

CHAPTER 17

Adjustment in Self-provisioning Societies

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17.1 INTRODUCTION

The impact of climate variation on society and appropriate methods for its assessment will vary according to the society that is being studied. In this

chapter we focus on self-provisioning societies, bringing to bear evidence from India and Tanzania. We focus on the variability of climate from one year to the next and over short groups of years, as these variations create pressing problems for self-provisioning societies. We also emphasize drought, which surpasses other climate variations in impact on these societies. For a discussion relevant to the effects of gradual long-term climate change on self-provisioning societies, see Parry (Chapter 14), who offers historical examples from Europe and North America. The question of impacts of seasonality is addressed here in part; for a more extensive treatment, see Chambers (1982). It is also informative to contrast the issues and approaches in this chapter with those in Pilgrim (Chapter 13), who describes social impact assessments undertaken in developed countries.

The two procedural and primary steps in discussing the adjustment mechanisms of self-provisioning societies to climate variability are: to define or identify such societies, and to understand their perception of the phenomenon of climate variability. In place of attempting rigid definitions of the terms, we prefer description of the situations as they obtain in the real-world context.

Literally speaking, a self-provisioning society is one in which its members manage their production and consumption requirements by themselves and the market, or formal exchange transactions, has little place in the system. Such societies, however, are hard to find in the present age except in completely isolated remote habitats. A more meaningful definition of the term would include farming communities where the bulk of production inputs originate from a person's own farm and household and the bulk of output not only is consumed by the household, but also satisfies most of its consumption needs. Market, or formal, exchange plays a very limited role as a link between the farm household's production and consumption activities. Even when dependence on the market is significant (as in the case of small-holder producers of certain cash crops such as cotton), the objective in using the market is largely to support subsistence. Methodologically, using the ratios of: 1. home-supplied inputs to the total inputs used on farms, 2. self-consumed output to the total output of the farm, and 3. the farm's own supplies to the total consumption requirements, one can not only segregate self-provisioning farming communities from highly commercialized farming communities, but also easily rank the communities on the basis of their degree of self-provisioning or subsistence character.

Several field studies, in largely rainfed farming areas of tropical India have noted the extent of self-provisioning. According to these studies, important own-farm-originated inputs such as human labor, bullock labor, seed, manures, and fodder for draft animals account for 65-90 percent of the total used amount of concerned input (Bharadwaj, 1974). A similar range applies to the share of total consumption items originating from 'own farm'. The extent of self-provisioning is even higher in most parts of Africa (Ruthenberg, 1968, 1976; Collinson, 1972; Lagemann, 1977; Abalu and D'Silva, 1980).

The literature on subsistence or peasant agriculture has discussed at length the features of such communities (see, for example, Krishna, 1969; Mellor, 1969; Wharton, 1969). Two features of such communities which have significant bearing on their adjustment to climate variability are discussed below.

First, to the extent that the household is both a major supplier of production inputs and major final user of the bulk of the output, the production and consumption decisions are quite interlinked. The integration of household (as a family unit) and farm (as a production unit or a firm) helps offer greater internal flexibility for sustaining the impact of climate variability.

Second, lesser dependence of farm households on the market implies their lesser integration with the rest of the economy. This in turn reduces the capacity of farm households to transmit shocks of climatic variability to others, for example, input suppliers and output buyers. (This situation contrasts with that of commercial firms during a crisis period.) Consequently, unless helped by external agencies or public relief, farmers in self-provisioning societies have to bear the weather-induced risk on their own. Further, since their dependence on the market for the purchase of inputs and disposal of products is limited, climate-induced production uncertainties play a more important role than price and technology-related uncertainties in shaping their adjustment strategies (Wharton, 1968).

