of the mother on the nutrition and health of her children have also received substantial attention from researchers. In her review of studies of the effects of maternal employment on children in developing countries, Carloni concluded: "there is precious little data to support the hypotheses of nutritionists regarding the harmful effects that maternal employment is supposed to have on children's nutrition" (1984: 11). Our results are in line with Carloni's assessment. Controlling for per capita consumption expenditure in table 9.3, children of mothers who participated in the daily-hired labor market in and around the villages were characterized by significantly higher beta-carotene and ascorbic acid intake than other children. For energy and the other nutrients, labor market participation was negatively associated with children's nutrient intake, but those estimated coefficients are not statistically significant.

Women in these villages receive a larger share of their wages in kind than men (21 versus 12 percent). Hence, women's labor earnings may have a better chance of being transformed into effective food consumption for children. (If simultaneous equation bias exists for women's participation and per capita consumption, it may be that "more capable" women participate in the labor market and provide better nutrition and other health inputs for the family.)

The highly significant positive but small consumption expenditure elasticities in table 9.5 suggest that the income effects from mothers'participation may outweigh any negative substitution consequences. Similar results were obtained by Kumar (1978) in Kerala, where she showed that the wage elasticity for working mothers with respect to weight-for-age of their children was 0.7, net of the adverse substitution effect. In contrast, Reutlinger and Selowsky (1976) found that a decline in working mothers breast feeding in Calcutta could have adverse effects on child nutrition as the marginal propensity to consume milk out of earnings was less than that required to purchase sufficient milk to compensate.

Turning to anthropometric measures, children's height but not weight was significantly and inversely related to the mother's participation rate in the hired labor market (Ryan et al. 1985). This result suggests that, while children's transitory nutritional status may not be unduly affected by their mother working, their past nutritional status may well have been. A nutritional explanation for these differential effects on transitory and longer term health status center on the neglect and subsequent stunting of preschoolers immediately after weaning between twelve and eighteen months. Conversely, the direction of causality may be reversed: mothers may have gone out to work because their young children were at nutritional risk. Whatever the case, a much larger sample and more focused research are needed to address the impact of mother's labor market participation on health status.

Caste Compared to other household characteristics such as farm size, caste did not play a large role in explaining the interpersonal variation in energy and nutrient consumption. The lowest castes represented by Caste 4 fared worse than the highest with regard to riboflavin intake for both children and adults and calcium consumption for adults. But, *ceteris paribus,* both adults and children of the lowest caste communities had the highest intake of beta-carotene. The latter result is not surprising. The eating of greens and leafy vegetables rich in beta-carotene is consistent with low caste status, which partially explains why vitamin A is highest in the lowest castes.

If consumption expenditure is a function of caste, then our estimates understate the part played by caste in conditioning energy and nutrient intakes. Nevertheless, caste seems to be a decidedly less important factor than several other variables listed in tables 9.3 and 9.4.

Cash Cropping The evidence about the differential impact of income earned in cash from that earned in kind on nutritional well-being is mixed (Kennedy and Pinstrup-Andersen 1983). Some argue that substitutions of cash crops for food crops leads to reduced local availability of food, a rise in food prices, and consequently a decrease in food consumption and nutritional status (Berg 1981). Others counter that farmers commercialize only if it enhances their income, which in turn increases household food consumption. Empirical evidence supporting either position is sparse.

To investigate this issue the regression equations in tables 9.3 and 9.4 were reestimated with a variable measuring the proportion that cash crop sales represented of gross crop income for the cultivator households in the sample. (The household average cash crop share was 44 percent, ranging form 4 to 97 percent.) The estimated coefficient on the extent of cash cropping was not statistically significant for energy or for the other nutrients of interest in either the children's or adults' regressions. From our cross-sectional evidence in these villages, greater commercialization does not imply an inferior nutritional status.

Seasonality As with the incidence of cash cropping, evidence for strong effects of seasonality on children's nutrient intake was not empirically persuasive (table 9.3). Consumption of riboflavin increased marginally in the surplus season. Likewise, the weights of children were unaffected by season (Ryan et al. 1985).

For adults, seasonal effects were somewhat stronger. Intake of calcium fell and beta-carotene rose significantly in the surplus season. A drop in toddy palm wine consumption, mainly in Aurepalle, coupled with increasing fodder scarcity and declining milk production accounted for the decline in calcium intake in the surplus season. Higher consumption of coarse grains, mangos, and betel leaves, rich sources of beta-carotene, were responsible for increased intake of vitamin A in the surplus season.

Village The regressors that consistently accounted for most of the explained variation in nutrient intake were the village dummy variables. The village effects primarily reflect differences in local price regimes and in agroclimatic and resource characteristics. Aurepalle is used as the point of reference in the regression analysis. Adults and children in Aurepalle had significantly lower intakes of energy, protein, and beta-carotene than those in most of the other villages. Much of those difference are attributed to lower cereal intake in Aurepale than in the other villages. For example, taking the simple average of total cereal intake across the seven age-sex groups and two seasons gave a grand mean consumption of 433 g/caput per day. A similar estimate for Dokur was about 496 g/caput per day.

But Aurepalle's residents did not unambiguously trail the other study villagers in all nutrient dimensions. They, particularly adults, had higher intakes of calcium, riboflavin, and ascorbic acid than the other study villagers. Greater buffalo milk and buttermilk consumption in Aurepalle than in the other villages was the major reason for Aurepalle's advantage in calcium and riboflavin status. Only in Aurepalle did milk's contribution to the supply of calcium and riboflavin in the diet exceed cereals' share as a source of those two nutrients. The adults' superiority in calcium intake in Aurepalle also stemmed from considerably greater consumption of sweet toddy. Differences in ascorbic acid intake in Aurepalle vis-à-vis the other villages derived mainly from greater chilli production and consumption. Unlike Dokur, Aurepalle has a large patch of black soil conductive to the rainfed cultivation of chillies in August, and the practice of growing well-irrigated chillies is more entrenched than in Dokur.

Intrahousehold Intake of Nutrients and Energy

The previous regression analysis quantifying the role of personal traits, household characteristics, village, and season in explaining the variation in energy and nutrient intake has not explicitly addressed the intrahousehold component (measured in figure 9.5) of the total variation in nutritional status. Interest in the distribution of food within the household is motivated by several concerns (Haaga and Mason 1987). Nutritionists have observed malnourished members in otherwise well-nourished families and well-nourished individuals in families steeped in poverty. Attaching systematic explanations to these observations is attractive because such understanding could "short-circuit the delay in waiting for economic development to prevent malnutrition" (Haaga and Mason 1987:148). But the prospects for coming up with systematic findings without a high degree of location and/or cultural specificity are not bright. In a recent exhaustive review of the linkages between culture and intrahousehold distribution of food in South Asia, Harriss concludes:

> Evidence of discrimination in feeding practices and nutrients' allocation within the family in South Asia certainly exists. It is rarely of a dramatic nature. The young child and the elderly are groups most generally discriminated against. . . the age and gender impact of discrimination, its social and seasonal incidence and severity all vary regionally through the subcontinent at levels which are below those at which the policy processes of agenda formation, authorisation and resource mobilisation and allocation normally operate. It is most unlikely that this situation would be changed by further research (1987: 67).

One simple way to assess the potential for improved intrahousehold distribution of food to result in improved nutritional status is to compare the incidence of shortfalls in RDAs under the actual situation with the estimated individual RDAs to a scenario of perfect parity in RDAs for all members within the household (i.e., each member receives the household mean RDA). This comparison does not establish an upper bound estimate of the equality in the distribution of food according to requirements because, as Haaga and Mason (1987) point out, food could be redistributed in such a way (for instance, from adults with higher requirements to children with lower) so that the mean household RDA would also increase. Nonetheless, the comparison does provide a rough idea of how much can be gained in improved nutrient intake status from a more equitable distribution of food within the household.

A common sense observation on the scope for ameliorating energy and intake deficiencies via an improved intrahousehold distribution of food emerges from table 9.6. A better within household distribution of food does not lead to substantially higher proportions of people attaining 50 to 80 percent of their RDAs of the micro-nutrients chronically in short supply in the diet. Indeed, the negative signs for beta-carotene and ascorbic acid are reminiscent of the observation in chapter 4 that more inequality implies less poverty when the size of the pie is so small. The potential is much greater for a more equitable sharing of food within the family to eliminate deficiencies of nutrients, such as protein, iron, and thiamine, that are above or close to the 100 percent RDA line in figure 9.1. If we define deficiency as meeting less than 50 percent of RDA in table 9.6, then almost all the energy, protein, iron, and niacin deficiencies in the sample would disappear if each individual had its household mean RDA.

Which age-sex groups are most disadvantaged relative to other household members in the intake of energy, protein, thiamine, and iron? Among the six age groups, one to three years, four to six, seven to twelve, thirteen to seventeen, eighteen to sixty, and over sixty, for each gender, one-to-three-year-old children (both boys and girls) stand out as the most relatively disadvantaged; their intakes of iron and energy are not only significantly less than other family members' but fall considerably short of their RDAs. None of the 121 one-to-three-year-old children in the sample exceeded their household's mean estimated RDA for iron, and on average their shortfall from the household mean %RDA was about sixty points. For energy, the size of their relative deficit was less, about twenty points. Some of the inferiority in energy and iron status may stem from measurement error, as many of these young children are not yet weaned and the consumption of mother's milk was not measured but imputed. Still, the one-to-three-year-old group's relative shortfalls of iron and energy intake were large. No other age-sex group by energy, protein, iron, or niacin observation on average fell below 100 percent RDA and was at the same time characterized by a significant shortfall in nutritional status relative to the rest of the household.

The most efficient way statistically to evaluate the extent to which age-sex groups are systematically shortchanged in the distribution of food is to compare the nutritional status of members of specific age or gender groups that are thought to be discriminated against to other members of groups believed to be favored within the same household. As discussed earlier in this chapter, boys are usually viewed as favored relative to girls and older children favored relative to younger children.

Based on the nutritional survey data in the study villages, Behrman

Table 9.6. Effects of equalizing RDAs within the household on shortfalls in %RDA by nutrient

	% below 50% RDA			% below 80% RDA		
Nutrient	*Without Equalization*[b]	*With Equalization*[c]	*% Gain from Equalization*	*Without Equalization*	*With Equalization*	*% Gain from Equalization*
Energy	4.7	0.5	3.2	29.6	26.0	3.6
Protein	2.2	0.0	2.2	9.0	4.4	4.6
Calcium	42.9	32.6	10.3	76.3	81.1	-4.8
Iron	6.0	0.0	6.0	19.8	8.3	11.5
Thiamine	8.8	5.7	3.1	20.5	17.3	3.2
Riboflavin	40.0	34.5	5.5	77.4	77.2	0.2
Niacin	4.9	0.3	4.6	25.0	19.1	5.9
Ascorbic acid	91.1	92.1	-1.0	98.4	99.2	-0.8
Beta-carotene	94.3	96.9	-2.6	98.3	99.0	-0.7

[a]Based on 1,563 observations for each nutrient. For each of the 1,563 houshold individuals, %RDAs were averaged across the rounds; household mean %RDAs were calculated from those average values for individuals.
[b] Reflects the actual distribution of %RDAs within the household.
[c]Assumes that each member receives his or her household's mean %RDA.

(1988) evaluated 269 boy-girl comparisons for households having children of different sex in the same age groups—one to three, four to six, and seven to twelve. He documented a small but statistically significant pro-boy bias of about 5 percent in RDA in the lean food availability season. That difference disappeared in the surplus season.

Similar research, based on 387 pairs of children in the lean season and 378 pairs in the surplus season, found a small but statistically significant birth-order differential favoring older children (Behrman 1987). During the lean season, parents weighted a given health-related outcome from an earlier-born child about 5 percent more heavily than the identical outcome for a later-born child; during the surplus season birth-order preferences fell to 3 percent. Values between 3 and 5 percent do not indicate that birth order preference favoring the earlier-born or gender bias against girls in the intrahousehold allocation of food was pronounced in the study villages.

Combining our earlier evidence on the size of the relative shortfall in energy and iron intake of one-to-three-year-old children with Behrman's findings on paired comparisons on gender bias and birth order preference leads to the following conclusion: The main bias in the allocation of food resources within the household is against young children in general and not against girls relative to boys or the earlier born relative to the later bom.

Bidinger, Nag, and Babu (1986b) in their fifty-two-week, forty-family study in Dokur in 1982/83 also observed that young children, particularly those less than two, were the age group least favored in the distribution of food within the household. Two types of families appeared most likely to shortchange young children in the distribution of food: (1) large farm families with women who were responsible for recruiting and supervising labor and did not appear to have adequate time for their children and (2) poorer landless and small farm families who cooked only two meals a day, once in the morning and again in the evening. In the latter families, older children had greater access to places were food was kept during the day and were more capable of articulating their needs to elders than younger children. Female labor market participation was also found to be conducive to a significantly increased energy intake of young children. Women who worked appeared to have a larger role in household decision making in general and in the allocation of food in particular.

Changes since the Late 1970s

We have not updated the nutrition and health surveys canvassed from 1976 to 1978. Visual evidence suggests that the village health environment has not further deteriorated and in some cases may have been improved. For example, the public-sector installation of a borehole in Dokur in the early 1980s gave the village a protected water supply; an annual cholera outbreak is no longer a regular feature of village life (Bidinger, Nag, and Babu 1986a).

We do, however, have reliable information on changes in nutritional status in Dokur, where weekly dietary intakes of a forty-household sample referred to earlier in this chapter were carried out in 1982/83 (Bidinger, Nag, and Babu 1986a). Data on nutritional status for the ICRISAT households and for the 1982/83 sample were updated in 1985/86 and 1986/87 in the context of a drought consequences study. The initial results of comparing the data across the three points in time (1976 to 1978, 1982/83, and the initial months of 1985/86 before the effects of drought could become pronounced) are generally consistent with statistically significant and sustained improvement in energy and nutrient intake as measured by RDAs. The trend toward higher RDAs for most nutrients was not matched by equivalent gains in weight-for-height or weight-for-age, which increased only marginally.

The decade from the mid-1970s to the mid-1980s was generally a time of increasing prosperity in Dokur. With rising investment in well irrigation, agricultural production was trending upward within the village. Food grain prices were also remarkably stable (chapter 4). Additionally, villagers benefited from an expanded direct food distribution scheme on rice at Rs 2 per kg. That scheme was initiated in the village in 1983/84; the limit for eligible households was 25 kg per month. Increased investment in well irrigation in the village, sustained growth in cereal production at the national level, and the rice at Rs 2 direct food subsidy are most likely responsible for the improvement in energy and nutrient intake.

Implications for Nutrition and Health Policy

Several implications for nutrition and health policy can be derived from the results presented in this chapter. First, nutrition programs should, in the first instance, focus on the entire village as the basic unit of intervention. Much of the explained variation in absolute and relative nutritional status measured by both dietary intake and by anthropometric measures was attributed to interregional and, in the case of the Mahbubnagar villages, to intervillage differences. For example, Aurepalle has the typology of a village whose inhabitants Schofield (1979) would classify as being most nutritionally at risk. It is poorly developed and subsistence oriented, with a high degree of seasonality and substantial relative and absolute poverty. With the possible exception of the larger landowning families, virtually all its inhabitants would seem to qualify as being among Lipton's ultra-poor. If we acknowledge that vitamin and mineral deficiencies are more seriously debilitating than protein and energy deficiencies, then the overwhelming majority of Aurepalle villagers are ultrapoor and deserve to be the target of any nutrition program.

Second, in designing nutrition interventions, the regression results weakly support the desirability of differentiating between the landless and households with small landholdings, on the one hand, and the largest farm households, on the other. The influence of larger holdings on vitamin and mineral consumption by children suggests that some home-produced protective foods are either not demanded by landless and small farm families and/or are not available to them in village markets. Much of these differences revolved around the variation in the consumption of milk and milk products. Members of large farm households, who were more likely to own milch animals, particularly buffalos, drank more milk and ate more milk-related products than other households in the village. Thus, programs such as the IRDP (described in chapter 4) that encourage the acquisition of buffalos by landless labor and small farm households may result in some nutritional gains to their beneficiaries over and above income effects.

As pointed out in chapter 4, the gap between desirability and feasibility in such subsidized and targeted asset-generating programs is often large and difficult to bridge because of constraints such as short fodder supplies. Likewise, programs that bring the home or kitchen gardens to landless and small farm households, with the object of encouraging them to grow foods high in vitamin and mineral content, could be desirable. Major constraints to implementing that standard textbook prescription is the shortage of space within and around village housing sites and the scarcity of water for irrigation.

The case for targeting on specific members within the household is strong only for young children, who are least favored in the intake of energy and some other nutrients, especially iron, relative to their requirements and to those of other household members. Although intrahousehold differences contribute from 25 to 50 percent of the total variation in energy and nutrient intake and 50 to 75 percent of the variation in anthropometric status among individuals, systematic attribution to age/sex groups (apart from young children) within the household of that variation was not forthcoming. We found little evidence for strong gender and birth order effects. We did not specifically measure the nutritional status of pregnant and lactating women, who are generally regarded as being among the most vulnerable groups, nor did we pay much attention the aged over sixty because of a small sample size. Thus our lack of advocacy for targeting within the household centers mainly on girls relative to boys, younger children relative to older, and women relative to men.

The leakages which occur to other family members also make individually targeted nutrition programs less cost effective (Berg 1981). Given the evidence cited in chapter 5 of the payoff to improved nutrition of men in the form of higher daily wages, such leakages may make good economic sense for the concerned families and may not be necessarily discriminatory. Indeed, evidence on the wage-enhancing effects of improved nutritional status itself provides a rationale for the explicit inclusion of men in such intervention programs.

Third, the Shah (1983) effect appears to operate whereby villagers with increased income prefer better quality, tastier food, which is often higher priced per unit of nutrient. Perhaps with more education about the relation between nutrients and other food characteristics or with the development of plant varieties in which the nutritional benefits are more closely associated with food attributes that consumers value highly at the margin, stronger positive associations between nutrient intakes and income could be developed. But our findings suggest that optimism about better nutrition with rising income is unwarranted.

Two caveats should be added to this discussion on the link between income and nutrition. First, calcium stands out as a nutrient whose intake is quite responsive to changes in income and/or expenditure. Income elasticities of demand for milk and milk products for poor rural households are high, often exceeding 2.0; for the richer rural households demand for milk is still strong, as income elasticities do not differ significantly from unity (Radhakrishna, Murthy, and Shah 1979). Thus we have every reason to be sanguine that the calcium deficiencies present in the sample will to a large extent be reduced with increased income.

The second caveat pertains to the existence of a relationship, documented in table 9.3, 9.4, and 9.5, between permanent income, consumption expenditure, and nutrient intake. Given the income variability noted in chapter 4, it is not surprising that mean per capita consumption expenditure is more successful in predicting nutrient intake than average net household per capita income. Two implications flow from this relationship, which applies especially to children. First, sustained growth in permanent income is needed in these regions to result in enhanced energy and nutrient intake. Second, nutritional benefits would seem to accrue from programs such as the Maharashtra Employment Guarantee Scheme that can influence consumption expenditure through their effect on permanent income.