17.1.1 Climate Variability

The rationale and operational efficacy of farmers' adjustment strategies to climate variability can be appreciated better once one has some idea of farmers' own perceptions of the phenomenon. Rainfall—its amount, timing, and duration—is identified by subsistence farmers as the dominating climate variable. Areas of subsistence agriculture, where rains constitute a principal source of risk, generally are characterized by high interyear and intrayear variability of rains. When rains are normal or higher than normal they seldom get special attention. But rains lower than normal or their unfavorable distribution are considered a cause for concern. Further, the role of rainfall variability is perceived in a rather short-term intrayear or interyear context and defensive measures are adopted accordingly. The varieties of measures adopted in order to meet the short-term situation, however, constitute integral parts of the overall farming systems, which in turn have evolved over generations in response to the long-term behavior of climate variables (especially rainfall) in a given geographical region. Hence, the subsistence farmer's adjustment mechanisms to weather-induced risk can be better understood in terms of the relevant features of his farming system that help accommodate the periodic shocks generated by short-term fluctuations in weather conditions.

To further facilitate the understanding and identification of areas for improving the potential efficiency of adjustment mechanisms, features of farming systems can be grouped in two categories. The first category can be called *adaptations* and includes elements through which farming systems have accommodated to long-term agroclimatic features of the regions. These elements help in harnessing favorable opportunities offered by the environment and also inject preparedness to defend against unfavorable situations created by erratic patterns of rains. The second category includes responses to short-term fluctuations in weather conditions. They are adopted once intraseason weather conditions become unfavorable. We may call them *adjustments*. Adjustments become possible because of the first category of features.

17.1.2 Method of Study

Before we discuss the adaptations and adjustments facilitated by farming systems, a brief digression on methodology to study them in the context of self-provisioning societies may be helpful. In a way, the risk management attributes of a given farming system are largely an outcome of farmers' perceptions of climate-induced risk and efficacy of possible alternatives to handle the risk. Farmers' perceptions, in turn, are largely conditioned by the objective circumstances which generate risk, for example, the pattern of rainfall. Hence, in order to gain understanding of adaptations and adjustments to climate-induced risk, the study-frame should include contrasting situations in terms of rainfall pattern. Climatological data, particularly the extent and distribution of rainfall along with broad information on agricultural activity in the region, can help in the selection of relevant locations for the study (Mallik and Govindaswamy, 1962-63; Sen, 1971; Jodha *et al.*, 1977). Farm surveys of different intensities may be conducted in the selected locations. Data-gathering in self-provisioning or subsistence farming communities requires caution and emphasis on participant observation, as there is likely to be a communication gap between investigators, often urban-trained, and respondents, who are generally illiterate and suspicious. Simple, unstructured questions, supplemented by group discussions, can provide more insight into the rationale behind the components that characterize traditional farming systems (Collinson, 1972; Norman, 1973; Friedrich, 1974; Kearl, 1976; Binswanger and Jodha, 1978).

The information collected should cover farmers' resource bases and their use patterns, types of crop combinations and their time-and-space specific management practices, as well as input-output details, farm production and disposal, and the like. The climate-induced differences between the sets of information relating to areas, years, and seasons with different rainfall patterns can clearly reveal the risk management elements in the farming system. This is illustrated by three studies briefly reported in Tables 17.1, 17.2 and 17.3, contrasting farmer behavior by climate, season and extreme events.

Table 17.1 Diversification strategies to handle climate risk in two areas in semi-arid tropical India

	Akola villages	Sholapur villages
<i>A. Characteristics of climate risk</i>		
Annual average rainfall (mm)	820	690
Probability of favorable soil moisture conditions for rainy season cropping	0.66	0.33
<i>B. Indicators of spatial diversification</i>		
Number of scattered land fragments per farm	2.5	5.8
Number of split plots per farm	5.0	11.2
Number of fragments per farm by distance from village		
- Zero distance	0.2	0.0
- Up to 0.5 miles (0.8 km)	0.3	1.4
- Up to 1.0 mile (1.6km)	1.1	3.4
- 1 to 2 miles and above (1.6-3.2 km)	0.1	1.0
<i>C. Indicators of crop-based diversification</i>		
Number of total sole crops planted	20	34
Number of total combinations of mixed crops planted	43	56
<i>D. Crop/stock-based mixed farming</i>		
Crop income/livestock income ratio	94:6	89:11

Source: ICRISAT's village level studies (Jodha *et al.*, 1977); Binswanger *et al.* (1980).

Table adapted from Walker and Jodha (1982).

Table 17.1 contrasts the extent of risk management practices in two areas of India with vastly different amounts of rainfall and probabilities of soil moisture to help the germination of crops. In Sholapur, the more risky area, the farmers resort to more resource-based and crop-based diversification as an insurance mechanism against climate-induced risk.

Table 17.2 contrasts the farming practices followed by a similar group of farmers in the Kilosa area of Tanzania during short (uncertain) and long (certain) rains in the same year. The practices and measures which have greater probability of success with uncertain rainfall, or which can offer partial crop salvage values despite unfavorable rains, are adopted more during the short rains.

Table 17.3 contrasts the measures and farming practices followed by farmers in the arid zone of India during a normal rainfall year and a drought year. The practices having greater potential for protecting the crops, saving the resources and augmenting the supplies (even of inferior products) despite the failure of rains gain significance during the drought year.

Table 17.2 Risk-minimizing farming practices and rain type in four villages of Kilosa, Tanzania during 1980-81

	Short rains	Long rains	Total
A. <i>Characteristics of climate risk</i>			
Average rainfall (mm)	260	763	—
No. of rainy days	21	68	—
Chances of crop failure in 10 years	5	1	
B. <i>Indicators of risk-minimizing strategies</i>			
	%	%	
Share of total low lying areas planted in the year	83	17	100
Share of uplands planted	26	74	100
Share of compound plot areas planted	92	8	100
Share of total salvage crops in total crops of season	72	32	—
Share of intercropping in season	95	79	—
Share of staggered planted area in the season	35	69	—

Source: Jodha (1982). Table adapted from Walker and Jodha (1982).

As these illustrations indicate, the main focus of such studies is to capture the contrast among farming practices as dictated by temporal and spatial differences in rainfall patterns. Depending upon requirements, the investigations can be extended to further depths, as will be indicated by subsequent tables.

17.2 RELEVANT FEATURES OF FARMING SYSTEMS

The features of traditional farming systems that have evolved to handle climate-induced risk can be defined as (a) adaptations, and (b) adjustments, classified by their long- or short-term character. These features are interrelated and constitute a complex of crop-based, resource-based and management practice-based measures. Some of them are group-centered, requiring social action, while others are individual-centered, in the control of the farm unit. In some of them traditional technology plays an important role and in others the role of institutional factors is more significant. The actual adoption of a measure or combination of measures is largely a function of farmers perceptions of a risky situation and the efficacy of a particular measure to meet the situation. Since the ultimate objective of these measures is to cope with a common factor, risk generated by weather or climate, one comes across a broad similarity in adaptation/adjustment measures in different locations such as India and Africa, despite their cultural, infrastructural and demographic differences.

Table 17.3 Loss-minimizing activities during a drought year and a non-drought year in selected villages in the arid zone of India

	Drought year (1963-64)	Normal year (1964-65)
A. Characteristics of weather risk		
Rainfall during the year	159 mm	377 mm
Total rainy days	8 days	21 days
B. Risk/loss-minimizing measures: crop practices		
Collected weeded material as fodder	53 plots	5 plots
Harvested field borders for fodder	68 plots	6 plots
Harvested premature crops	27 plots	—
Harvested crop byproduct only	49 plots	2 plots
Harvested mature crop	16 plots	144 plots
Interculturing done	7 plots	65 plots
Weeding done more than once	18 plots	—
Thinning done	37 plots	—
Post-sowing operations abandoned	36 plots	—
Hired resource used for post-sowing operations	2 plots	24 plots
Harvested premature <i>Z. nummularia</i> (bush) for fodder	92 plots	—
Lopped trees for fodder/fuel	53 plots	4 plots
C. Risk/loss minimizing measures: social practices		
Cases of nonpayment of dues	49	7
Marriages, etc. postponed	9	—
Children withdrawn from school	34 plots	3

After Jodha (1967).

17.2.1 Long-term Adaptations

The evolution of farming systems in climatically unstable areas has bestowed several features which ensure the flexibility and viability of the system in the face of climatic hazards.