Jodha's (1975, 1978a, 1978b) research shows that maintenance of productive assets figures foremost in households' strategies to mitigate the adverse consequences of drought. Their first response is to reduce food consumption, especially of "nutritious" foods rich in vitamins and minerals such as milk, vegetables, fruits, and meat. Drought relief measures set in motion only when there is evidence of migration and increased sales of livestock may arrive too late to prevent deterioration in the nutritional well-being of the affected population. Wages from relief works if available loom large in income in drought years. A program such as the Maharashtra Employment Guarantee Scheme should therefore be contributing significantly to maintaining longer-term household consumption expenditure levels. Summing up, measures to increase and stabilize consumption expenditure across years will do more to raise nutrient intakes than will efforts to enhance income per se.

Fourth, caloric deficiency may not be a good poverty-related food adequacy standard in India's SAT. Besides the likely over-estimation of the extent of poverty using energy intake cutoff points because of the Shah effect, reliance solely on caloric consumption ignores the ubiquitous nature of vitamin and to a lesser extent mineral deficiencies.

Fifth, mothers' participation in the labor market is not itself deleterious to the short-run nutritional well-being of their children. Children of mothers who worked more outside the home had significantly higher intakes of beta-carotene and ascorbic acid—the two micronutrients with the greatest shortfall from RDAs—than the children of mothers who participated less in the village labor market. But the former were shorter than the latter, so our results are ambiguous on the effect of maternal employment on the health of the child. More controlled and focused research is needed to unravel the causality and timing of these effects. Still, it is safe to say that augmenting labor demand should enhance nutritional welfare provided women's labor earnings are transformed into increased consumption expenditure, which in turn dominates any substitution effects.

Sixth, intrayear seasonality does not express itself in significant variability in nutritional status. The conventional wisdom that the wet season is when malnutrition and morbidity are at their peak is an oversimplification so far as these six Indian villages are concerned. Even though food grain availability may be greater in the surplus (dry) season, effective access to "protective" foods such as leafy vegetables is much more restricted than in the wet season. As the major dietary gap in these SAT villages is the lack of vitamins and minerals, directing nutrition programs to the wet season would not solve the problem of vitamin and mineral deficiencies prevalent in the dry season.

Further development of common property resources (CPRs), such as village forests and fallow lands, could play a role in mitigating some vitamin and mineral deficiencies. Jodha (1985a) found that CPRs contribute significantly to income generation and to the improved nutritional status of lower-income groups in some of the SAT villages he studied. If sources of vitamins and minerals that were freely available in the dry season could be tapped and if these crops could be grown and managed on CPRs, a major nutritional problem could be alleviated. However, these are two big ifs. As with home gardens, the gap between desirability and feasibility will likely be wide. Fruit trees probably offer the best prospect. Further research is required to quantify more precisely the seasonal patterns of availability of nutrients derived from common property resources and their associated property rights.

10 Assessment of Technology

Technical change in agriculture can impinge on one or more of the following four food policy objectives commonly recognized by economists: growth and efficiency, equity, nutrition, and food security (Timmer, Falcon, and Pearson 1983). Agricultural research is primarily a vehicle to attain the first objective, growth and efficiency. During the past twenty years concern has been increasingly expressed that the performance of agricultural research could be improved to better satisfy equity, nutritional status, and food security objectives.

The bulk of this chapter deals with that concern. Emerging from the discussion is an assessment of the outlook for different types—biological, chemical, and mechanical—of technical change in India's SAT. For dryland agriculture in a harsh environment, the objective of growth also warrants some discussion, particularly of trade-offs between technical optimality and economic demand. Returns to public-sector investment in land improvements, especially those related to watershed development, is perhaps the fuzziest area of technology evaluation in dryland agriculture in India's SAT. Sound economic documentation on the worth of such public-sector investments in both developed and developing countries is sparse (Dumsday 1988). Some of the issues and their related trade-offs are set forth in the following section.

Efficiency and Land Improvements

Relatively high population densities in India's SAT set the stage for enhanced profitability from investments in land improvements. Such investments can have an impact on crop productivity in three ways: (1) directly, through the alleviation of a physical or chemical constraint, such as too little or too much water; (2) indirectly, by augmenting the fixed resource base leading to the better expression of variable inputs such as improved varieties and inorganic fertilizer; and (3) ultimately, through reduced soil erosion and soil loss (Binswanger and Pingali 1988). Indeed, in the Seventh Five-Year Plan the major loci for investment in dryland agriculture by both the center and several state governments are watersheds ranging in size from tens to thousands of hectares. Although such initiatives encompass many types of investment activities, ranging from biological technology to social forestry, land improvements are central to the watershed approach. Examples include soil bunding techniques, other engineering structures for soil conservation, farm ponds for water harvesting and recycling, percolation tanks to enhance groundwater recharge, and *in situ* land and water management practices to more effectively utilize scarce water resources.

The problem with many of these land improvements is that they do not compete favorably with the alternative of agricultural intensification around wells and tanks in India's SAT. Although our brief discussion of the profitability of dug wells in chapter 3 did not convey the impression that investing in wells was excessively remunerative, dug wells are still the preferred investment option of SAT farmers.

The proponents of the watershed approach argue that enhanced groundwater recharge should be one of the benefits of dryland watershed development. Such benefits are difficult to quantify. Hydrological consequences are extremely susceptible to before-and-after confounding effects. Rigorous with-and-without comparisons are hard to establish and implement even in smaller watersheds. The spatial distribution of benefits within the watershed is also hard to quantify with much precision. The assumption that everyone will benefit is usually erroneous. For example, planting trees in the upper reaches of the watershed may adversely affect groundwater regimes of downslope agricultural systems (Dumsday 1988). Ultimately, the analyst has to resort to modeling, which can be very information intensive, or to answering simple questions such as, Did the farmers maintain, ignore, or destroy the works constructed or did the investment engender group action?

One can find examples of farmers privately investing in soil conservation in India's SAT, but heavy subsidization is often needed to persuade farmers of the economic worth of recommended soil conservation and land and water management practices. Reasons for the lack of private investment in land improvements (other than wells) in dryland agriculture can be established by returning to the intertwined direct, indirect, and longer term effects discussed at the outset of this chapter.

Much of the research on land and water management in India's SAT has been based upon the realization that water is the limiting natural resource in agricultural production. Research strategies have endeavored to develop technology options which increased and stabilized crop yields by improvements in water use efficiency. One option which has received considerable attention is the harvesting of excess runoff in small farm ponds for later use as supplementary irrigation on upland crops such as cereals, pulses, and oilseeds in periods of moisture stress.

Unfortunately, the benefit-cost calculus of water harvesting and supplementary irrigation has not yet been found to be attractive. Ryan et al. (1981) assessed the economics of water harvesting and supplementary irrigation in three agroclimatic environments using a simulation model which included rainy season sorghum-moisture stress response functions, rainfall-runoff relations for alternative land management practices, and a module specifying alternative irrigation rules depending upon the rainfall pattern in a given year. The simulations were performed using long-run historical daily rainfall data for fairly rainfall-assured Hyderabad and drought-prone Sholapur.

Results from their study point out some of the factors limiting the profitability of water harvesting and supplementary irrigation from small catchments in India's SAT. In more than half the years, at Hyderabad on Alfisols (red soils), which were most suitable for runoff, the sorghum crop did not experience moisture stress; therefore, water collected in the pond could not be productively used for supplemental irrigation. On Vertisols, this scenario would occur in two of three years. The high frequency of such coincident events—full farm ponds and no or negligible response to water applied to the crop—reduced the payoffs from the occasions when stress occurred and stored runoff was available. The following observation sums up the gist of the Ryan et al. (1981) results: water was in the pond when it was not needed and not there when it was needed.

These findings suggest that it would be difficult to justify water harvesting and supplementary irrigation for rainy season, low-value crops such as upland sorghum. High value cash crops, such as vegetables, would be better candidates for waterharvesting technologies. More simulation work (Krishnagopal and Ryan 1983) showed that the use of runoff water to irrigate higher value pigeon pea in the post-rainy season did pay on Alfisols, provided irrigation equipment did not have to be owned individually but could be custom hired.

On paper, one of the most economically congenial environments for water harvesting and supplementary irrigation in India's SAT is the rainfall-assured region of central Madhya Pradesh. Irrigation is only needed in some years to wet the seed bed to establish the post-rainy season crop, following rainy season soybeans. Modeling research indicated that in two of three years a post-rainy season crop of wheat could not be grown after soybeans because the top soil layers would be too dry for adequate germination (Pandey 1986). Hence, the gross returns with water harvesting and supplementary irrigation could be higher than the farmers' recently adopted practice of rainy season cropping with soybean in two of three years. Thus, the stage was set for economic benefits to accrue to water harvesting and supplementary irrigation.

Factors affecting the returns to water harvesting include the distribution of rainfall; soil type; capital costs of farm ponds, pumpsets, and pipes; crop response to water; and the rate of seepage from the pond. In the Central Madhya Pradesh case study, the most important variable governing profitability was the seepage rate. Water harvesting and supplementary irrigation were economically attractive if the seepage rate was less than 20 mm per day (Pandey 1986). Subsequent diagnostic research on the incidence and control of seepage generated estimates in excess of 20 mm per day. Available sealants were not cost effective in controlling seepage.

Undeniably, one can find regionally specific cases where land and water management practices and related infrastructure have made a difference. Success stories have also been recorded in West Africa's SAT. Rock bunding in Burkina Faso is probably the most notable recent example (ICRISAT 1986a: 307-309). One prominent success story in India's SAT is the Indo-U.K. project in relatively high rainfall eastern Madhya Pradesh, where larger-scale main drainage of hard-to-manage heavy clay soils resulted in increased rainy season cropping and indirectly led to greater investment in well irrigation (Chaudhari 1981). Some of the conditions that made that project a success included the following: (1) drainage was clearly a constraint to extending the length of the growing season, (2) soybean processing in response to an export market came on stream and soybean was ideally suited to a higher rainfall production environment on Vertisols, and (3) the traditional cropping system, rainfed rabi wheat grown under a receding soil moisture regime after rainy season fallowing, was fairly easy to beat because of its relatively low productivity given the abundant natural resources available.

We now turn to the second effect: the interaction between land improvements and biological and chemical components. The watershed approach is predicated on the hypothesis that a marriage of biological technology to improved land and water management practices could spark a large enough productivity increase to entice farmers to adopt a more integrated solution to environmental problems (perceived by researchers) of low productivity and high soil erosion. That hypothesis was to a large extent generated from the failure of farmers to adopt the so-called Bombay dryland farming practices extended in the 1930s. Adoption not up to expectations was attributed to the absence of improved biological components to showcase the potential gains from improvements in soil conservation and land and water management.

Recently, Pingali, Bigot, and Binswanger (1987) concluded that the linking of biological and mechanical technologies did not significantly alter the trajectory of adoption of animal traction or tractors in sub-Saharan Africa. Adoption was largely influenced by cost saving and area expansion, as synergistic productivity effects (if they existed) were incidental to the adoption decision.

The jury is still out on whether or not biological technology should be explicitly tied to agronomically optimal land and water management. Evidence on farmer acceptance of technology tested in small watershed, verification trials in three wet heavy black-soil sites of high production potential in India's SAT demonstrates the tenuous nature of the linkage hypothesis. Components of the watershed technology package included broadbeds-and-furrows, field and main drainage channels, improved varieties and cropping systems, modest doses of fertilizer, dry seeding of rainy season crops just before the onset of the monsoon, improved placement of seeds and fertilizer, and improved plant protection (ICRISAT 1986b).

Although drainage was thought to be a constraint to rainy season cropping in the three sites, the uptake of broadbeds-and-furrows and field drainage (following the two-to-three-year validation exercise) was nil or much slower than the diffusion of biological and agronomic components. In one site, pest control applicators resulting in significant cost savings were rapidly adopted (Hardiman 1985); in another, demand was quite high for improved pulse/pulse cropping systems (Walker, Ryan, Kshirsagar, and Sarin 1983), and in the last site the diffusion of inorganic fertilizer and rainy season soybean cultivation was accelerated as a result of the verification trial (Foster et al. 1987).

The consequences of broadbeds-and-furrows and the drainage practices tested in the verification trials were not transparent. In contrast, some of the agronomic practices, such as timely pest control, had a clearly demonstrable effect on yield. Farmers did not perceive that the incremental contribution of the land and water management practices would justify their moderate investment cost.

Farmers' perceptions of constraints would appear to be the overriding consideration in the adoption of improved land and water management practices. It is hard to see how the marriage of technically optimal land and water management to biological technology is going to alter those perceptions.

The longer term efficiency consequences of land improvements are embodied in diminished soil erosion and ultimately reduced soil loss. (Soil salinity is not a major problem in dryland agriculture in India's SAT.) Similar to the short term benefits from land improvements, farmers often feel that the longer term returns from antierosion investments are low. India's SAT is characterized by gently undulating topography, for the most part, with mild slopes, crop cover in the rainy season, and rainfall less erosive than in Africa's SAT or in the humid or subhumid tropics. The experience of the Maharashtra villages, where the contour bunding program has been met with indifference bordering on mild enthusiasm if the government foots the bill, is typical. Farmers often do not perceive that such works in and of themselves result in tangible benefits in increased productivity or even in the reduction in soil loss. Visibility is blurred because soil erosion may translate into significant soil loss only sporadically, once in every ten to fifty years.

Of the study villages, the Sholapur villages appear to be the most vulnerable to soil erosion. The heavy black clay soils in the lowlands are not protected by crop cover during the rainy season, and the uplands are also fallowed in the rainy season in about two years in ten during times of severe rainfall scarcity.

Equity

Targeting technology for vulnerable groups in society is probably the most ubiquitous equity-related issue in technology design. In the 1960s and 1970s, the most often mentioned vulnerable group was resource-poor small farmers, many of whom had supposedly not shared in the fruits of the green revolution. More recently, concern has shifted in some quarters to women, who are discriminated against in the extension process, in labor markets, and presumably in the intrahousehold allocation of resources. Counterarguments have also emerged that technology should be explicitly targeted to large farmers because theirs is a more favorable investment pattern for regional growth (Hazel and Roell 1983).

We argue in this section that targeting technology for groups within a region is not only undesirable but also unfeasible. The best way to approach equity objectives through agricultural research is to focus on the regions where poor people live and on the commodities they produce. Agricultural technology is ultimately location-specific. Producers in regions where specific technologies are compatible with the agroclimatic, soil, and socioeconomic environment gain relative to those located where the technologies fit in poorly with the regional ecology. As we saw in chapter 3, interregional disparities may endure for many years and are the main welfare cost of differential diffusion of biological technologies.

While we dwell on the presumed desirability of targeting technology away from large farmers and toward small farmers in this section, one aspect of the feasibility of technology targeting is worth mentioning. Results from Jodha's (1985b) intensive historical field surveys of Rajasthan villages illustrate the ephemeral nature of technology targeting. Raising sheep and goats is the traditional occupation of low caste and seminomadic tribal groups in Rajasthan. Hence, one would have thought that benefits from sheep and goat research would accrue primarily to these poor producer groups.

Following the land reforms in Rajasthan in 1952, the profitability of raising sheep and goats increased sharply as households no longer had to pay land revenue to feudal landlords and a cess for the use of common property resources. With the privatization of land, households invested in sheep and goats that could survive better on increasingly overgrazed pastures. Small ruminant investment was also spurred on by highly favorable wool and mutton prices.

As a result of those institutional and economic changes, sheep and goat herding became an acceptable high caste occupation. Jodha found that by 1963/64 many high caste households in his study villages were engaged in sheep and goat production; in 1955 no higher caste households had invested in those enterprises. Researchers, thinking that benefits from sheep and goat research in the 1950s would be expropriated only by the poorest households in the community, would have been sadly disappointed. Jodha's case study underscores the importance of dynamic economic and institutional forces in determining equity outcomes from prospective agricultural technologies and confirms the observation that the targets of agricultural research are not stationary (Maxwell 1986).

Small and Large Farms: Dichotomy or Nexus?

Critics of the green revolution such as Frankel (1971), Palmer (1972), and Vallianatos (1976) claimed the benefits were primarily captured by the large and more affluent farmers. These criticisms, although often emotive rather than based on careful analysis, led international donor agencies and policy makers to exhort scientists to design technologies which were appropriate for so-called small farmers. At some research institutes like ICRISAT there was even an active search for technologies that were not just scale-neutral but even scale-negative.

The induced innovation hypothesis of Hayami and Ruttan (1971) served as a point of departure for Ryan and Rathore (1980) in analyzing whether it was desirable for research scientists purposefully to design technology specifically for small farms. Hayami and Ruttan postulated that farmers and research administrators had been induced by differences (and changes) in relative factor prices to search for technological options which would save the increasingly scarce factors of production. Hence, countries such as the United States and Australia with low person-to-land ratios developed their agricultural sector by employing land-using and labor-saving technological innovations. In contrast, Japan, with a person-to-land ratio more than thirty-six times that of the United States, relied on biological innovations of a land-saving type. It is not clear whether the induced innovative hypothesis can also be used as a normative tool in an ex ante framework, but the implication has always been that it can.

The mean *resource endowment ratios* are significantly different between large and small farm-size groups in all the study villages. Large farm households command from 250 to 500 percent more land per available family member than small farm households. The differences were statistically significant in all six villages. The concern in developing countries that owners of small farms require unique technology options denied them in the past is based on the hypothesis that initial differences in ownership endowments are translated into significant disparities in *factor use ratios* for different farm-size groups within the same region.

Are the factor use ratios that much different between farm-size groups in the same village? In an earlier study using data for one year in the six study villages, the answer appeared to be no (Ryan and Rathore 1980). Only in Aurepalle were the mean land-to-labor and capital-to-labor use ratios significantly different between small and large farm groups. As we discussed in the section on farm size and labor intensity in chapter 5, once we adjust for access to irrigation, those farm-size differences in Aurepalle largely disappear.

Updating Ryan and Rathore's earlier analysis did not appreciably change those results (table 10.1). Land/labor endowment ratios were significantly higher on the large farms in all cases but not so when land/labor use ratios were compared, except for Aurepalle. Similar results were obtained comparing capital/labor endowment and use ratios between small and large farm-size groups within the same village (table

Table 10.1. Land/labor resource endowment and use ratios by village for small and large farm households, from 1975/76 to 1983/84

	Owned Land (ha) / Family Labor Available[a]			*Operated Land (ha) / Total Labor Used ('000 hr)*[b]		
Villages	*Small Farms*[c]	*Large Farms*[c]	*t Values of Difference in Means*	*Small Farms*	*Large Farms*	*t Values of Difference in Means*
Aurepalle[d]	0.34 (82)'	2.50 (50)	16.43**[g]	6.55 (63)	2.79 (61)	8.05**
Dokur[e]	0.29 (44)	2.71 (131)	4.26**	1.00 (166)	1.70 (118)	1.69
Shirapur[d]	0.68 (91)	1.16 (69)	4.46**	5.07 (102)	6.22 (78)	1.55
Kalman[e]	1.33 (48)	2.72 (52)	6.47**	5.50 (58)	5.10 (45)	0.72
Kanzara[d]	0.45 (88)	1.86 (54)	13.46**	2.82 (48)	2.74 (34)	0.45
Kinkheda[e]	0.79 (73)	4.34 (79)	7.09**	2.70 (50)	2.70 (34)	0.45

[a]The total number of people in the household in man-equivalents.
[b]The time spent by family plus hired labor in crop work in man-equivalents.
[c] Based on operational landholdings.
[d]Data, refer to the years 1975/76-1983/84.
[e]Data refer to the years 1975/76-1979/80.
[f]Coefficients of variation (%) are in parentheses.
[g]** denotes statistical significance at the 0.01 level.

10.2). Although the disparity in endowment ratios was as great as sevenfold between small and large farms in Kinkheda, the nonlabor working capital/labor use ratios showed considerable parity. Of the six study villages, the most marked and significant difference between large and small farm groups was in Kanzara, where the capital/labor use ratio was about 20 percent higher for the large farm group.

In contrast to the insignificance of mean factor use ratios between farm-size groups within villages, interregional household mean factor use ratios within the same farm-size group were significantly different at the 5 percent level for ten of the twelve paired comparisons for both small and large farm classes. Variation in factor proportions among regions is clearly larger than the variation between farm-size groups within regions, suggesting once again that the region should be the focus for technology targeting.

The large coefficients of variation of factor proportions within each size group within each village further indicate that a classification of farms based on operational size or owned area is not appropriate for delineating the type of technology which is likely to be viable. Unless small and large

Table 10.2. Capital/labor endowment and use ratios by village for small and large farm households, from 1975/76 to 1983/84

	Nonland Assets!Family Labor Available[a]			*Nonlabor Variable Costs/Total Labor Used*[b]		
Vi//ages	*Small Farms*[c]	*Large Farms*[c]	*t Values of Difference in Means*	*Small Farms*	*Large Farms*	*t Values of Difference in Means*
Aurepalle[d]	1.33 (125)[f]	5.19 (97)	7.15**[g]	0.87 (66)	0.78 (30)	1.23
Dokur*	1.72 (110)	2.97 (75)	2.73**	0.95 (136)	0.78 (32)	0.81
Shirapur[d]	1.14 (78)	2.16 (68)	5.42**	0.87 (64)	0.97 (56)	1.23
Kalman*	0.65 (135)	1.98 (52)	7.16**	0.63 (35)	0.73 (20)	2.45*
Kanzara[d]	0.53 (136)	3.7 (73)	11.83**	0.73 (60)	0.92 (28)	3.49**
Kinkheda*	0.71 (91)	5.19 (72)	8.28**	0.48 (52)	0.59 (42)	2.19*

[a]The total number of people In the household in man-equivalents.

[b]The time spent by family plus hired labor in crop work in man-equivalents.

[c] Based on operational landholdings.

[d]Data refer to the years 1975/76-1983/84.

[e]Data refer to the years 1975/76-1979/80.

[f]Coefficients of variation (%) are in parentheses.

[g]* and ** denote statistical significance at the 0.05 and 0.01 levels, respectively.

farms comprise disjoint sets on a factor ratio space, it is not possible to infer that small farms in these villages require technologies which, in terms of their basic resource-saving or resource-using characteristics, differ in substance from those of large farms.

To probe deeper into this issue, we plotted the mean input-output ratios by farm-size group for the three continuous study villages (figure 10.1). Within each village, small, medium, and large farm households were not clustered around different diagonals representing clearly demarcated land/labor use ratios but instead were scattered uniformly across the double logarithmic scale of the factor/output space. The absence of clustering by farm-size group says that interhousehold differences in resource use are not sufficiently large to warrant technology targeting.

Differences in Personal Characteristics Another justification for technology targeting is based on supposed differences in personal characteristics between small and large farmers. The characteristic that has received the most analytical scrutiny in the literature is the farmer's willingness to take risk (Moscardi and de Janvry 1977). Intuition suggests that small farmers would be much less willing to take risks than large farmers; however, the experimental results in chapter 8 amply demonstrate that the majority of respondents in the study villages were intermediately to moderately risk averse, as the distribution of risk aversion was tightly and unimodally cluster for the games with higher stakes. Targeting technologies to accommodate what intuitively appear to be intergroup differences in risk attitudes would also not be feasible. Experimentally measured risk attitudes were poorly correlated with personal and resource endowment characteristics of farm households (Binswanger 1980); thus, there is little empirical basis for establishing criteria to separate farmers into homogeneous risk attitudinal groups.

Early Innovators' Rents Much of the rationale for targeting technology to the needs of small farmers stems from the popular perceptions that early adopters are predominantly large farmers who earn sizable innovators' rents or that early adoption by the few impedes later diffusion to the majority. In chapter 3, we showed (consistent with most of the adoption literature on the green revolution technologies; Feder, Just, and Zilberman 1985) that small farmers do indeed catch up; however, the speed of diffusion does depend on the component— slower for pesticides and fertilizer and faster for varieties.

The perception about innovators' rents is true but one-sided. The cost of innovation is not considered. It is clear that early adopters of technologies earn innovators' rents. Indeed, in situations where commodity demand is inelastic these can be the only producer benefits. But technological information is often highly imperfect. Innovators' rents are partially a payment to superior information searching and processing capabilities and also a necessary compensation for the risk of failure of new techniques borne by the early adopters, who provide later adopters with cheaper and more reliable information (Binswanger and Ryan 1977). Often social science research concentrates on the success stories, which leads to overestimation of innovators' rents relative to what happens over longer stretches of time within which failures also occur.

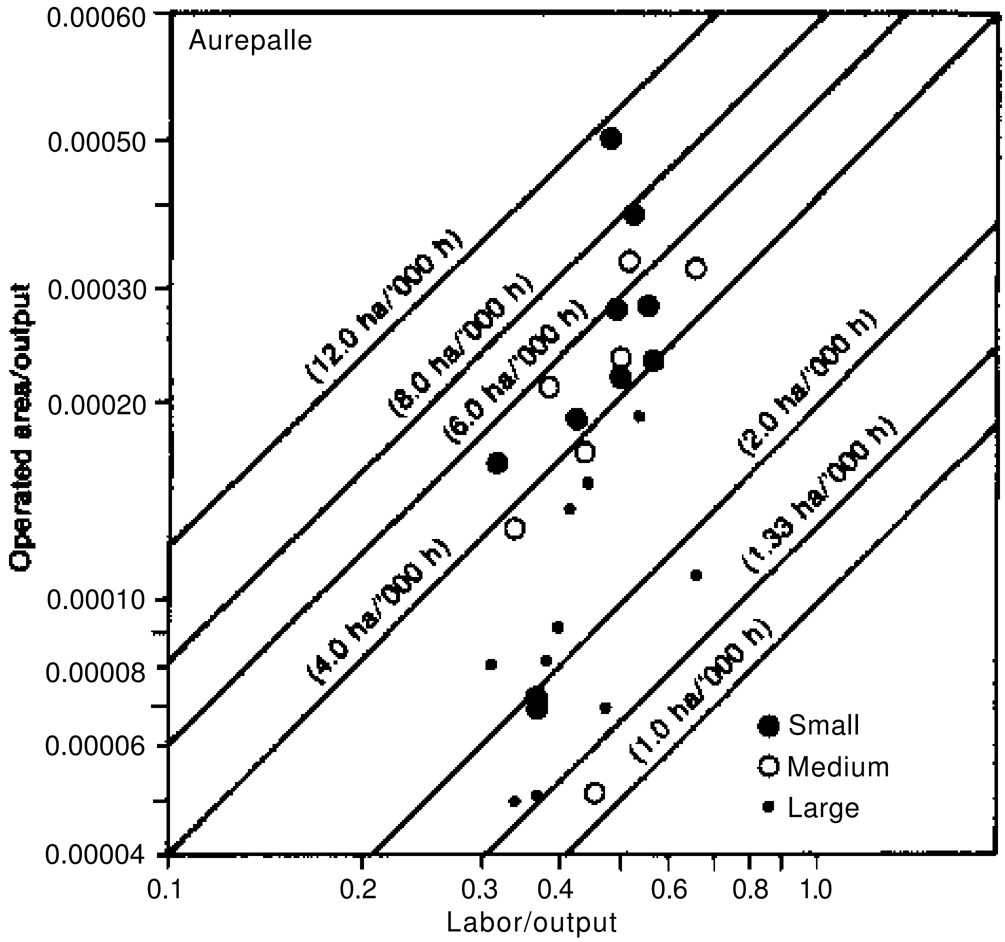
Examples of innovators suffering losses are not often reported in the literature, but they are not rare. The first-generation pearl millet hybrids released in the late 1960s in India were extremely susceptible to downy mildew. The new hybrids were wiped out by the disease in the early to mid-1970s. As a consequence, the rate of adoption in some of the major producing regions plummeted. Second-generation hybrids were bred that, at that time, were much less susceptible to downy mildew. Relative to other farmers in the region, early adopters of the second-generation hybrids gained; initial adopters of the first-generation hybrids lost. Early adopters' losses were manifested by the normal S-shaped adoption curve, giving way to a roller coaster pattern of diffusion (Walker 1989a).

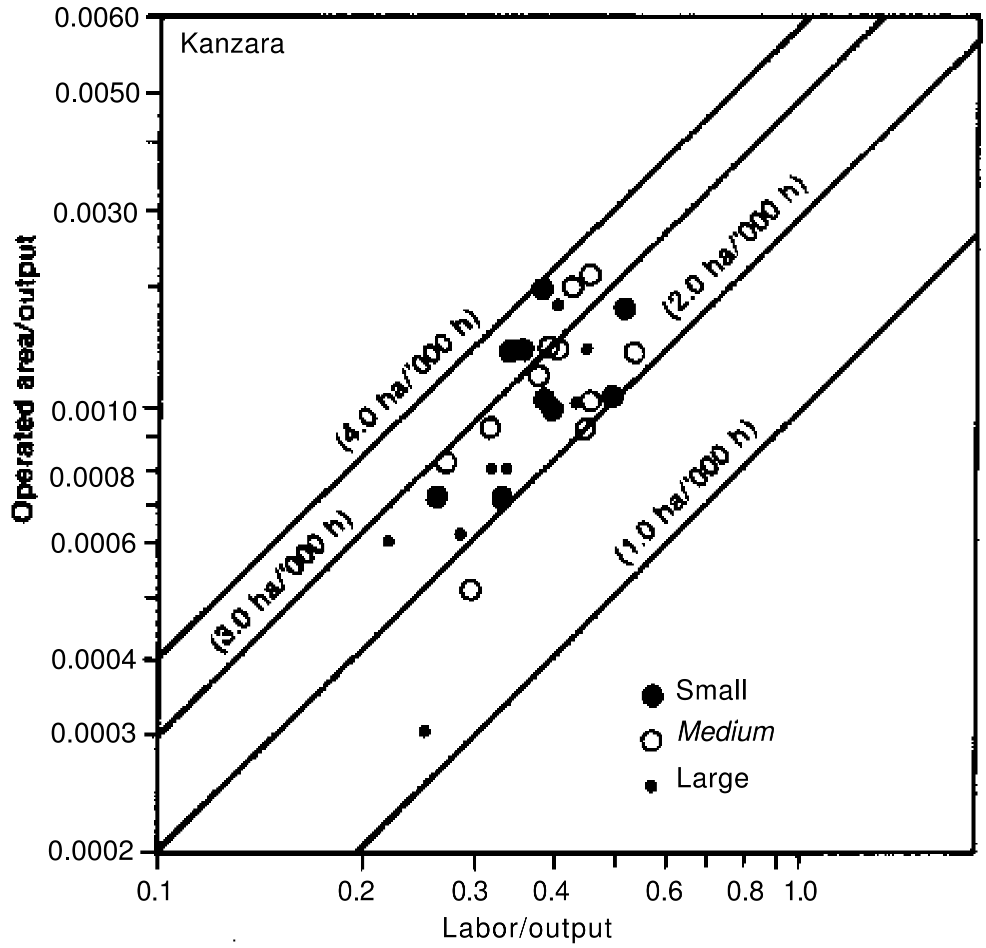
Employment

Equity considerations in impoverished regions like India's SAT are almost synonymous with employment opportunities. In this subsection, we focus on some employment consequences of technical change in dryland agriculture.

Labor Seasonality How much should prospective dryland technologies avoid seasonal peaks in labor demand? Everyone agrees that filling in the troughs is desirable, but accentuating peaks is controversial. Under land-abundant conditions, particularly where the growing season is short (characteristic of some of Africa's SAT), increasing labor seasonality should be avoided as far as possible in technology design (Schofield 1974; Ouedrago, Newman, and Norman 1982). In India's SAT, population densities are high, and labor seasonality does not loom as large as an issue in technology assessment. Creating labor peaks is one of the few avenues whereby laborers can benefit from higher wages (Ghodake, Ryan, and Sarin 1981). Moreover, within- and between-region seasonal migration can further benefit the poorest labor households in the land-scarce economies characteristic of India's SAT.

What is often overlooked in the analysis of technology by labor seasonality interactions is the ease with which seasonality can be overestimated both in present and prospective cropping systems and technologies. Difficulties in measuring seasonal labor demand for current and prospective technologies are vividly illustrated in figure 10.2. In panel a seasonal labor demands between a prospective watershed technology researched at the ICRISAT Research Center and farmers' existing prac-


Aurepalle
0.00060
0.00050
0.00030
0.00020
0.00010
0.00008
0.00006
0.00004
Operated area/output
(12.0 ha/'000 h)
(8.0 ha/'000 h)
(6.0 ha/'000 h)
(4.0 ha/'000 h)
(2.0 ha/'000 h)
(1.33 ha/'000 h)
(1.0 ha/'000 h)
Small
Medium
Large
0.1
0.2
0.3
0.4
0.6
0.8
1.0
Labor/output


Kanzara
0.0060
0.0050
0.0030
0.0010
0.0008
0.0006
0.0004
0.0003
0.0002
Operated area/output
(4.0 ha/'000 h)
(3.0 ha/'000 h)
(2.0 ha/'000 h)
(1.0 ha/'000 h)
Small
Medium
Large
0.1
0.2
0.3
0.4
0.6
0.8
1.0
Labor/output

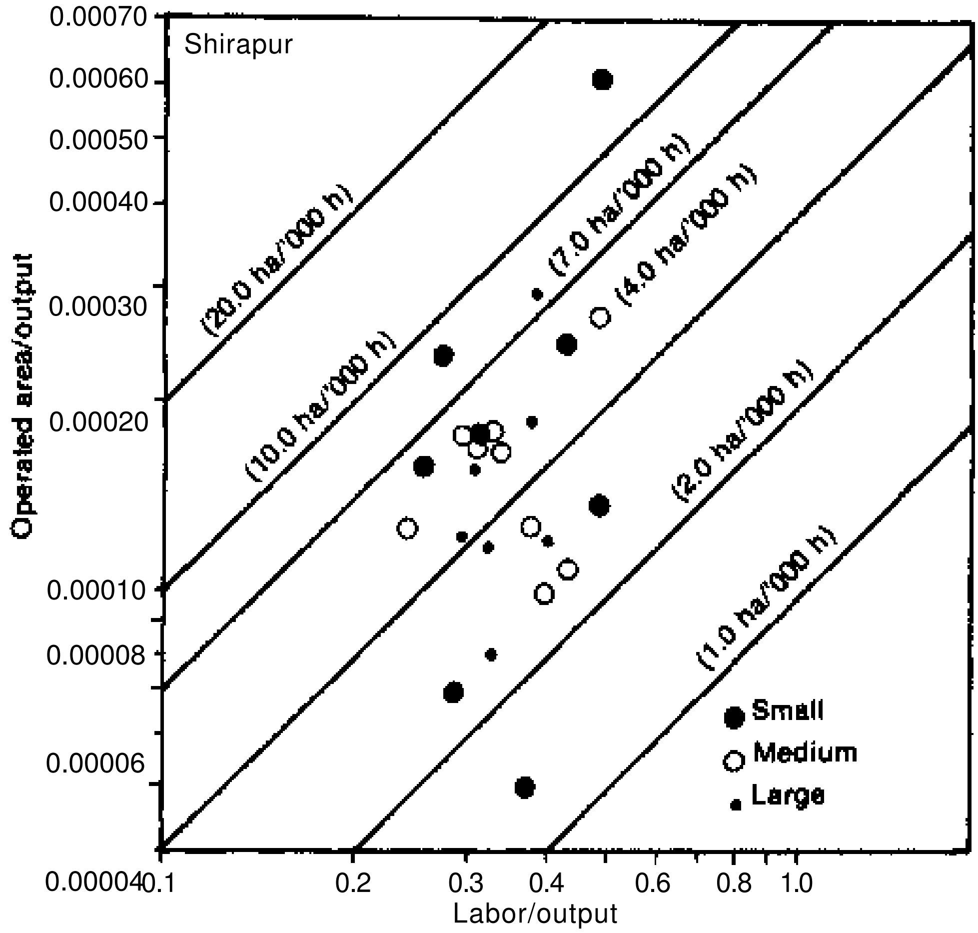


Figure 10.1 *(opposite and above)* Mean input-output ratios for three study villages from 1975/76-1983/84 by farm-size class; diagonals are operated area (ha)/labor (hr) ratios

tices were compared in the study villages (Ghodake, Ryan, and Sarin 1981). In panel b the same comparisons are made for the aforementioned three verification trial sites for the Vertisol technology options.

Two points are noteworthy in figure 10.2. First, with the existing cropping systems (designated by the solid lines), labor seasonality appears to be much greater in the verification village test sites than in the study villages. That difference is largely an illusion, because the sample for the verification trials is based on twenty to thirty plots surrounding the watershed test site, while the sample for the study village sites includes all the plots (annually numbering in the hundreds) from the respondent households in the study villages. The comparison essentially restates one of the main points brought out in chapter 3: there are numerous and diverse cropping systems in each of these dryland villages. Relatively large samples have to be taken to draw reliable inferences on the seasonality of labor demand under current farmer circumstances. Figure 3.3 in chapter 3 additionally conveys the message that labor demand peaks with existing cropping systems are only notional and cannot be predicted with much accuracy in variable production environments like Aurepalle, where we showed that the peak in crop labor demand is highly dependent on rainfall and can occur any time from June to January.