17.2.1.1 Diversified Production Strategy

The farming activities are diversified to accommodate the temporal and spatial variability characterizing the natural resource base (land, rainfall, etc.) conditioning the overall production possibilities available to the farmers. The degree of diversification can readily be perceived from the farmers' choice of enterprise combinations (such as mixed farming through cropping and stock farming) with varied capacities to ensure earning in good and bad rain years, and from the choice of crops with varying attributes in terms of maturity period, drought tolerance, input requirements, main product-by-product

ratios, end uses of the product, and so forth (Collinson, 1972; Ruthenberg, 1976; Abalu and D'Silva, 1980; Jodha, 1980). Table 17.1 illustrates the relative extent of resource-based and crop-based diversification attempted by farmers in two agroclimatically different areas of semi-arid tropical India.

17.2.2.2 Operational Diversification

Diversification in farming does not end with resource- and crop-based diversification. Traditional agronomic and other management practices also have a significant scope for diversification and flexibility. These practices include lowland-upland (toposequential) planting, staggering of planting and other operations, splitting of plots, splitting of inputs, and skipping certain inputs as warranted by the situation (Jodha, 1967; Ruthenberg, 1968; Collinson, 1972). Table 17.2 illustrates some degrees of diversification attempted by Tanzanian farmers during short and long rains.

Diversification based on resource bases, crops and operations helps generate operations with varying probabilities of success in the face of highly variable weather conditions. The farmers' concentration on specific practices changes according to their comparative advantages in the emerging intraseason weather situation. In the favorable season the options with high payoffs get better attention, whereas in less favorable seasons the options with greater insurance elements are emphasized. This is illustrated in Table 17.2, which shows the priority given to high insurance measures during short (uncertain) rains in the Kilosa area of Tanzania, and Table 17.3 for a drought period in India.

17.2.1.3 Flexible Resource Use Patterns

The degree of diversification and consequent flexibility of the farming system is further strengthened by the diversity and flexibility of resource and consumption patterns. This flexibility is facilitated in turn by the fact that the household is both a production and a consumption unit. Household production and consumption in self-provisioning farming societies are therefore highly interlinked physically, as well as financially. Since the household is a major supplier of production input (human and bullock labor, seed, feed, fodder, manure, etc.) it offers effective control over resource use to contract or expand the farm operations (or their intensity) as required by quick response emerging weather situations during the season (Jodha, 1967; Collinson, 1972, 1977). A variety of recycling devices, including a limited prior commitment of resources for current production and an accretionary process of asset or capital formation, further help to inject flexibility in resource use (Jodha, 1967).

17.2.1.4 Flexible Consumption Patterns

Similarly, since the household is a major direct consumer of its own farm output (except some cash crops), the fluctuations in production largely get absorbed internally. Highly flexible demand and consumer preference (for example, preparedness to consume damaged grains or even green cobs/pods in place of fully ripe grain, consume normally non-edible stuffs, or drastically cut food intake during poor crop years) helps match the demand situation to the emerging supply situation. The flexibility on the consumption front is further strengthened by on-farm storage and a variety of recycling and food processing devices (which may often convert non-edibles into edibles) (see Jodha, 1967, 1975; Collinson, 1972)

17.2.1.5 Adapting the Environment

The above discussion shows that farmers operating under an unstable environment try several ways of adapting their production and consumption activities to the variability of climate. They also know that greater stability of their farming system could be achieved by some means of adapting the environment to their requirements. Since erratic rainfall is the key variable to determining instability or risk to their farming, any means to manipulate rainfall or other effective moisture to their crops is considered as a permanent or more reliable source of stability. This leads to attempts to place irrigation facilities in at least part of the land. In some drought-prone areas of India, wells or tanks (based on storage of surface runoff) are used as sources of irrigation by a limited number of farmers. In yet other areas, both in India and Tanzania, moisture availability, depending on soil characteristics and topography, is manipulated by means of conservation measures such as contour bunding, field border bunding, ridges and furrows, and the like (Ruthenberg, 1968; Jodha, 1980, 1982).