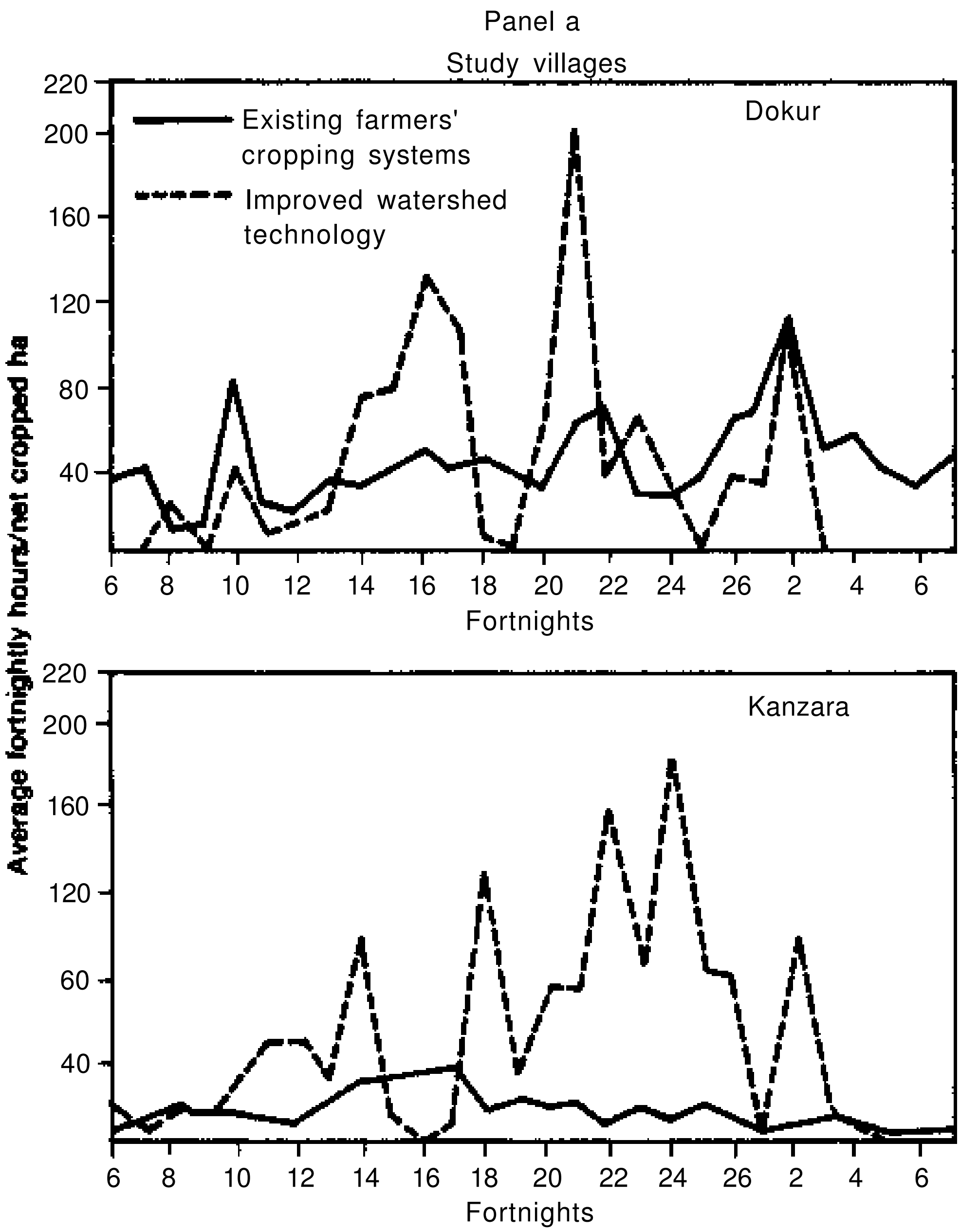
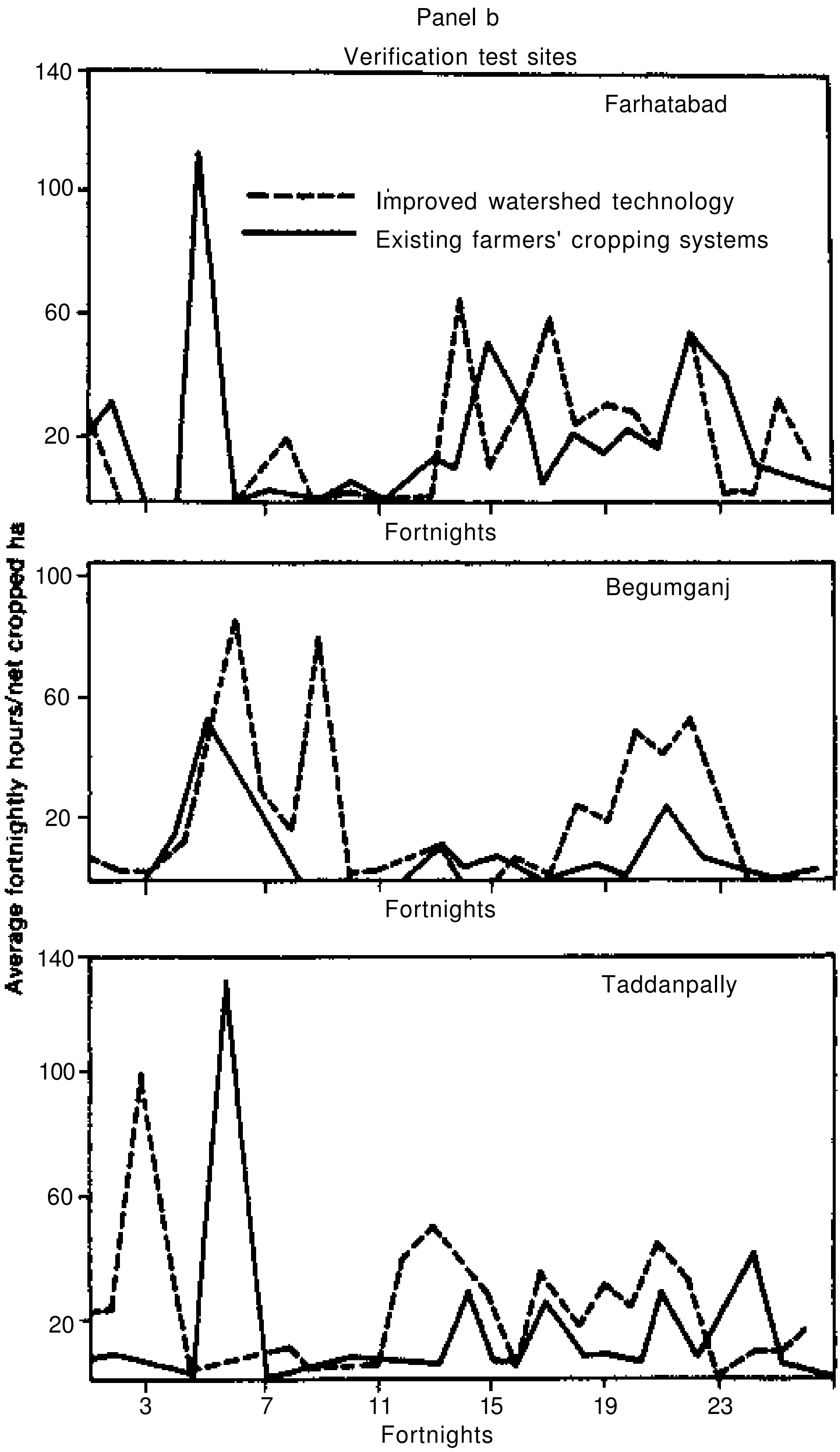


Figure 10.2 *(above and opposite)* The seasonality of labor demand with improved watershed technology and existing farmers' cropping systems in two study villages and three verification trial sites

Much the same point applies to estimating seasonal labor demand with prospective technologies. In the crosshatched lines in the Dokur and Kanzara panels in figure 10.2, it is assumed that farmers will plant only two of the prospective cropping systems. In the verification test sites, the estimates are based on the proportional areas of the prospective cropping systems, usually five to ten, planted in the test watersheds. The seasonal peaks and troughs in labor demand for the prospective cropping systems are much sharper in the study village panels, indicating that estimates of labor seasonality for prospective cropping systems are extremely sensitive to the number of cropping patterns planted by the farmer. It would be a rare occurrence indeed if all farmers instantaneously adopted the same prospective cropping pattern. While the estimates in both panels provide



a feel for the differences in seasonality between present and prospective cropping systems, they are only indicative and err on the side of overestimating seasonality with the prospective technology.

In general, we can say that seasons matter most in limiting the scope for prospective sequential cropping technologies in some of the more fertile and rainfall-assured or bimodal rainfall production environments in India's SAT. Harvesting the first crop while retaining enough moisture in the soil to plant the second crop can be constrained by seasonal labor demand, which may be so sharp (i.e., timebound) that incentives to increase local labor supply through migration are substantially dampened. A very short turnaround time and planting horizon for the second crop may also accentuate the seasonality in demand for supervisory and management time, hence hastening selective mechanization. Improved intercropping systems featuring short- and long-duration crops are usually characterized by less labor seasonality than improved sequential crops. They use the seasons just as efficiently and score as well on economic criteria as sequential cropping systems (Willey, Reddy, and Natarajan 1987).

Labor Displacement Examining shares of the agricultural wage bill by gender and by operation is one starting point to quantify how much casual agricultural labor would be hurt initially by different types of mechanization or other innovations that substitute capital for labor (table 10.3). In paddy cultivation, dominating the rural casual labor market in Aurepalle, two operations carried out by women—transplanting and harvesting—comprise more than 50 percent of the agricultural wage bill. In the dryland Maharashtra villages, the wage bill is spread somewhat more evenly among operations. Mechanizing postharvest operations, mainly

Table 10.3. Operations contributing more than 5 percent of the wage bill over three years, from 1982/83 to 1984/85, by village and sex

Village	Sex	*Operation*	*Contribution to the Wage Bill (%)*[a]
Aurepalle	Female	Transplanting	28.5
	Female	Harvesting	27.4
	Female	Postharvesting	14.3
	Male	Postharvesting	7.3
	Female	Weeding	6.6
Shirapur	Female	Postharvesting	23.9
	Male	Field preparation	13.7
	Female	Harvesting	12.2
	Male	Sowing	11.1
	Male	Harvesting	10.9
	Male	Postharvesting	8.1
	Male	Interculturing	7.3
	Female	Weeding	6.6
Kanzara	Female	Harvesting	28.9
	Female	Weeding	17.7
	Male	Harvesting	14.5
	Male	Field preparation	11.0

[a]Simple mean of the three years.

threshing, could potentially displace a large amount of female labor in Shirapur. In Kanzara, potential labor displacement from mechanizing harvesting and weeding would be large.

What is the subsequent likelihood that those operations will be mechanized in the near to medium-term future? Historically, operations such as pumping, transport, threshing, and to a lesser extent field preparation that are intensive users of power are mechanized first; activities like planting, interculturing, and harvesting requiring skill, judgment, and control are only mechanized at a much later stage of development (Binswanger 1986). Hence, one of the most likely candidates for mechanization is threshing, which figures prominently as a postharvest operation in the wage bill in Aurepalle and Shirapur (table 10.3).

Preparing fields mechanically could be another candidate, but the pace of tractorization has been slow in India's dryland SAT. Growth in mechanized agriculture has mainly been confined to irrigated tracts, where the prospects for the development of rental markets are brighter because irrigation makes for a longer growing season and less synchrony in the timing of operations. Additionally, intermediate forms of mechanization, such as power tillers, are effective alternatives to bullock draft and the four-wheel tractors in irrigated agriculture. In contrast, in dryland agriculture the scope for economically attractive intermediate mechanization is considerably less, as evidenced by unsuccessful attempts to introduce bullock-drawn wheeled tool carriers (Kshirsager et al. 1984; Starkey 1987).

Other considerations that loom large in the transition from draft animals to tractors include the size of the savings in wages to compensate for the cost of a tractor, credit availability, the relative costs of fodder and diesel, and access to spare parts and servicing facilities (Binswanger and Pingali 1988). Credit availability is increasing, fodder is becoming dearer, and repair and maintenance are relatively inexpensive, but for the vast majority of farmers in the study villages the savings in labor cost are not large enough to begin to offset the cost of a tractor. Secularly declining farm size, discussed in chapter 6, further erodes the profitability and subsequent likelihood that tractor density will increase markedly in India's dryland SAT in the near future. Land ceiling legislation has greatly diminished the incentive to accumulate enough land to make tractorization an attractive investment in dryland agriculture (World Bank 1987).

The consequences of tractorization are also well known in South Asia. In and of themselves, tractors do not lead to increased cropping intensity or yield; rather, they substitute for labor and bullock power and shift the cost advantage toward larger farms (Agarwal 1983; Binswanger 1978b; Farrington 1985; World Bank 1987).

Herbicides represent the other source of substituting capital for labor, mainly in weeding and interculturing but also in transplanting in paddy if their use results in direct seeding. The use of herbicides in India is trending strongly upward from a small base and is mainly concentrated in the irrigated agriculture of Punjab, Haryana, and western Uttar Pradesh. Although herbicides have not yet penetrated into India's SAT, nominal wages have risen much faster than the nominal prices of herbicide during the past ten years. In the Philippines, herbicides have been widely adopted in selected regions, even under falling real wage rates (Coxhead and Jayasuriya 1985). As the patents expire on some herbicides and as biotechnology permits less selectivity in their application, the competitive edge of herbicides should become sharper in the 1990s.

The forecast that herbicides may make their way into India's SAT in the near future is contingent on a number of policy responses and forthcoming technical and market changes. Nonetheless, given the size of the potential labor displacement consequences, it is incumbent on social scientists to analyze as many dimensions of the likely impact as possible. We take a harder look at both herbicides and threshers in the following two subsections.

Herbicides Hand weeding and intercultivation (or interculturing) with animal-drawn implements are the two methods traditionally used to control weeds in the three SAT study regions. The effectiveness of farmers' traditional weed-control practices varies considerably by region, season, and crop. Based on plot data on the timeliness and intensity of weeding and interculturing, on the investigators' counts of weed species in common cropping systems, and on personal observations of weed incidence, Binswanger and Shetty (1977) found that effort in controlling weeds was closely linked to the basic fertility of the region, crop value, and crop condition at weeding and interculturing. Farmers invest proportionately more resources in the Akola villages, where the majority of cotton fields are intercultured more than four times and where more than 90 percent of the food crop mixtures and cotton are intercultured within twenty-five days after sowing. The intensity and timeliness of weeding were lowest for the rainy season crops planted in the Sholapur villages, where the incidence of seasonal crop failure is high because of drought (Singh and Walker 1982).

Almost all hand weeding is done by hired women, while interculturing with bullocks is carried out by men from within the family or permanent servants attached to the household. Hand weeding is mostly performed within rows, whereas interculturing is for interrow weed control. Although some dryland crops are not weeded manually, relatively more time is spent on hand weeding than interculturing in each of the study villages. In the Akola villages, for each hour spent on interculturing, 2.5 hours are allocated to hand weeding. In the more heavily irrigated Mahbubnagar villages, more than three times as much time is spent in hand weeding than in interculturing. Earnings from hand weeding constitute a significant share of women's wage income in all the villages (table 10.3). Thus any reduction in hand weeding hours made possible by herbicides would primarily reduce work and income opportunities of the most disadvantaged labor group, female agricultural laborers.

A highly positive relationship between crop value and soil fertility and the intensity and timeliness of weed control suggested that little in the way of yield increases would be forthcoming if herbicides were applied to the higher value crops in the more fertile environments. Yields could be presumably increased somewhat in the lower valued crops in the more marginal environments, but it was evident that greater weed control either with herbicides or with traditional methods would not pay. The key empirical issue, therefore, centered on the scope of herbicides to reduce the cost of the traditional methods in the higher valued cropping systems, which require more intensive weed control.

Combining data from the village studies and from experimental station research, Binswanger and Shetty (1977) evaluated the costs and returns from three stylized weed-control alternatives. The three plans were designed to achieve the same level of weed control in six common village cropping systems using hand weeding and interculturing, partial herbicides plus traditional methods, and herbicides only.

Table 10.4. The ratios of the cost of herbicide treatments to the cost of controlling weeds with farmers' traditional practices in the study regions in 1975 and 1985 prices, by cropping system

		Treatment[a]	
Cropping System	*Year*	*Full Herbicide*	*Partial Herbicide*
Cotton	1977	3.3	2.0
	1985	2.7	1.8
Groundnut	1977	5.0	2.5
	1985	3.5	1.9
Castor	1977	4.8	1.7
	1985	1.9	1.4
Hybrid sorghum	1977	4.5	2.0
	1985	3.0	1.6
Pearl millet	1977	3.2	2.0
	1985	2.3	2.1
Sorghum/pearl millet/pigeon pea	1977	6.6	2.6
	1985	4.0	1.7
Paddy	1977	4.7	1.0
	1985	3.2	0.8

[a]Specifications about the input requirements for each treatment and for farmers' traditional weed control methods are given in Binswanger and Shetty (1977).

At prices prevailing in the late 1970s, the cost of the pure herbicide treatment was so high that it was not economical (table 10.4). The full herbicide plans were at least 2.5 times more expensive than the plans without herbicides. Even if wage rates were to rise by 50 percent, the pure herbicide plans were still about twice as costly as the no herbicide plans for pear millet and cotton, the crops with the lowest proportional cost differences between treatments. On the basis of cost considerations alone, Binswanger and Shetty concluded that pure herbicide plans were out of the picture for some time to come.

The partial plan was also not attractive for the rainfed crops but was profitable for paddy. Even a farmer using his own family labor might find applying a preemergent herbicide to paddy cheaper than relying on hand weeding. In the rainfed crops, however, even a rise in the wage rate by 50 percent would not make the partial herbicide plan attractive. In pearl millet, partial herbicides would still be 25 percent more expensive than no herbicides, and in the other crops the cost difference between the plans was larger. Mixed cropping systems such as the sorghum/pearl millet/pigeon pea intercrop in Aurepalle further eroded the advantage of herbicides because more selective and costly herbicides had to be used to attain the same level of weed control.

The fact that we have seen little if any use of herbicides in the study villages testifies to the robustness of Binswanger and Shetty's central message on the economic unattractiveness of herbicide use. Redoing Binswanger and Shetty's calculations eight years later in 1985 prices shows that herbicides are becoming increasingly competitive (table 10.4). Across the seven cropping systems, the mean ratio of cost of the full herbicide treatment to farmers' traditional control practice declined from about 4.5 to 3.0. Still, the full and partial herbicide plans were unattractive for several of the dryland cropping systems. But applying partial herbicides for paddy cultivation would appear to be increasingly remunerative over the past eight years as wage rates for hand weeding and interculturing have risen faster than the international or border prices of herbicides.

In some regions of India's SAT, benefits from herbicides may extend beyond cost savings. Some perennial grasses make small patches in farmers' fields uncultivatable in the study villages. In the assured rainfall Vertisol regions, poor weed control without herbicides was one of several competing explanations for fallowing in the monsoon season. To the extent that weed damage using traditional methods is a constraint to rainy season cropping, appropriate herbicide practices could raise cropping intensity and actually enhance employment in these agriculturally high production potential rainfed cropping environments. Heavy infestations of difficult to control perennial weeds like kans grass *(Saccharum spontaneum)* in Madhya Pradesh depress land prices; hence, eradication of such weeds would be reflected in higher land values (Foster et al. 1987).

The parasitic weed Striga can also be a significant yield reducer on sorghum in some sorghum-growing regions. These examples are the exception to the general observation that the competitiveness of herbicides will depend entirely on cost savings. The difficulty in controlling perennial weeds is also easy to exaggerate; fields infested with perennial weeds often reflect poor farm management.

Depending on Indian trade policy, we would expect to see increasing adoption of herbicides in paddy-growing areas of India's SAT. The size of the cost reduction in paddy production could be substantial if herbicide use facilitated direct seeding, thereby making transplanting and hand weeding obsolete. The amount of labor replaced or displaced would also be considerable.

In dryland agriculture, the incentive to adopt herbicides would not be as strong because farmers transplant few upland crops; chillies are the exception. If herbicides did spill over into dryland agriculture, for relatively small cost reductions the labor substitution effect could be very large. Without a large unit cost reduction, the social profitability of herbicide use would be questionable.

In the late 1970s and early 1980s, there was a great deal of interest in the consequences of mechanization in Asia. In the 1990s, herbicides will likely be at the top of the consequences agenda, not only with respect to their potential for labor displacement but also their environmental impact.

Threshers Diffusion of threshers in India's SAT has not been widespread. For example, by 1972 the density of threshers per 1,000 tn of cereal production for the Indian Punjab was 10.5 compared to 0.4 for predominantly rainfed Maharashtra. Between 1972 and 1977 the number of threshers increased from about 75,000 to approximately 215,000 in Uttar Pradesh, while comparable estimates show an expansion from about 1,000 to 5,000 in Maharashtra. Since 1977 machine threshing of dryland crops has been increasing in importance in some SAT states like Maharashtra.