17.2.1.6 Traditional Forms of Rural Cooperation

Traditional forms of rural cooperation and informal institutional arrangements also have the capability for mutual sharing of risk during bad years and helping fully harness the potential of bumper crop years (Jodha, 1967; Kirkby, 1974; Wisner and Mbithi, 1974; Hitchcock, 1979). However, under the pressure of modernization and commercialization and institutional interventions by governments, these traditional collective means to facilitate flexibility to the farming system are fast disappearing (Jodha, 1978; Walker and Jodha, 1982).

17.2.2 Short-term Adjustments

The features of farming systems which take the form of responses to short-term climate-induced crises (such as midseason failure of rains) are called adjustments. Adjustment measures, unlike adaptations, are initiated once unfavorable weather performance is known. For example, once midseason failure of rains is certain farmers can initiate two types of action. The first category is directed towards minimizing the losses due to unfavorable weather; we call it specific risk/loss minimizing measures; Berry *et al.* (1972) describe it as measures to modify the loss potential. The second category includes all steps undertaken to manage the losses or adjust to the losses. We designate them specific risk/loss management measures. In Table 17.4 we relate the specific adjustment measures to the adaptive features of farming systems described in Sections 17.2.1.1 through 17.2.1.6. The characteristics of the short-term adjustment measures grouped together under two categories are elaborated in Sections 17.2.2.1 and 17.2.2.2.

17.2.2.1 Risk/Loss Minimizing Measures

Following the intraseason failure of rains, certain measures are adopted for extracting whatever little the adversely affected crops can offer at a minimum of additional input cost. The measures can be further grouped under the following categories.

1. *Salvage operations.* Several recovery efforts, depending on the situation, are made. Examples are: recovery of fodder (byproduct) in the face of the definite impossibility of getting the main product; harvesting green cobs/pods in place of a ripe crop; collection of weeded material (as fodder) rather than allowing it to go to waste; concentration on normally low-value production activities such as harvesting field borders for fodder (for details, see Jodha, 1967 and Table 3: Jodha, 1982).
2. *Midseason corrections/adjustments in operations.* Depending on which crop, plot or operation has higher chances of success in the face of unfavorable rainfall, selectivity and discrimination become important features of the decisions regarding deployment of resources, intensity of operations, etc. for different crops and/or plots. For instance, in the face of a midseason dry spell, plots lying lowest in the toposequence get more attention; intensive weeding and emergency thinning is done in the case of drought-resistant and still promising-looking crops; and depending on the moisture situation, especially after the break of the dry spell, partial resowing and patch cultivation is done (see Jodha, 1967, 1982; Berry *et al.*, 1972; Wisner and Mbithi, 1974; and Tables 17.2 and 17.3 above).

3. *Cutback on resource use.* Cost saving is attempted by reducing dependence on hired resources. Owned resources are used where usually hired resources are employed. Family resources also are spared for alternative earning opportunities outside the family farm. Operations, techniques and priorities are changed for the maximum saving of resources (Jodha, 1967, 1982; Berry *et al.*, 1972; Wisner and Mbithi, 1974).

Table 17.3 summarizes the details of some farm operations which become important only during unfavorable rain years. These operations in their respective ways help the risk/loss minimization measures adopted by the farmer.

17.2.2.2 Risk/Loss Management Measures

Under this category measures are directed towards ensuring the survival and maintenance of the productive capacity of the farm household in the face of a crisis situation caused by the failure of the crop. These measures have been put into five subgroups and are illustrated by detailed data from various drought-affected areas in India. A broadly comparable situation has been observed in the very dry villages of Kilosa, bordering Dodoma in the arid region of Tanzania (Jodha, 1982), but comparable quantitative details could not be collected. Mascarenhas (1973) provides a detailed discussion of relevant issues and problems in the context of Tanzania. Broad similarity in farmers' approaches to meet the consequences of droughts in different countries can be seen from various studies on the subject (Dupree and Roder, 1974; Hankins, 1974; Heijnen and Kates, 1974; Kirkby, 1974; Wisner and Mbithi, 1974).

1. *Reduction in current commitments.* This is attempted through postponement, cancellation, or reduction of expenditures related to current consumption, future production, payment of dues, and so forth. Table 17.5 (adapted from Jodha, 1981) summarizes the situation in drought and post-drought years in three areas of western India. It reveals that consumption expenditures of sample farmers during drought years (compared to non-drought years) declined by 8-13 percent in the affected areas of the states of Gujarat and Rajasthan. The magnitude of decline varied significantly among the different expenditure categories. For instance, decline in the expenditure for total food items was the smallest of all the categories. To prevent further decline in this category, however, expenses on other 'non-essential' consumption items like protective food (including milk, meat, vegetables, sugar, fruits, etc.), education, medicine, clothing and socioreligious ceremonies were curtailed drastically. But despite maintenance of the level of expenses for food in drought years near to those of non-drought years, the per capita food intake (due to high prices) declined by 12-23 percent in different areas. For similar observations in

Table 17.5 Changes in expenditures and food grain consumption in three drought-prone areas of India

Items	Jodhpur (Rajasthan)		Barmer (Rajasthan)		Banaskantha (Gujarat)	
	63-64 ^a A	64-65* B (B-A)/B	69-70† A	70-71* B (B-A)/B	69-70† A	70-71* B (B-A)/B
	(Rs)	(%)	(Rs)	(%)	(Rs)	(%)
<i>Per-household consumption expenditure on:</i> ^b						
Total food items	1181	-1.6	1183	+2.6	1701	-5.8
Protective foods ^c	291	-28.8	235	-42.1	501	-28.3
Clothing, fuel, etc.	274	-16.2	269	-14.8	334	-30.9
Socioreligious ceremonies ^d	54	-63.5	57	-48.2	61	-30.7
Others ^e	168	-35.2	102	-41.7	127	+29.6
Total	1677	-13.3	1611	-8.2	2223	-10.2
<i>Consumption per adult unit per day (g)</i>						
Total foodgrains	514	-13.9	535	-11.7	567	-23.4
Superior cereals ^f	112	+93.1	40	+82.5	42	+35.7

Source of data: Jodhpur area: Jodha (1975); Barmer and Banaskantha areas: Chaudhuri and Bapat (1975); Sholapur area: data collected under ICRIASAT Village Level Studies (Jodha *et al.*, 1977); Aurangabad area: Borkar and Nadkarni (1975). For details of number of sample households see Table 17.7.

^a †Drought years; *Post-drought (normal) years.

^b To facilitate comparisons, all rupee values in this and the subsequent tables have been converted into 1972-73 value of the rupee, using index of general prices for agricultural laborers in the respective states.

^c Includes milk, fats, sugar, jaggery, fruits, etc. These are included in total food items, also.

^d Socioreligious ceremonies related to deaths, births, marriages and festivals.

^e Includes education, medicine, recreation, travel, payment to village functionaries for day-10-day services, remittances to children studying outside, etc.

^f Mainly wheat available through fair-price shops during the drought year.

Adapted from Jodha (1981).

drought-prone areas of Kenya, see Wisner and Mbithi (1974). See Escudero (Chapter 10) for a discussion of the relation of climate variability to nutrition.

2. *Resource augmentation.* This is attempted through the use of hitherto rejected or non-edible produce and the conservation and recycling of food/fodder, using different processing techniques (Jodha, 1967; Berry *et al.*, 1972; Hitchcock, 1979).
3. *Asset/inventory depletion.* During the crisis period it is quite usual to sell or mortgage assets or inventories accumulated over the run of good crop years. The main reason for asset depletion through distress sales is for augmentation of liquid resources to supplement meager income during drought years. Apart from deliberate disposal, asset losses are due also to deaths of animals and to theft, quite common during stress periods. Compared to the respective pre-drought years, assets declined by 15–42 percent in different areas during the drought years, as revealed by Table 17.6. In most cases the productive assets, particularly livestock, had the highest (19-60 percent) decline. Moreover, the recovery of depleted assets in post-drought years was not quick enough. By the time asset losses are fully recouped the next drought may occur. Thus over an irregularly occurring famine cycle the asset depletion-replenishment cycle completes itself without leaving surplus resources for agricultural investment and growth in drought-prone areas (Binswanger, 1978). Besides asset depletion, the drought-affected farm households resort to heavy borrowing through formal and informal land and labor debts during the crisis period. As indicated by Table 17.6, in these areas the incidence of indebtedness increased from 63 to 224 percent within a single drought year. The long-term consequences of such indebtedness include permanent pauperization of the people (for evidence see Jodha, 1981, Table 8).
4. *Other measures for sustenance income.* Other loss management devices during drought years include dependence on public relief works, hiring out of human labor and bullocks, earning during outmigration, remittances from well-off relatives, sale of handicrafts, and various means of mutual risk-sharing.