Portable threshing machines have not yet made many inroads into the Sholapur and Mahbubnagar villages, but they are now widely used in the Akola villages. Machine threshing started in Kanzara in 1976/77. Within four years, five households in the village had purchased threshers. By 1980 all the respondent households had hired machines to thresh at least a part of their sorghum and wheat production as machine threshing rapidly displaced traditional methods of bullock treading and hand beating. Initially only sorghum and wheat were threshed by machine; more recently, farmers are increasingly using mechanical power to thresh pulses, particularly mung bean. In the early 1980s machine threshers also made their debut in Kinkheda. By 1985, the bulk of hybrid and local sorghum, wheat, and mung bean grown in the Akola villages was threshed by machine.

Because of few confounding effects, Kanzara offered an excellent vantage point to evaluate the consequences of machine threshing (Walker and Kshirsagar 1985). The production and employment data from 1975/76 provided a benchmark of the "before" situation prior to the introduction of threshers. The same type of data for Kinkheda in the late 1970s furnished a point of reference for the "without" situation.

No farmers in Kanzara produce enough to make threshers a remunerative investment without hiring out their machines. The most salient feature about threshing in Kanzara is the rate structure that owners of threshers have adopted to promote increased utilization of thresher capacity over the season. For sorghum, regardless of the size of output, they retain 4 percent of production as a payment for threshing. The first owner in 1976 appears to have skillfully calculated what the market would bear when he introduced the 4 percent charge, which has not yet changed. This charge seems to be close to a standard one for machine threshing in Asia, as Hayami and Kikuchi (1981) quote a figure of 4 to 6 percent for the Philippines.

The hiring market made mechanical threshing widely available to all households in the village. Although all farmers in the sample could and did use hired machines, machine threshing was more widely used by farmers who produced more sorghum, planted proportionally more hybrids, cultivated more land, and had less draft power. Nonetheless, substantial use did not translate into widespread producer benefits. Direct cost savings were relatively small. Although threshing by machine cost about 20 percent less than threshing by traditional methods, the absolute cost savings were only Rs 1 to Rs 2 per 100 kg, a small, almost negligible saving in value of production.

The 4 percent in-kind fee charged by thresher owners has not been exorbitant, but the spatial oligopoly nature of the village threshing market suggests that the cost-reducing potential of mechanical threshing has only partially been realized. With present levels of cereal production in SAT India, only a few machines per village are economically feasible. A few machines per village do not lead to competitive pricing. Under these conditions, it is questionable whether potential benefits from reduced costs derived from new threshing technologies will be passed on to machine renters and to consumers. Also, machine threshing did not increase cropping intensity. In theory, mechanical threshing of hybrid sorghum in October could release family and bullock labor for sequential cropping in the post-rainy season. In practice, double cropping potential is conditioned by access to well irrigation and seasonal rainfall. In only one year from 1976/77 to 1979/80 did significantly more farmers in Kanzara (with mechanical threshing) crop land in the post-rainy season than farmers in nearby Kinkheda (without mechanical threshing). And in that year post-rainy season cropping accounted for only 5 percent of total cultivated area in Kanzara.

The producers who benefited most from mechanical threshing were machine owners, particularly the first owner, who was able to profit from a strong demand for machine hiring without having to share throughput with other machine owners. Differential benefits from the time of machine ownership were strongly determined by the limited size of the crop available for threshing. Calculations on the profitability of machine threshing highlight this point. Suppose all sorghum and wheat harvested in Kanzara are threshed by machine. Under some reasonable assumptions based on the village study data and Singhal and Thierstein (1979), we estimate an internal rate of return to management and capital of over 100 percent when one machine of 300 kg per hour capacity threshes all available produce. If another thresher of the same capacity is brought into the village and the two machines equally divide the harvest, expected profitability on each thresher falls to 30 percent. The addition of a third and fourth machine of identical vintage lowers the internal rate of return on investment to 13 and 4 percent, respectively.

The principal losers were male hired laborers, who were displaced by machine threshing; however, a diversified output mix mitigated the potential adverse impact on male hired laborers' welfare. Because cotton is the dominant crop in Kanzara, we did not see marked labor displacement from machine threshing. Comparing the before and after employment picture, we find that in 1975/76 sorghum threshing accounted for about 6 and 11.1 percent of male labor hired for crop production during the peak threshing fortnights in October (for hybrid sorghum) and December (for local sorghum), respectively. By 1977/78, these percentages had fallen to 2.6 and 5.1. Thus, the net reduction in male hired labor demand at the village level was not that large, between 3 and 6 percentage points. We would expect to see much greater labor displacement in rainy season fallow, post-rainy season sorghum-growing villages like Shirapur, where postharvest operations comprise a large share of the wage bill (table 10.3).

We can think of few good reasons for public investment in research or in subsidies of machine threshing technology in India's SAT. The private sector seems quite capable of responding to current demand with simple innovations. Moreover, as the results from the Kanzara case study amply demonstrate, the social benefits to machine threshing are most unlikely to exceed the private benefits.

Nutrition

The type and extent of agricultural research, whether on food or on nonfood crops, have implications for human nutritional status. Policy makers and research administrators can significantly alter the nutritional outcomes of agricultural research through changes in emphasis on commodity priorities, commodity characteristics, technology characteristics, and production systems (Pinstrup-Andersen, Berg, and Forman 1984). In the subsections that follow, we adhere to the Pinstrup-Andersen, Berg, and Forman taxonomy to describe some of the attempts to incorporate nutritional considerations into the design of research and choice of technology strategies for rural households in India's SAT.

Commodity Priorities

The most significant determinant of nutritional outcomes from technological change is the choice of the commodity portfolio on which research is conducted. In assessing the likely nutritional implications from alternative commodity strategies, it is important to take account of direct, cross-price, and income effects of demand (Pinstrup-Andersen, de Londono, and Hoover 1976). Unless one does, inferences drawn can be incorrect. Pitt (1983), for example, has shown that the cost per unit nutrient is a poor and often misleading guide in identifying candidates for commodity price subsidization with an objective of enhancing energy and nutrient status.

All-India estimates of demand parameters for several important SAT commodities are available for five expenditure groups in both rural and urban India (Murty 1983), but similar estimates for the SAT or for regions within the SAT are not yet available. One way to examine how much technological change in different commodities results in enhanced energy and nutritional status is to simulate the effects of a relative supply increase. In this section, we report two such "back-of-the-envelope" calculations: the first is founded on the all-India data and Murty's estimated demand parameters; the second blends the information on dietary intake in chapter 9 with Murty's estimates.

Before turning to those simple simulations, several features of Murty's estimates, based on many rounds of National Sample Survey data from 1950/51 to 1970/71, merit discussion. The average budget shares for the five rural and five urban expenditure classes and the nine commodity groups are presented in figure 10.3. The dominance of the superior cereals (wheat and rice) is marked in the all-India expenditure pattern in all income groups. Sorghum, pearl millet, and other cereals only loom large in the expenditure patterns of the poorest rural and urban consumers.

As is usually the case, the commodity expenditure elasticities are inversely related to income or (to be more precise) expenditure levels.

Except for chick-pea and other cereals, low-income rural groups have expenditure elasticities greater than unity for all other commodity groups. Their demand for sorghum, pearl millet, edible oils, and other pulses is more expenditure elastic than for the other food commodity groups. For urban households, expenditure elasticities for coarse grains and other pulses are much lower than for rural households within the same income group, suggesting that those commodities are much less preferred in urban than in rural areas.

Note that the magnitude and sign of the coarse grain expenditure elasticities are at variance with previously received wisdom. FAO (1971) estimated the income elasticity of consumption demand for those crops to be -0.2. The NCAER (1962) estimated figures of -0.3 for rural India and -0.6 for urban areas. Bapna's (1976) corresponding figures were 0.10 and -0.35. For Africa, FAO (1971) reports positive elasticities in the range from 0.2 to 0.6.

As usual, the absolute size of the estimated price elasticities of demand for food are inversely related to per capita expenditure. For low-income groups in both rural and urban India, food demand is highly price elastic especially for cereals, coarse grains, chick-pea, and other pulses. Technological change shifting supply functions and subsequently leading to price declines should result in substantial increases in the consumption of these basic food grains and could considerably enhance nutritional status.

To make quantitative predictions of the nutritional implications of alternative commodity research strategies, the estimated elasticities have to be translated into nutrient dimensions. The simplest way to make this translation is to use nutrient content coefficients and scale the income and price elasticities into nutrients (Murty 1983; Murty and von Oppen 1985). Directly converting the quantities consumed into nutrients and then reestimating the whole system would probably have resulted in much smaller absolute values of the elasticities than what Murty estimated with the scaling approach (chapter 9). Nonetheless, in this section we are more interested in the relative importance of commodity groups in conditioning nutritional outcomes than in the size of their effects. The energy and protein price elasticities of demand are much larger (in absolute value) for superior cereals (wheat and rice) than for other food grains, even for low-income households, reflecting the dominance of wheat and rice in the diet.

To illustrate the differential effects of technological change at the national level, we have calculated the consequences of a 10 percent increase in equilibrium supplies of each commodity group on the quantities of energy and protein demanded. We first calculated the population weighted average price elasticities of demand for the crops on an all-Indian basis and applied the 10 percent (equilibrium) supply shifts to

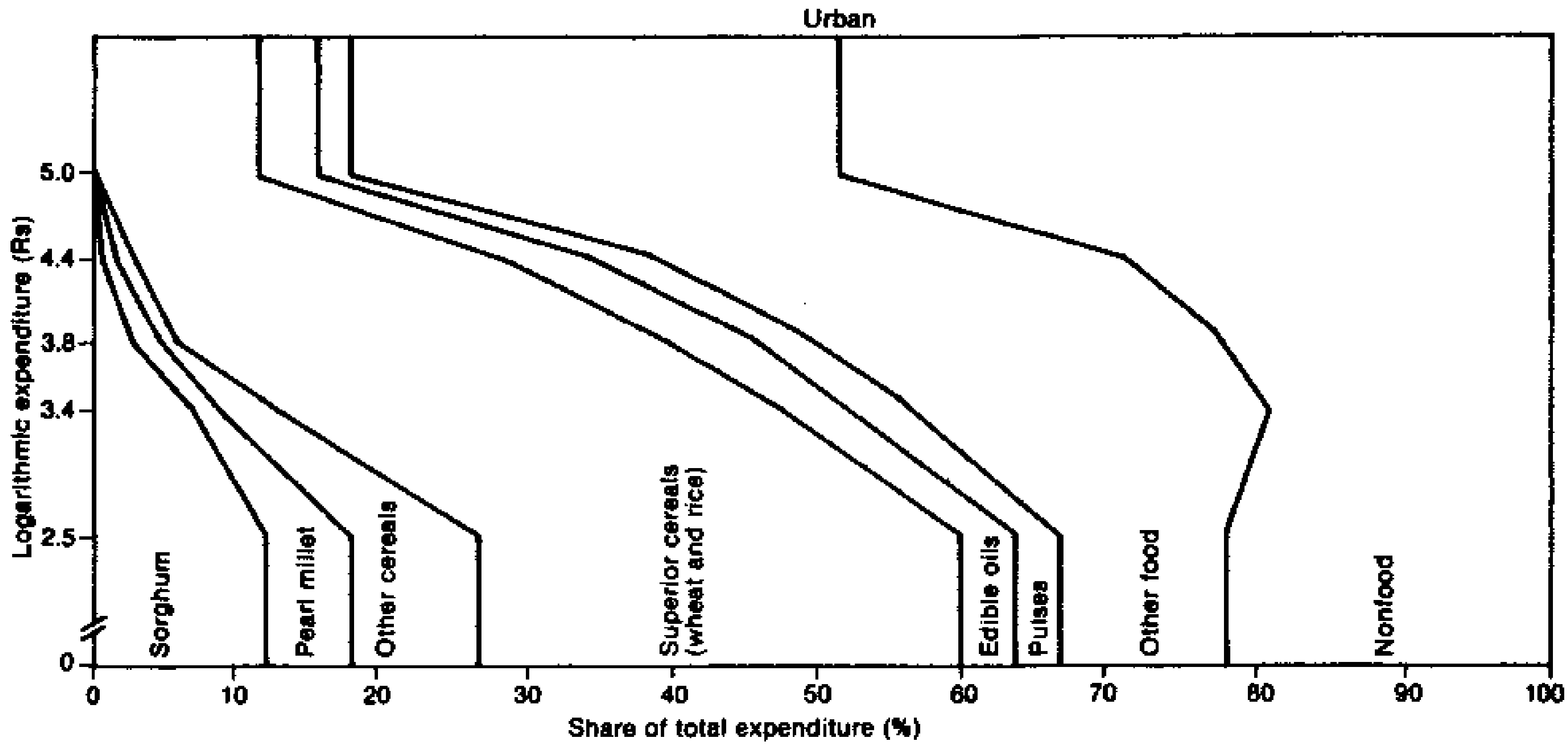
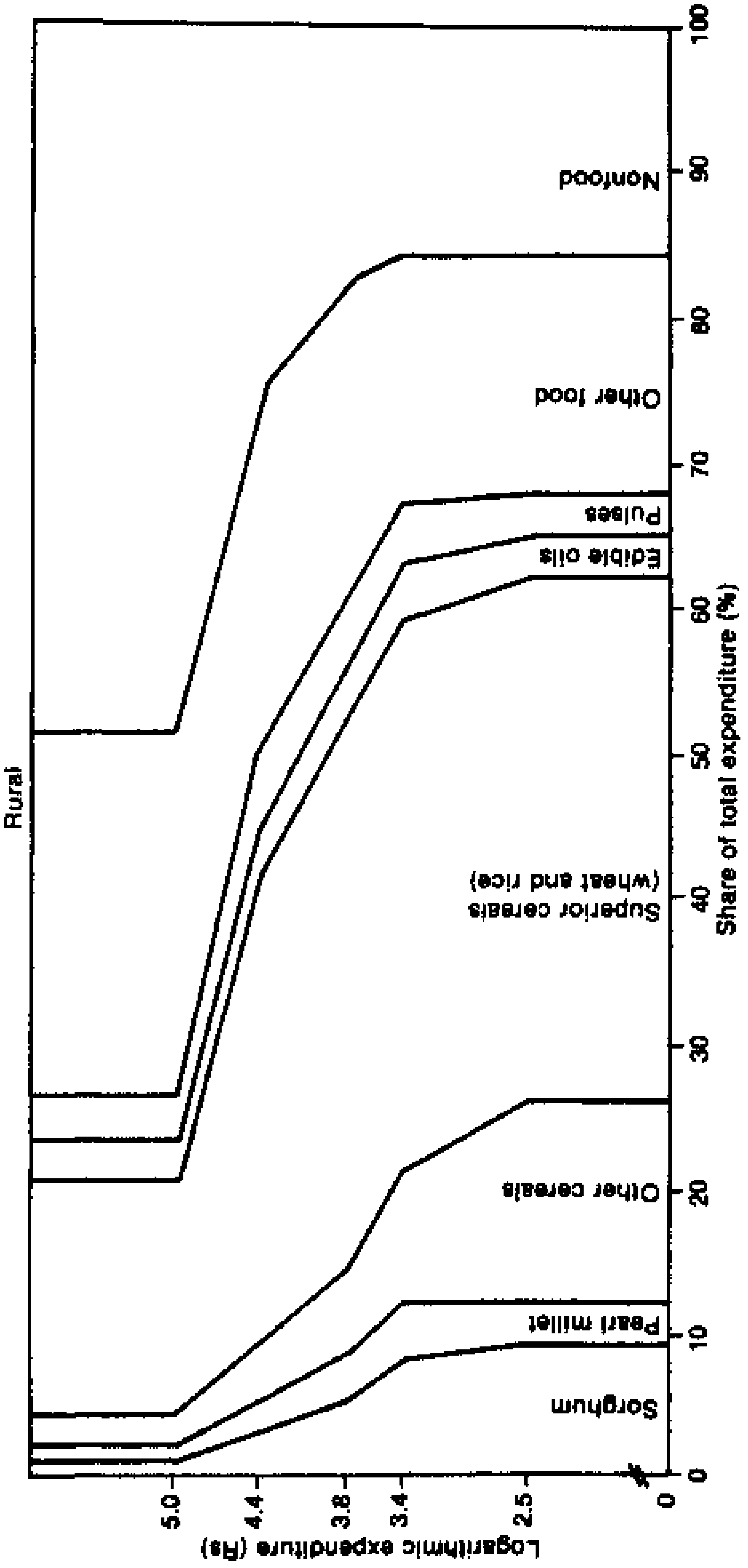


Figure 10.3 (*above and opposite*) Average All India budget shares of total expenditure on commodity groups for rural and urban consumers

Source: Constructed from Murty and von Oppen (1985).



Rural
Nonfood
Other food
Pulses
Edible oils
Superior cereals
(wheat and rice)
Other cereals
Pearl millet
Sorghum
0
10
20
30
40
50
60
70
80
90
100
Share of total expenditure (%)
5.0
4.4
3.8
3.4
2.5
0
Logarithmic expenditure (Rs)

these to estimate the price effects. These ranged from a 7.8 percent price reduction for pearl millet to 19.6 percent for edible oils. These price falls were then employed with the nutrient elasticities to determine the increase in equilibrium national demand for energy and protein resulting from the supply shifts (table 10.5).

We have not accounted for long-run general equilibrium effects in this analysis. In their scenario analysis of the effects off a sharp rise in sorghum productivity in Indian SAT regions, Behrman and Murty (1985) found relatively small changes in the equilibrium supplies and demands of other commodities. That result stems largely from the initially small cross-price effects in consumption and production.

Proportional productivity gains in rice and wheat will have a much more dramatic effect on the energy status of Indian consumers at the national level, even those from low-income households, than will improvements in productivity of crops like coarse grains, which have been traditionally regarded as poor people's staples. The ubiquitous nature of rice and wheat in India since the green revolution, their relative price inelasticity of demand, and their 45 percent contribution to the energy in diets of low-income rural households (Murty and von Oppen 1985) place them at the top of the nutritional priority agenda for allocation of national resources to agricultural research. The same finding applies to protein. Improvement in pulses would not seem to be as potent a means for enhancing protein consumption in India as improvement in rice and wheat. Even though the price effects are about the same, protein consumption would rise at least three times more for the lower income rural and urban consumers for an equal percentage shift in the supply of rice and wheat than for an equivalent change in pulse supply (table 10.5).

The nutritional potential of the superior cereals and of a yield-oriented research strategy for their improvement was also borne out by a study of the effects of the green revolution in wheat in six Indian states (Ryan and Asokan 1977). Using trend analysis, Ryan and Asokan concluded that total annual food grain production in 1974/75 in the six states would have been 13.4 percent less had the HYVs of wheat not been introduced. That calculation took into account the reduction in production of pulses, winter rice, and barley that occurred as a result of the increased wheat production. Total lysine production would have been about 6.4 percent more had HYVs not been introduced. This small reduction in lysine was an acceptable price to pay for the substantial increases in production of food grains, energy, and protein which resulted. When the record production year of 1975/76 was compared with projected pre-green revolution trends, the production of all nutrients, including lysine, showed a substantial increase over what would have occurred had pre-green revolution conditions prevailed.

A major and transparent shortcoming of the previous analysis is that

Table 10.5. Percentage effect of a 10 percent increase in equilibrium supply of various commodities on final demand for nutrients in India

Expenditure Group (Rs/Capita/Month)	*Rice and Wheat*		*Sorghum*		*Pearl Millet*		*Edible Oil*		*Pulses*	
	Calories	*Protein*	*Calories*	*Protein*	*Calories*	*Protein*	*Calories*	*Protein*	*Calories*	*Protein*
Rural										
0–24	4.97	3.85	1.58	2.08	0.53	0.72	0.33	0.06	0.38	1.18
25–34	6.07	4.96	1.15	1.44	0.67	0.88	0.47	0.20	0.54	1.31
35–55	5.06	4.60	0.52	0.58	0.27	0.34	0.49	0.27	0.61	1.23
56–100	3.57	3.12	0.20	0.23	0.22	0.33	0.45	0.22	0.49	0.90
>100	2.29	2.06	0.19	0.22	0.19	0.24	0.53	0.10	0.44	1.03
Urban										
0–21	7.14	7.03	0.96	1.13	0.11	0.18	0.61	0.14	0.57	1.49
22–34	6.24	5.56	0.83	1.00	0.46	0.58	0.76	0.18	0.59	1.23
35–55	4.56	4.20	0.25	0.38	0.12	0.16	0.86	0.27	0.66	1.39
56–100	2.50	2.23	0.15	0.19	0.05	0.07	0.96	0.24	0.52	1.08
>100	1.46	1.40	0.03	0.04	0.00	0.00	0.71	0.16	0.16	0.72
Price elasticity of demand	−0.77		−1.10		−1.29		−0.51		−0.61	
Price falls (%)	14.3		9.1		7.8		19.6		16.4	

the estimates of the demand parameters were based on national-level data. The coarse grains dominate diets of rural people in large regions of the SAT states of Maharashtra, Gujarat, Andhra Pradesh, Madhya Pradesh, Karnataka, and Rajasthan. For example, in the dietary survey reported in chapter 9, cereals on average accounted for more than half the energy, protein, thiamine, and niacin intake in each of the study villages (figure 9.2). In the Maharashtra villages, those cereals were the coarse grains, particularly sorghum, which provided over two-thirds of the dietary calories of adults in the landless and small farm household groups. Thus, although the nutritional impact of successful research on coarse grains at the national level may be submerged by the consequences of research on wheat and rice, this is unlikely to be true in some large SAT regions.

The incidence of marketed surplus also varies across the cereals. Only 13 percent of sorghum and millet production was marketed in India in 1976/77, whereas 32 percent of the wheat and 27 percent of the rice found their way to markets (von Oppen and Rao 1982). Interregional trade in coarse grains is also concentrated primarily within the SAT regions, where these crops are traditionally grown and consumed (von Oppen, Raju, and Bapna 1980). It can therefore be expected that cost-reducing technological change in the coarse grains will largely accrue to the SAT regions and will generate sizable benefits to low income consumers in these areas.

Murty's estimated elasticities can be combined with the village study nutrient intake data to make an inial approximation of the nutritional impact of increasing sorghum output in a predominantly sorghum-consuming region exemplified by the Maharashtra villages. Ignoring cross-price elasticities of demand and assuming a 10 percent supply shift for sorghum (causing a 9.1 percent sorghum price decrease), we arrive at a sorghum substitution effect of 21 percent using -2.30 as the price elasticity of demand of sorghum for the poorest rural households and an income effect (because of the price elastic demand) of -5 percent using a calorie expenditure elasticity of 1.02. Applying the former percentage to coarse grain calorie consumption from the diet survey of 1,785 kcal for adult males and 1,576 for adult females in the Maharashtra villages and the latter percentage to their total calorie consumption of 2,756 and 2,478 respectively, leads to a net increase in calorie consumption of 8.5 percent for men and 8.3 percent for women as a result of the 10 percent increase in sorghum production. These are more than five times the changes in energy intake recorded in table 10.5 based on the all-India calculations. Clearly, regional differences are potentially important in predicting the nutritional impact of alternative commodity allocations in agricultural research. Estimating regional demand parameters will be a necessary first step to sharpen those predictions.

Commodity Characteristics

Breeders have attempted to incorporate many desirable traits into the improved cultivars of crops on which they conduct research. These include increased yield potential, disease, drought and pest resistance, improved protein content and amino acid composition, photoperiod insensitivity, shorter duration, and enhanced consumer acceptability. Unfortunately, nature rarely if ever provides any free lunches and the introduction of one desirable attribute is generally attained at the expense of others. Thus, determining the appropriate mix of commodity characteristics to aim for in research programs is not easy, because trade-offs are common. Nutritional considerations must compete with other traits for the attention of research administrators.

Until the early 1970s, the conventional wisdom was that the major nutritional problem facing developing countries was a "protein gap." Nutrition and research programs were aimed at increasing protein content and quality in human diets. One such enterprise was the high-lysine maize program initiated in the early 1960s at Purdue University and the International Maize and Wheat Improvement Center (CIMMYT) which served as a model for other cereal-breeding programs such as those at ICRISAT. Other examples were the various food fortification programs in developing countries.

Reviews of nutrition studies conducted in SAT countries of Africa and South Asia by Ryan, Sheldrake, and Yadav (1974) and Ryan (1977) clearly demonstrated that the nutrient deficiencies in SAT diets were not protein or amino acids but primarily calories, vitamins, and minerals. That conclusion applied to both the poor and affluent in urban and rural areas. Results from the detailed diet and nutrition study described in the previous chapter confirmed that conclusion.

No doubt a significant cause of the altered nutritional picture which began to emerge in the early 1970s was the downward revisions in the recommended daily allowances of protein and to a lesser extent of calories by the Food and Agriculture/World Health Organisation (FAO 1971) expert committee over recent years, as discussed in Poleman (1981). Eminent scholars like Sukhatme (1972, 1973) and Clark (1972) led the growing numbers of critics of the protein-gap philosophy.

A review of the evidence from feeding trials by Ryan (1977) also showed that while nutritionally vulnerable groups like pregnant and lactating women had calorie, vitamin, and mineral deficiencies, fortification of their diets with protein and lysine would be of doubtful value. Increasing intakes of existing dietary components would be a preferable strategy, providing much-needed calories and augmenting protein and amino acid consumption. The need for vitamin and mineral enhancement would likely remain.

Grain quality improvement by genetic means would also not help the vulnerable groups a great deal. Even with significant progress in improving grain quality, the amounts eaten are such that their overall dietary position would be little improved. They will remain vulnerable because their vulnerability lies mainly in lack of food. More and better protein is likely to be the answer to childhood malnutrition only for populations subsisting largely on starchy roots, which are low in protein (McLaren 1974). These represent only about 5 percent of the world's malnourished and they reside mainly in the humid tropics.

The inference from the above discussion is that crop improvement programs for India's SAT should give major emphasis to yield improvement. Improved protein and lysine contents should not rate a high priority on desirability criteria. That inference is strengthened when one considers feasibility criteria. Usually an inverse relationship exists across genotypes of cereals and legumes between protein percentage and yield per hectare and between protein percentage and the lysine percentage of protein. Apparently, it is extremely difficult to successfully combine the attributes of yield, protein content, and quality in one variety. The above inverse relationships, together with the experience of the high-lysine maize program at CIMMYT, caution against major breeding programs directed at incorporating all three attributes.

Because in the SAT nutritional deficiencies are primarily calories, vitamins, and minerals, breeding for yield increases (even at the expense of some protein content if this eventuates) ought to rank at the top of the priority list. Breeders could also address the possibility of selecting food grain cultivars with superior contents of calcium, iron, copper, zinc, vitamin A, and Vitamin B-complex. All have been found to be deficient in Indian diets. For a major sorghum-eating state like Maharashtra, sorghum contributes up to 50 percent of the calories and iron, 18 percent of the calcium, and 20 percent of the vitamin A in the diets of the lowest income group (Ryan 1977). Thus, the scope for reducing deficiencies in these nutrients by screening cultivars in sorghum-breeding programs could be fairly substantial. Belavady (1977) also suggests that among improved Indian sorghum cultivars there is a wide range in content of tannins (which affect iron absorption and protein utilization), beta-carotene, iron, copper, calcium, and zinc. But the amount of leverage that agricultural research has in alleviating human micronutrient deficiencies is debatable.

Genotype by environment interactions further diminish the feasibility to breed or even screen for nutrient traits. The ranking of cultivars with respect to nutrient contents changes substantially depending on when and where they are grown. For example, crossing of the high-lysine Ethiopian sorghums both at ICRISAT and in the All-India Coordinated Sorghum Improvement Project has not yet produced viable lines which yield well and retain the protein content and quality of the parents.

Most IARCs now recognize that the nutritional rewards of yield-oriented research approaches are likely to be far greater than strategies which emphasize the improvement of the nutrient content of grains (Ryan 1984b). At ICRISAT, nutritional improvement now represents an insignificant part of the research portfolio of most crop improvement programs (Jodha 1984). Prior to 1979, nutritional considerations were much more important, especially in the sorghum program. Emphasis has shifted to incorporation of desirable food and consumer quality traits and reduction of antinutritional factors in these programs. The vast majority of projects focus on developing improved cultivars with resistance/tolerance to drought, pest, disease, and other environmental stresses together with greater yield potential.

Additionally, screening cultivars of the cheaper energy sources for preferred evident quality parameters such as seed size, color mix, cooking quality, storability, etc., can help ensure that the ultra-poor will accept increased supplies of these commodities as a result of successful research. If the poor purchase the more expensive varieties with preferred evident characters in short supply, then successful evident quality breeding programs can contribute significantly to enhancement of the nutritional welfare of the poor. Therefore, a trade-off between increased production and improved food grain quality (as Lipton [1983a] suggests) is not inevitable. Good examples of the absence of such a trade-off are the second generation sorghum hybrids CSH-9 and CSH-11. Their food quality is preferred to first generation hybrids such as CSH-1, CSH-5, and CSH-6. They are priced 10 to 20 percent higher than those hybrids but considerably below the preferred but much lower-yielding local sorghum varieties. To the extent that the later hybrids with superior food quality and hence greater profitability can displace more local sorghum than the earlier hybrids, sorghum production will increase. The poor will benefit, if not by consuming the later hybrids directly, then by their impact on the price of inferior hybrids or on other crops.

Technology Characteristics

Characteristics of prospective technologies such as the seasonality of operations, the extent of employment creation or displacement, and sex bias have nutritional consequences. The effects are often complex. Different characteristics imply different energy expenditure patterns, which may or may not coincide with food availability. Different characteristics also can have differential impacts on household income, which in turn may influence nutritional status.

To conclude this section on nutrition, we return to the seasonality of labor demand, one technology characteristic that has received considerable attention in the literature. India's SAT with high population densities is substantially different from Africa's SAT, and the recommendation of Chambers (1982), Longhurst and Payne (1979), and Lipton (1983a) that improved technologies should avoid exaggerating labor peaks in the wet season lest energy balances be upset does not do justice to the production context in these study villages. To advocate as Longhurst and Payne do—appropriate mechanization, chemical weed control, and use of high-yielding varieties that are less time constrained in the wet seasons when energy balance is apparently negative—is to ignore three considerations.

First, creation of labor peaks is one of the few avenues whereby laborers can expect to increase their wage rates and employment opportunities. With expenditure elasticities of demand for calories around 1.0 for low-income groups in rural India, creation of wet season labor peaks and consequent wage and employment increases could result in a net improvement in nutritional status. Landless and small farm families, who rely mostly on wage labor for their sustenance, would benefit most. Labor-saving technologies can only make their economic position worse.

Second, in situations where soils such as the Sholapur Vertisols, which are spread over large tracts in SAT India, have a high moisture-holding capacity, peak labor activities occur mostly in the dry season of surplus food grain availability, as crops are grown in that season on residual soil moisture. In such agroclimatic environments and in villages with considerable irrigation, a trade-off between additional work activity in the peak labor periods and energy balance is not inevitable. The problem mainly emerges in areas such as Aurepalle that have Alfisols (red soils) with low moisture-holding capacity and little irrigation, where crops are grown only in the wet season, corresponding to the period when food grain availability is low and labor demand high. To a lesser extent, seasonality rears its head in regions such as Akola that have medium-deep to shallow Vertisols with moderate moisture-holding capacity. Here, as in Dokur, crops are grown during both wet and dry seasons.

Finally, seasonality did not explain much of the variation in calorie intake or in anthropometric status among individuals in the study villages. If seasonality were an important determinant of caloric intake and anthropometric status, then the case for paying more attention to peak season energy expenditures of different technologies would be much stronger.

Food Security

Improved technologies can have consequences for food security at several levels. At the micro level, improved technologies can affect the variability of household income and consumption; at the more macro level, they can influence the variability in regional and national production. With regard to agricultural research, the policy objective of food security is synonymous with yield stability, which figures in the mandate of many crop research institutes, particularly those located in variable production environments like India's SAT.

Agricultural research on both management practices and genetic improvements has implications for yield stability. For example, in West Africa's SAT improving soil fertility in general and enhancing phosphorous availability in particular appear to be the most effective means to achieve yield stability in the short term (McIntire and Fussell 1985). In this section, we focus only on genetic improvement as a means to achieve yield stability.

Increased production variability can flow from two yield-derived sources: increased yield variance at the farm level and higher yield covariances across regions, reflecting a growing similarity of varietal technology. The outstanding example, described earlier in this chapter, of varietal change increasing production covariance in Indian agriculture was the outbreak of downy mildew on the first series of pearl millet hybrids in the early 1970s. Since the advent of the green revolution, sorghum yields have also become increasingly covariate across the major growing districts (Walker 1989a). Increasing covariance is to be expected because the most popular and widely grow hybrids are descended from the same male parent.

At the national level, a judicious mix of international trade and storage policies can cost effectively offset most if not all the instability costs of increasing yield covariance. In the absence of efficient policies, investing in crop research to maintain and enhance resistance to yield reducers and to broaden genetic variation will have additional stability benefits over and above returns to increased production. A more regionally oriented varietal release strategy could also help in providing material more locally suited to the specific requirements of different regions, thus reducing the scope for covariate outcomes. In any case, more covariate regional yields were probably a small price to pay for productivity growth attributed to the sorghum and pearl millet hybrids.

In this section, we focus on yield stability at the farm level. Although much discussed, yield stability is conceptually and empirically elusive (Anderson, Hazel, and Evans 1986). Before examining the microconsequences of yield variability, we briefly describe some of the conceptual and measurement ambiguities in the next subsection.

Yield Stability: Concept and Measurement

To economists, more stability (at least in theory) implies either a fall in variance, holding mean yield constant, or a decrease in the incidence of lower-yielding outcomes for a given mean yield. But, in practice, yield stability is not easily cast in the economist's jargon of "mean-preserving spreads" to define risk (Rothschild and Stiglitz 1970). When farmers change varieties, mean yields are almost always affected, implying a mean-variance trade-off.

These differences in concept are illustrated by the frequency distributions of yield for hypothetical traditional (T) and improved (I) varieties in figure 10.4. The risk analyst feels at home in panel a. The mean yields of T and I are the same, and switching from T to I is unambiguously accompanied by increasing yield variance. What many people, including many biological scientists, mean by yield stability is represented in panel b. Changing from T to I is characterized by a reduction in low-yielding outcomes and, in the process, mean yield also increases. Under more favorable conditions, I is also somewhat more input responsive than T. In panel b, variety I could be the result of screening or breeding for sources of resistance to biotic and abiotic stress. Moving from T to I in panel b is clearly economically beneficial (assuming costs do not change and I does not fetch an inferior price to T) because mean yield increases.

Panels a and b do not begin to exhaust the conceptual and empirical definitions of yield stability. To plant breeders, yield instability is identified with yield crossovers, depicted in panel c of Figure 10.4. Input-responsive variety I with higher yield potential performs better in higher-yielding environments, while T with lower yield potential gives heavier yields than I in the lower-yielding environments.

What is the incidence of crossovers? Crossovers are usually measured from multilocational trial data. The mean yield at each location is the environmental index. Inferences on crossovers and on yield stability are often difficult to draw because the emphasis in multilocational varietal testing is on adaptability; that is, which cultivars yield well in which locations. How well they yield over time is very much a secondary issue. Entries are seldom repeated for more than a few years; therefore, time series data on varietal performance are rarely available. When such data are available, variation across space (adaptability) and variability over time (stability) are confounded in the standard regression approach—classic references are Yates and Cochran (1938), Finlay and Wilkinson (1963), and Eberhart ad Russell (1966)—used by plant breeders to analyze varietal testing data (Evenson et al. 1979; Binswanger and Barah 1980). Additionally, information (other than on yield) on rainfall, disease and pest incidence, and other yield reducers is usually not collected; thus, interpretation of data from large cooperative varietal testing trials is often problematic at best.

A second major empirical problem is that the testing environments are often not representative of farmers' fields. Trial results are usually skewed toward the higher-yielding environments in panel c. Most multilocational varietal testing is done in relatively well-protected, fertile environments. Some national varietal testing programs also stipulate that

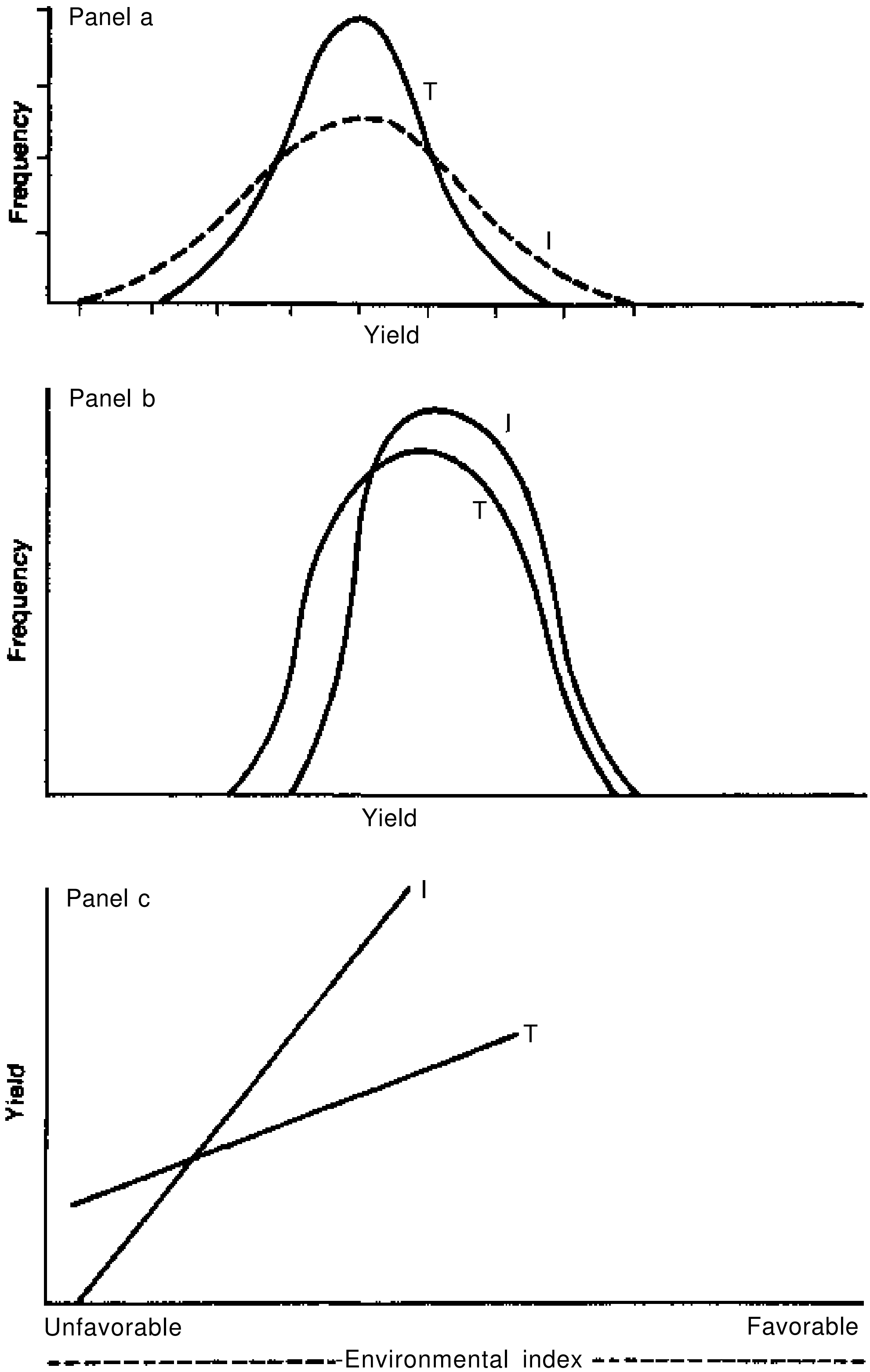


Figure 10.4 Alternative definitions of yield stability

mean trial yields have to exceed threshold levels, such as the national average, before they are subjected to analysis. Such requirements mean that little if any information is gathered on the truly low-yielding environments. Breeders have to make sure that their material does well in the better environments, otherwise the chances of release are remote. Finally, and this is primarily a problem of international centers, the rate of response (in the return of information on varietal yield trials) is usually much less than 100 percent. The potential correlation of nonresponse with the lower-yielding locations further biases the results toward the higher-yielding environments.

Research reported in Barah et al. (1981) is fairly indicative of the type of results one obtains with large, multilocation, multiyear data sets. The 2 : 1 standard deviation : mean trade-off ratio—the inverse of Z in table 8.2—reflected in farmers' intermediately to moderately risk-averse choices in the experimental games in table 8.3 was used to evaluate sorghum varietal performance in yield and variance dimensions. The variance of crop yields was partitioned into two components: stability over time and adaptability across locations (Binswanger and Barah 1980). Three varieties and two hybrids were risk efficient; that is, no other genotype achieved the same mean yield and also had a lower standard deviation or for a given level of standard deviation had a higher yield. The preferred cultivar by intermediately to moderately risk-adverse farmers was CSH-5, the highest-yielding genotype. Rankings based on risk performance and yield were highly correlated. For this data set, there was little conflict between yield potential and stability. Given the array of yield reducers that attack hybrid sorghum in farmers' fields in the study villages, one wonders whether these results would hold up in less protected conditions.

A contrasting result is obtained from a very large and comprehensive groundnut experimental data set in which entries were systematically submitted to both favorable and unfavorable states of nature (Rao and Williams 1985; Rao, Williams, and Singh 1985). Treatments consisted of twelve patterns of drought with eight intensities within each pattern giving ninety-six states of nature. The crossing varietal response line in figure 10.5 suggest a substantial trade-off in risk and yield potential (Bailey 1988). Under the more favorable events, where mean average yields across all entries are higher, varieties such as entry number 8, with higher yield potential, perform well. Under more adverse conditions, some varieties (like number 5), with lower yield potential, do better. When conditions are harshest, the yield of some of the high potential varieties is nil. Depending on the relative incidence of these events, it would be better to grow the high-yield potential types in some environments, the lower but less variable yielding ones in others. Not surprisingly, crossovers are more likely to be reported in crops acclimated to harsh growing conditions. For example, crossovers have been documented in barley in the arid tropics under marginal growing conditions (Weltzien and Fischbeck 1985).

The demonstration that crossovers contributing to yield instability are likely in some SAT environments begs several questions about their welfare consequences. Could less variably yielding varietal technologies improve the welfare of farm households by generating substantial reductions

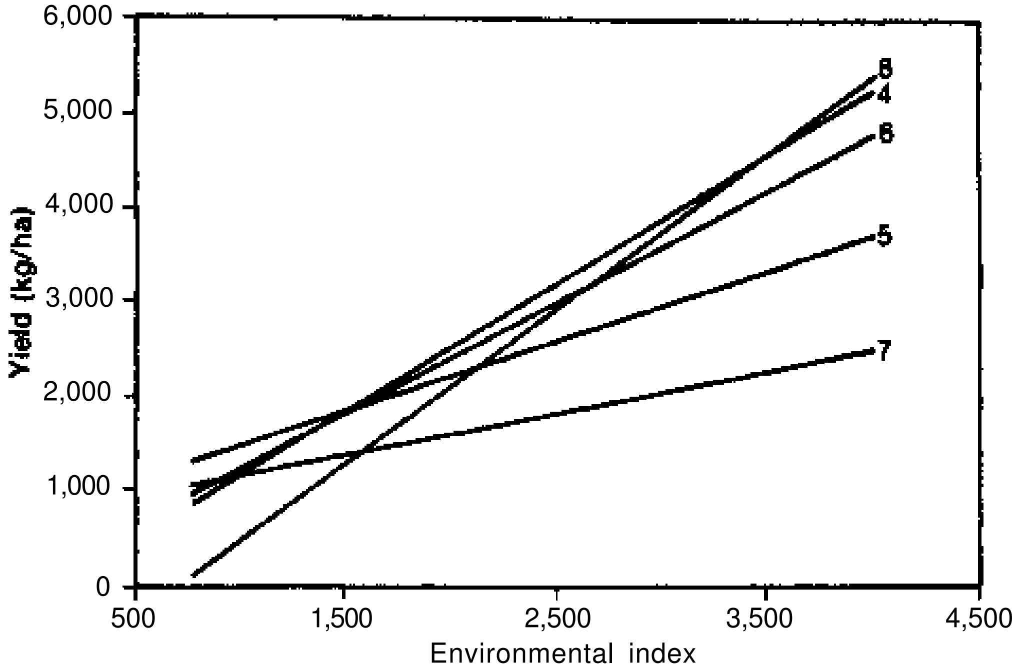


Figure 10.5 Crossovers in yield of selected groundnut varieties in different production environments
Source: Bailey (1988:182, figure 7.6).

in the variability of household income and consumption? Could such varietal technologies have sizable risk benefits for India's SAT over and above their consequences on output, equity, and nutrition? Those questions are addressed in the next two subsections. Their answers tell us something about the desirability of yield stability per se.

Consequences of Improved Yield Stability for Farm Households

Farm level benefits to enhancing yield stability can be divided into two components (Newbery and Stiglitz 1981). Risk benefits measure what the farmer would be willing to pay to achieve a less variable income and consumption stream. As pointed out in chapter 8, how much farmers will be willing to pay depends on their preferences for risk taking, their perceptions of how much alternative technological options would buy in terms of lessened household income variability, and their ability to adjust to those income risks through transactions in credit and asset markets and changes in storage. Transfer benefits are associated with a longer-term impact and are largely related to how more stable-yielding varieties and hybrids offer risk-averse farmers opportunities to plant large areas of the crops for which such cultivars have been released.

The magnitude of risk benefits can be assessed by repeating the simple simulation that we carried out in chapter 8 for crop insurance (Walker 1989b). We direct our attention to the sample households that planted the common cropping systems listed earlier in that chapter. Comparing the coefficients of variation of household per person income with and without yield stability gives a good approximation of the size of risk benefits derived from reducing yield variability of a common crop. In order to make the case as favorable as possible for yield stability, we assume that yield stability is equivalent to zero variance; that is, each household receives its simple mean yield each year over the period of analysis.

If perfect yield stability significantly decreases fluctuations in labor demand, risk benefits to producers will be underestimated. Similarly, to the extent that improved yield stability results in less fluctuations in area planted to the stabilized crop, our partial result could understate longer-term risk benefits. Nevertheless, perfect yield stabilization is an extreme assumption. Presently and into the foreseeable future, it is not even remotely feasible in dryland agriculture in India's SAT. Such an extreme scenario should more than compensate for the partial focus of the analysis to be biased toward underestimating risk benefits.

For that extreme case of perfectly stable yields, we see in table 10.6 that the risk benefits range from modest to negligible. For no crop does the mean proportional risk premium exceed 5 percent of mean household income. Ironically, risk benefits are highest in irrigated paddy, the crop with the lowest mean CV of yield in table 10.6. The importance of paddy in household income largely explains this counter-intuitive result.

For the common dryland crops, the largest risk benefits would accrue from stabilizing the yields of castor in Aurepalle; however, perfect yield stabilization would only reduce household income variability by about 5 percent. Such a modest change would be equivalent to less than 2 percent of mean household income.

In light of the discussion in chapter 8, these results are not surprising. The size of the risk benefits is limited by the importance of other sources

Table 10.6. Simulated risk benefits from perfect crop yield stabilization

Crop	*Village*	*Farms (N)*	*Mean Yield Variability (% CV)*	*Mean Household Income Variability (% CV)*	*Mean Reduction in Household Variability (% CV)*	*Mean Proportional Risk Premium (% CV)*[a]
Irrigated paddy	Aurepalle	9	31	46.6	15.4	2.9
Castor	Aurepalle	23	68	44.8	4.4	1.2
Sorghum	Aurepalle	21	66	34.4	1.0	0.2
Sorghum	Shirapur	21	69	34.0	-3.9	-0.2
Cotton	Kanzara	26	44	33.0	0.8	0.2
Hybrid sorghum	Kanzara	18	66	34.4	0.6	0.3

[a]% of mean household income from 1975/76-1983/84.
Source: Walker (1989b).

of household income; namely, labor earning, a multiplicity of cropping systems, and area variability characteristic of dryland agriculture.

The transfer benefits are not as easily measured and are very location specific. From our earlier discussion of the common cropping systems in chapter 3 and from the risk analysis in chapter 8, we expect that of the common cropping systems the transfer benefits would be largest for hybrid sorghum in the Akola region. Compared to its chief competitor (the cotton/pulse intercropping systems), hybrid sorghum is characterized by significantly greater yield and revenue variability. Form 1975/76 to 1980/81 sole-cropped hybrid sorghum was more profitable by about Rs 150 per hectare than the cotton intercropping systems, but the coefficient of variation of net crop income was also greater—91 compared to 58 percent. We would expect that the release of more yield-stable cultivars would be accompanied by an area shift out of cotton and into hybrid sorghum. For example, a 30 percent reduction in the coefficient of variation of hybrid sorghum yield, holding mean yield constant and assuming mean levels of risk aversion estimated in the experimental games described in chapter 8, would lead to an initial increase of 46 percent in area planted to sorghum (Walker and Subba Rao 1982b). Because the demand for sorghum is price inelastic, these initial transfer benefits would be eroded by sorghum price falls in subsequent periods as the benefits would increasingly be transferred to sorghum consumers. Later, in response to changing prices stemming from those supply and demand changes, land would be shifted back to cotton. Overall, the gains, especially the risk benefits, from improving yield stability at the farm level are small.

Conclusions

In spite of relatively high population densities, land improvements in dryland agriculture face stiff competition from well and tank irrigation in the process of agricultural intensification. The profitability of such improvements hinges on new components, such as cheap, easy to apply sealants to cost effectively reduce seepage, becoming available. A more selective approach is also needed to order location specificity so that land and water management components respond directly to physical constraints perceived by farmers.

An advocacy for technology targeting to accommodate the diverse needs of farmer groups with regions was found wanting on several counts. Our lack of enthusiasm for technology targeting was based on the surprising degree of parity in the factor use ratios between large and small farm groups, the absence of readily explainable behavioral differences in risk attitudes, and an appreciation for the costs of innovation. Policies which are aimed at enhancing the performance of factor markets and the accessibility by owners of small farms to them are likely to be more successful in achieving a more equitable distribution of the benefits to technological change than are attempts to design basically differentiated technologies for small farms.

That is not to say that it is undesirable to have differences in the degree or intensity of use of technology among farms of different sizes. Several authors (Ryan and Subrahmanyam 1975; Mann 1977; Walker 1981b; Byerlee and Hesse de Polanco 1986) have demonstrated the value of a gradient approach to technology verification and extension to provide more information on which clusters of practices are most profitable and compatible with farmer circumstances.

The need for assessing the direct employment consequences of technological change will continue to be greater in irrigated than in dryland agriculture. We were quite pessimistic that tractorization and herbicides would make their presence felt on dryland cropping in the study villages in the near to medium-term future.

Turning to nutrition, the main effect of agricultural research on nutritional status will still be derived from productivity gains increasing commodity supply, placing downward pressure on consumer prices. Because preferences for food grains vary considerably by region in India's SAT, more information on regional demand is needed to gauge the size of these effects from technological change in different commodities. While the consequences of yield-enhancing agricultural research on nutritional status are not known with a great deal of precision, the results in chapter 9 and in this chapter clearly indicate that nutritional welfare in the study villages is governed by the consumption of milk, rice, wheat, and the coarse cereals. Agricultural research per se may not be that effective in leveraging solutions to the widespread vitamin A and C deficiencies documented in chapter 9.

The results in the nutrition section are also consistent with assigning a minor role to commodity and technology characteristics in agricultural research in India's SAT. The exception to that generalization is food quality, which does not lose its importance although the regions and the households are poor. Even for resource-poor households in the study villages, exemplified by landless laborers in Aurepalle, who refuse to receive in-kind wages in hybrid sorghum, food quality as reflected in consumer preferences is an important consideration that influences varietal performance in the marketplace.

In general, focusing on crop yield stability (in its purest sense of reduced yield variance for the same mean yield) to diminish variability in household income and consumption is a misguided means to an end. Reductions in the variance of yield for a given level of yield would not have contributed appreciably to dampening fluctuations in income for the panel households in the continuous study villages.

Mean yield and profitability should remain front and center on the agenda of objectives. Economic gains from research by breeders, pathologists, entomologists, and physiologists will usually be manifested in the form of higher mean yields.

Deemphasizing stability per se also means that the cost of not gathering information on varietal performance in low-yielding environments representative of farmers' conditions will be reflected in the loss in mean yields when crossovers are pronounced. What is sacrificed in pure yield stability (for a constant mean yield) will only be of tertiary importance.

We would expect that these results would apply to other regions in India's SAT where land is scarce and labor markets are reasonably well developed. Risk benefits derived from enhancing yield stability could be considerably higher in the land abundant economies of Africa's SAT, where factor and product markets are in a much more rudimentary state of development.

Part Four Synthesis

11 India's SAT: Particularity and Prospects

We now assemble the empirical evidence from the study villages to review the conditions and their associated implications that set India's dryland semi-arid tropical agricultural regions apart from irrigated or more humid tropical environments of higher production potential and assess the prospects for land reform, labor absorption, technical change, and regional agricultural development. The book closes with our thoughts on one neglected public good that is not intimately related to the particularity of dryland agriculture: rural health care and related infrastructure, including village sanitation and drainage.

Particularity

Some distinguishing features of India's SAT apply to other semi-arid regions of the world; others are unique to India, which has a large and fairly well-integrated national economy and high population densities; and yet others would be shared with areas of unreliable irrigation such as the tail end of command schemes where the supply of water is uncertain.

Rainfall Uncertainty at Planting

Perhaps more than any other feature, rainfall uncertainty at sowing on soils devoid of moisture distinguishes dryland agriculture in the SAT. When the onset of the monsoon is erratic, farmers often make early and midseason corrections in their cropping pattern to adjust to emerging rainfall events. In extreme cases, particularly in villages fed by tanks dependent on seasonal runoff, land is fallowed in the rainy season if early season rainfall is sparse. Thus, in drought years, the actual cropping pattern may bear faint resemblance to what was planned. Higher rainfall uncertainty at planting induces area variability, which often looms larger in conditioning crop income volatility than fluctuations in yield.

Several implications follow. First, as discussed in chapter 8, crop insurance in large measure does not work because it cannot be easily and cost effectively modified to address area variability. Second, seasonal crop loan scales relied on by commercial banks and cooperatives to allocate credit to farmers are only notional because of the divergence between planned and actual area. Likewise, tying credit to inputs becomes even less attractive as the chances of economic use of in-kind loans are not unity. The returns to enforcing strict seasonal repayment discipline, particularly in areas with some scope for double cropping across seasons, are also diminished because the economically optimal decision may be to not plant the crop for which the loan was taken.

Greater flexibility in lending is required to cope with rainfall uncertainty at planting. Single loan disbursements for the entire cropping year and an emphasis on the general creditworthiness of the borrower are consistent with the spirit of a more flexible lending approach.

Rainfall uncertainty at planting also has implications for agricultural research. It prevents farmers from putting their preferences and ideas on desirable crop rotations into practice. Thus, the value of agronomic research on cheaply adding nitrogen to the cropping system though a low-cost, legume-cereal rotation is eroded because farmers in a variable production environment cannot always adhere to a recommended rotation.

More important, where area variability is high, reductions in yield variability through the generation and diffusion of more stable yielding genotypes are less likely to translate into reduced crop income variability. In summary, the need to make crop choices based on rainfall information emerging at planting makes it much more difficult to come to grips (either through public policy or agricultural research) with the problem of yield risk endemic to dryland arable farming in India's SAT.

In East and West Africa's semi-arid tropics, agroclimatologists have been able to show that either early aseasonal rains or an early onset of the rainy season are associated with a longer and wetter growing season (Stewart 1988; ICRISAT 1987: 264-266). If this prior information could be fashioned into timely and reliable extension advice for farmers, it could improve mean crop yield performance and reduce its variance. Presently, the promise of such response farming concepts is largely unfulfilled. More on-station research and on-farm validation are needed to determine the scope for capitalizing on such information. In India's SAT, agroclimatologists have not been able to document that premonsoon rainfall or the date of initiation of the monsoon is strongly associated with the length and wetness of the growing season.

Soil Heterogeneity and Location Specificity

As described in chapter 3, irrigation is a homogenizing influence on lands in the study villages. In general, dryland soils within and across villages displayed much greater spatial variation in soil type, as perceived by farmers and scientists, than irrigated soils.

Although the empirical fact of greater soil heterogeneity in dryland regions appears to be transparent and innocuous, some of its policy implications are subtle. For example, soil heterogeneity affects the propensity of heirs to partition fields at inheritance and there is every reason to expect that spatial soil variation would act as a friction to the implementation of public-sector land consolidation because the ease of striking an agreement on the fair value of a plot is related to how much that plot is perceived to be like others in the village. In the irrigated northwest, where consolidation programs have been successful, spatial soil variation within villages is not marked.

Soil heterogeneity can also impinge on the success or failure of stabilization policies such as crop insurance. To prevent farmers from taking unfair advantage of the program, yield estimates on which indemnities are based should be derived from a sampling frame on a wider geographic area. The greater the degree of soil heterogeneity the larger the sample size and resulting administrative cost and the lower the correspondence between the farmer's and the regionally estimated yield. Hence, soil heterogeneity increases the cost of crop insurance or results in reduced demand as farmers realize that the pattern of benefits based on regional measured yields will not be highly correlated to their yield variability.

Other implications of soil heterogeneity in dryland agriculture are straightforward. Aggregating components into large, uniform technology packages is not as attractive an approach to disseminate technical change as in irrigated agriculture, where soils are more homogeneous. Various parts of the package break down as soil heterogeneity increases. Cost effective soil conservation and land and water management practices are often highly location specific. More finely tuned options have to be provided to dryland farmers; hence, regional and local adaptive research attain relatively more prominence than in irrigated agriculture.

Targeting is one theme related to location specificity that threads its way through many chapters of this book. Our recognition of the importance of spatial variation across fields within a village, across villages within regions, and across regions within India's SAT does not translate into enthusiasm for targeting agricultural research and developmental policy at groups differentiated on household resource endowments or personal characteristics within a village. Our lack of advocacy for such targeting is founded on empirical findings, including the parity of factor use intensities across farm-size groups, the failure of household resource endowments or personal characteristics to account for much of the variation in several behavioral aspects such as risk preferences, the ubiquitous nature of dietary vitamin A and C deficiencies, and the difficulty in delineating meaningful topologies when the incidence of stochastic poverty is as high as it is in the more risky production regions.

We also saw that self-targeting public works programs, such as the Maharashtra Employment Guarantee Scheme, can be successful in selecting for the poorer households, which participate more actively than the richer households. Public distribution of coarse grains during times of drought could be another candidate for self-targeting. Other findings, such as the wage premium conferred on men with better nutritional status, raise the issue of the feasibility of targeting when it is in the economic interest of the family to feed some members better than others.

Nonetheless, we did observe instances when targeting could have helped redress the effects of discrimination, favoritism, or poor market access. Widows, usually late in the family life cycle, were clearly disadvantaged in the allocation of credit, especially from institutional sources. One-to-three-year-old children generally did not fare well in the distribution of food relative to their requirements and those of other household members. The ranks of the persistently poor were disproportionately filled by members of the Harijan community. Casual observation since 1975 suggests that affirmative action programs have helped improve the well-being of members of that community and that those programs are still needed.

Synchronic Timing of Operations

The requirement for timeliness in dryland agricultural operations, particularly the narrow planting window in the red-soil villages, means that rental markets for time-related tasks do not develop or are greatly limited in scope. Poorly developed rental markets in turn imply that tractorization is unprofitable to all but the largest farmers in the villages because tillage, planting, and cultivation have to be carried out in timely fashion. Mechanization will be restricted to operations such as threshing, which are usually not time-bound in dryland agriculture. Secularly declining farm size also diminishes the profitability of tractorization. Because small tractors and power tillers are not adapted to dryland agriculture, bullock draft should continue as the main power source into the twenty-first century.

Covariate Risk in a Large Country

The incidence of covariate risk in production and especially in consumption is less than we expected. Covariate risk, abetted by seasonality, in production still explains to a large extent why rotating credit societies will not figure prominently in financing productive investment in these dryland agricultural regions, why moneylenders do not allow their clients to open time deposit accounts, and why financial intermediation is limited in informal village credit markets (chapter 7). But the expected clustering or bunching together of production and consumption outcomes over time within villages, regions, or India's SAT did not obtain during the study period from 1975 to 1985.

The enormity of the Indian national economy greatly dampened the incidence of covariate risk in production and consumption. Drought was quite localized within regions; in almost every year some villages were rainfall deficit, others were rainfall surplus. Because of a large country with a relatively well-integrated national economy, localized or regional drought did not translate into sharply rising food grain prices. These results contrast sharply with what usually occurs in West Africa's SAT, where greater rainfall covariance and small countries combine to accentuate the potential for covariate risk to manifest itself in production and consumption.

Prospects

Land Reform

Our results strongly support Dantwala's (1985) assessment that redistribution of land in these SAT villages will not make a significant contribution to the eradication of poverty even though its net effect on village labor market participation may lead to increased wage rates. Based on the retrospective survey data, the problem of an inequitable distribution of land holdings is much less today than it was at Independence. Population increase and low rates of emigration and occupational change, coupled with the implicit legislative threats of tenancy acts and land ceiling laws, have resulted in a steep reduction in farm size for the biggest landowners since Independence.

That is not to say that one cannot find large landowners with holdings substantially exceeding the land ceiling in some Indian SAT villages. One can. But the problem of a bimodal distribution of holdings pales in comparison to what one finds in Latin America or even in Pakistan. In many villages, like the ones we surveyed, Dantwala's conclusion that enforcement of the land ceiling legislation would provide only enough land for housing sites to landless families rings true.

The case of agrarian reform would be stronger if we had found large effects of farm size on labor use intensity or land productivity. The evidence on both counts was weak.

Labor Absorption

The correspondence between expansion in agricultural output and employment is seldom one to one, especially in dryland agriculture. Elasticities of employment with respect to output growth of 0.15 to 0.45 for dryland SAT crops such as sorghum and millet are only about one-third to one-half the size of estimates (0.70 to 0.80) for largely irrigated crops like rice and wheat (Vyas and Mathai 1978; Sinha 1979; Tyagi 1981).

Thus, in general, optimism about dryland agriculture's capacity to absorb substantial quantities of labor through technical change and diversification is unwarranted. But, like much of the discussion throughout this book, that general conclusion masks considerable regional variation. At one end of the spectrum, we have the rainfall-unassured Mahbubnagar and Sholapur villages where the hopes for absorbing more labor are pinned squarely on an expansion in irrigated area. Intensification on irrigated land is most visible in grape gardens in Kalman, where green manuring is actively practiced to improve soil fertility and structure. Green manuring of the neighboring dryland fields would be economically unthinkable.

In the Sholapur villages, farmers are locked into the labor-extensive post-rainy season sorghum cropping system. Growing post-rainy season sorghum is still the most cost effective way to meet local fodder requirements given inadequate regional and national integration in the market for fodder. Rising urban demand for milk has also fueled the derived demand for fodder and allowed post-rainy season sorghum to retain its competitive edge against competing cropping systems. Unfortunately, for the reasons listed in chapter 3, the scope for technical change or intensification in post-rainy season sorghum, planted under a receding moisture regime, is restricted. Moreover, the constant threat of drought erodes the returns from greater investments in dryland cropping systems sown in the rainy season. The extensive nature of the dryland cropping systems in the Mahbubnagar and Sholapur villages largely accounts for the finding that the response in labor use intensity to a proportional change in assured irrigation was five to ten times higher in these villages than in the more rainfall-assured Akola villages. Therefore, intensifying labor use on irrigated, cash-cropping systems offers the best hope for absorbing more labor in agriculture in these poor dryland tracts.

If groundwater becomes less available through overexploitation, farmers in villages like Dokur of low dryland production potential and with some groundwater resources may rue the day they decided not to take a greater interest in their dryland agriculture. But for now, agricultural intensification means concentrating resources on the small irrigated holdings around dug wells.

Dryland agriculture can easily hold its own against irrigated agriculture in the Akola villages, where the outlook for absorbing more labor and intensifying production on dryland is considerably brighter. We documented a moderate but sustained increase in labor use intensity derived from the intensification within dryland cropping systems and from the switch to more labor-intensive rainfed cropping activities. The pace of labor absorption should continue to keep pace with the rate of population growth in the Akola villages.

At the brightest end of the prospect spectrum, we have the rainfall-assured Vertisol regions discussed in chapter 10. The widespread diffusion in the 1970s and 1980s of soybeans in rainfall-assured central Madhya Pradesh is the most salient example of a substantial recent change in labor absorption in dryland agriculture in India's SAT. Before more labor-intensive soybean was introduced, the Vertisols were fallowed in the rainy season and sown in more labor-extensive wheat or chick-pea in the post-rainy season. Soybeans replaced rainy season fallowing, and in one year in three there is sufficient moisture in the upper soil layers to also establish a wheat crop, thereby increasing cropping intensity (Pandey 1986). Because soybean was processed and exported, output expansion was not constrained by inelastic demand. Area increased from less than 10,000 ha in the early 1970s to more than 1 million ha by the mid-1980s. Irrigation undoubtedly played a supporting role, but much of the output expansion took place on dryland fields in Madhya Pradesh. The feasibility of replicating the soybean experience in Madhya Pradesh to other dryland regions in India's SAT is limited because such untapped production potential exists in few other regions.

Turning to policy and labor absorption, one cannot single out specific sectorial policies, such as easy access and terms of credit to the purchasers of combine harvesters in the Punjab (Rath 1985), that directly impinge on the prospects for labor absorption in India's SAT. The potential for subsidized mechanization to hurt labor is circumscribed by declining farm size and the limited opportunities for rental markets to develop for time-bound operators. The choice of production activity should have a greater bearing on labor absorption than the choice of technique within an activity. For example, in response to labor market tightening, the rising popularity of sunflower and eucalypts in India's SAT partially stems from their more extensive and less seasonal demand for labor. The policy of edible oil self-sufficiency underscored in the Seventh Five-Year Plan, while a boon to poor SAT farmers, would further appear to circumscribe the potential for labor absorption in dryland agriculture in India's SAT. Several oilseed crops are less intensive in their demand for labor—groundnut is an exception—than other competing cropping systems.

Overall, then, we are pessimistic about the prospects for significantly absorbing more labor in dryland agriculture in India's SAT regions. But if the trends of the labor market tightening apply on a wider scale and continue, labor absorption within agriculture will be less of an issue than it has been. Clearly, off-farm labor demand must accelerate so less labor is offered to employers in the village labor market.

Technical Change

At the outset of this book, we cited the growth rates of cereal output in the study districts to show how their productivity performance compared to the rest of India's SAT. Assuming government commitment to investing in agricultural research, extension, and rural infrastructure does not weaken, the recent history on cereal productivity performance should be a reasonably good guide to the outlook for technical change in the short- to medium-term future.

The interregional disparities in the rates of technical change will most likely continue. In the Akola region, the pace of technical change should outstrip the rate of natural increase in the population. The adoption of higher cost fertilizer and pest control practices associated with the diffusion of modern sorghum hybrids will form the basis for the expansion in cereal output. More important, input-responsive and often labor-intensive cash crops such as short-duration pigeon pea will lay increasing claim to the productive dryland soils.

In the Mahbubnagar and Sholapur regions, the prospects for dryland agricultural growth are considerably bleaker. Pearl millet hybrids and improved oilseed cultivars should continue to make headway in the red-soil, rainfall-unassured Mahbubnagar villages. While such varietal change is without question economically beneficial and should not be belittled, its effects are often masked by the variability and constrained by the low potential of the production environment. The uptake of more costly management practices associated with such varietal change will be limited and slow unless such techniques clearly result in a lowered cost per unit of output. Advances in cereal productivity will be derived largely from agricultural intensification in paddy production on small well-irrigated plots.

The prospects for even incremental varietal change in cereal production are dim in the Sholapur region. That and the lack of response to fertilizer in dryland farmers' fields are the main reasons why Sholapur lags so far behind other predominantly agricultural districts in India's SAT in growth in cereal productivity. The supply of sorghum grown in the post-rainy season has not kept up with demand, mainly because rabi sorghum, like some other crops produced under a receding soil moisture regime, has been resistant to technical change for the intertwined and mutually reinforcing explanations cited in chapter 3.

The role of improved seeds as a catalyst for technical change was evident in the study villages. The consensus emering from West Africa's semi-arid tropics is that varietal change is a necessary but not sufficient condition for technical change (Office of Technology Assessment 1986). Seasoned observers see enhanced soil fertility, especially phosphorous and reduced soil erosion, as necessary conditions for the adoption of improved varieties (Fussell et al. 1987). In contrast, many resource-poor Indian SAT villages such as Aurepalle have experienced varietal change in dryland agriculture. Some improved varietal types, such as the INDORF series of improved finger millet genotypes in Karnataka and our example of the Gujarat castor hybrids, have been rapidly adopted by farmers without prior improvements in the resource base. In the poorest production environments, these higher yield potential improved cultivars have often gone largely on their own without much ancillary plant protection or additions to soil fertility through inorganic fertilizer. While such varietal change may not strike a responsive chord with research administrators or bureaucrats weaned on the green revolution experience in the Punjab, it offers the best bet for technical change in the poorest dryland production regions in the short term. To accommodate varietal change, the infrastructure for seed multiplication and distribution needs to be strengthened, particularly for some pulse and oilseed crops such as groundnut with low seed multiplication ratios and less scope for eliciting greater private sector participation because the prospects of economic hybridization are dimmer than for the coarse cereals.

Crop improvement in India's SAT should also be more attuned to the regionally specific needs of farmers to break adoption ceilings that are significantly less than 100 percent. These adoption plateaus are largely explained by interregional differences in climate and soil (Jansen 1988). For example, extending sorghum hybrids in Aurepalle now is largely a waste of time because information on their performance does not constrain their adoption, which is blocked mainly by grain quality and diseas-e considerations, resulting in low prices. A centralized varietal release policy was effective in the 1960s and 1970s in mapping the high production regions where the sorghum hybrids were clearly superior to the locals. Now a two-pronged approach is called for: an emphasis on yield potential and hybrids in the regions where the hybrids are popular and a more decentralized regional approach to generate improved genotypes that are qualitatively different from the sorghum hybrids to break regional bottlenecks to adoption (Jansen 1988).

High population densities coupled with a more developed infrastructure for distribution of biological and chemical inputs make yield-enhancing technical change an eminently more tractable proposition in much of India's than in most of Africa's SAT (Binswanger and Pingali 1988). Nonetheless, some types of yield-increasing technologies are presently and into the foreseeable future nonstarters in dryland agriculture in India's SAT. Technologies such as minimum tillage and alley cropping of leguminous tree species that rely heavily on mulching are the salient examples of those having limited applicability. Because of biomass scarcity, giving rise to valued alternative end uses, the economics of mulching and green manuring in dryland agriculture is decidedly unattractive (Walker 1987). Moreover, few of the biological advantages documented in Africa for alley cropping systems (Kang, Wilson, and Sipkens 1981) and none of the economic advantages (Hoekstra 1984) appear to hold in India's SAT, which is characterized by potentially sharp competition for soil moisture between trees and crops (Ong 1989; Walker 1987). Unlike parts of West Africa's SAT and of Rajasthan's arid zone, strong complementary effects of growing trees and crops near to each other in the same field have yet to be identified in India's SAT.

Our assessment of the prospects for technical change would be incomplete without referring to the longer-term comparative advantage of India's SAT and the study regions. With improving marketing and rural infrastructure leading to greater national integration, one should observe a trend toward specialization in agricultural activities of regional comparative advantage. The outline of regional comparative advantage has become sharper over time and is most visible on the highly productive, well-irrigated land in the villages. Examples include castor moving onto irrigated land and replacing paddy in Aurepalle, the introduction and widespread diffusion of grape gardens in Kalman, and the establishment of small orchards around well-irrigated land in Shirapur.

For India's dryland SAT as a whole and especially for the regions of higher production potential such as the Akolas, comparative advantage is synonymous with oilseeds, cotton, pulses, and coarse grains but with an increasing demand for alternative uses such as for fodder and animal feed. In the dryland Mahbubnagars and Sholapurs of low production potential and high risk, regional comparative advantage resides in nonarable farming activities such as farm forestry and more extensive livestock production, featuring a longer gestation period than annual crops and more independence from the vagaries of the monsoon.

Bridging Disparities in Agricultural Growth Potential

Increasing national economic integration should result in population movements congruent with regional long-term comparative advantage. The role of the national economy has clearly been felt in the dryland study villages. Poorer households have reaped the benefits of stable food prices. Landless laborers have benefited from an improved bargaining position accompanying a tightening labor market that is more susceptible to outside influences.

Still, the modest rates of national economic growth during the period of analysis were not of an order of magnitude to change some important aspects of economic behavior. For example, a more vibrantly growing economy would have been signaled by net transfers from relatives living outside the villages, playing a larger role in risk adjustment. More important, the rate of net emigration in the low potential Mahbubnagar and Sholapur villages has still not overtaken the rate of natural population increase. Temporary migration is increasing, and the villagers are more spatially mobil, but out-migration to areas of higher production potential within and outside India's SAT seems to be painfully slow (compared to the experience of other developing countries).

Some would argue that the stickiness in net emigration is a blessing, but gradually the interregional disparities in production potential within and outside India's SAT will have to be equalized through migration from the lower production potential Mahbubnagars and Sholapurs to the more well-endowed Akolas. Education should facilitate that adjustment process. If labor moves to new markets or occupations, one can expect-greater rewards to investment in human capital. Thus, expansion in private nonfarm rural employment will be critical to reaping the full rewards of public investment in education in low potential SAT regions.

In the interim, we endorse Booth and Sundrum's (1984) Keynesian prescription that the labor absorption problem should be tackled through increased government investment in rural infrastructure via labor-intensive public works programs in the poorly endowed production regions within India's SAT. The generally positive impact of the Maharashtra Employment Guarantee Scheme on the poor in the Sholapur study villages attests to the merit of this suggestion. That is not to say that public works programs are the answer to the labor absorption problem. Public works programs only represent a holding action until economic growth expands to the extent that relatively few laborers offer their services for what should be very low paying work.

Knowledge about the nexus between national economic growth, interregional migration, and regional agricultural production potential is still sparse. We also do not know much about the effects of alternative national and state interventions such as direct food subsidies and public works programs on interregional migration.

Closing Thoughts

Finally, we turn to an area of development that has little to do with the particularity of dryland agriculture in India's SAT: rural health infrastructure. Our advocacy for investing more in primary health infrastructure is not grounded in the often expressed concern that illness in the wet season—a period of alleged lean food grain availability and high energy expenditure—potentially constrains technical change in dryland agriculture. Indeed, we do not find much evidence for seasonality in nutritional status.

Different strands of empirical research on the village studies' data have, however, unearthed the following health-related observations that support the case for economic benefits from improved nutritional and health status. Holding other things equal, better nutritional status conferred a wage premium on male laborers; female laborers with better weight-for-age participated more actively in the casual village labor market. Better nutritional status also translated into higher family labor productivity in working on one's own farm.

Poor households with ill or disabled workers were also more vulnerable to sharp shortfalls in income because they could not make up for such deficits through greater labor market participation. In particular, individuals who were chronically ill or who could not do hard physical labor were the major exception to the general observation that the Maharashtra Employment Guarantee Scheme implicitly selected for the poorest of the poor. Hence, improved health should augment the capacity of poor households to cope with income volatility, which is high in India's SAT. Ironically, during drought, when the need is often greatest, resources for maintaining and improving rural health infrastructure are most vulnerable to diversion to politically more popular interventions, such as credit subsidies through loan waivers and direct food grain subsidies.

Aside from more direct economic productivity and risk benefits, one can strengthen the case for investing more in rural health infrastructure and for improving delivery systems by appealing to several considerations that were not examined in this book. First, such investments can have a high benefit in utility terms. Second, the potential for interactions between nutrition and health interventions, especially immunizations and oral rehydration therapy to combat serious malnutrition in young children, should not be overlooked. Third, one can cite longer-term demographic benefits; a wealth of evidence suggests that improving child survival prospects facilitates the acceptance of family planing, which in turn should dampen the rate of growth of the farm work force.

In closing on the role of the state, the pendulum has swung too far in the direction of welfare-motivated, asset-generation programs. Not enough attention has been paid to rural health infrastructure, which, unlike many of the myriad of government schemes designed to benefit specific segments of the village community, truly has a public goods character.

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