Table 17.7 presents the relative contribution of different sources of income towards the sustenance of farmers during a drought year. Public relief works account for the single biggest source of sustenance income in most of the areas. The sale of assets is the next major single source of sustenance income. The data suggest that in the absence of public relief, the farmers' adjustment devices for sustenance are quite weak.

5. *Outmigration.* This is an important measure to adjust to the spatial variability of rainfall. Farmers, with or without animals, travel long distances during stress periods. Jodha (1978) reported that about 37-60 percent of farm households were affected by outmigration during drought years in

	Average per household value of assets and liabilities ^a in (A) pre-drought years ^b (B) drought years and (C) post-drought years in:														
	Jodhpur (Rajasthan)			Barmer (Rajasthan)			Banaskantha (Gujarat)			Sholapur (Maharashtra)			Aurangabad (Maharashtra)		
	(A)	(B)	(C)	(A)	(B)	(C)	(A)	(B)	(C)	(A)	(B)	(C)	(A)	(B)	(C)
	62-63 ^b	63-64	64-65	68-69	69-70	70-71	68-69	69-70	70-71	71-72	72-73	73-74	71-72	72-73	72-73
Assets	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)
Livestock ^c	1546	849	1230	1287	786	837	1565	1222	1498	2096	1707	1549	732	464	NA
(% change) ^d		-(45.1)	+(44.9)		-(60.4)	-(6.5)		-(21.2)	+(22.6)		-(18.6)	-(9.3)		-(36.3)	NA
Agri. implements ^e	409	372	389	202	201	201	645	638	635	496	465	483	751	685	NA
(% change)		-(9.0)	+(4.6)		-(0.5)	—		-(1.1)	-(0.5)		-(6.3)	+(3.9)		-(10.1)	NA
Consumer durables ^f	658	459	486	175	167	164	292	284	284	106	73	85	NA	NA	NA
(% change)		-(30.2)	+(5.9)		-(4.6)	-(1.8)		-(2.7)	—		-(31.1)	+(16.4)		NA	NA
Financial assets ^g	1239	840	726	1226	947	921	1668	1398	1380	310	216	190	296	258	NA
(% change)		-(32.2)	-(13.6)		-(22.7)	-(2.7)		-(16.2)	-(1.3)		-(30.3)	-(12.0)		-(12.8)	NA
Total assets	3852	2520	2831	3590	2101	2123	4170	3542	3797	3008	2461	2307	1779	1407	NA
(% change)		-(34.6)	+(12.3)		-(41.5)	+(1.1)		-(15.0)	+(7.0)		-(18.2)	-(6.3)		-(20.9)	NA
Liabilities^h															
Debts outstanding	189	552	637	498	873	949	111	360	302	375	613	651	NA	NA	NA
(% change)		+(192.0)	+(15.4)		+(75.3)	+(8.7)		+(224.3)	-(16.1)		+(63.5)	+(6.2)		NA	NA

Source of data: See Table 17.5.

^a Value of assets and liabilities (in Rs) expressed in terms of 1972-73 prices. Assets exclude land and buildings.^b Pre-drought year indicates the situation at the beginning of the drought year.^c Draft animals, milch stock, sheep, goats, etc.^d Percentage change over the preceding period. The change is composed of sales, gifts, losses (of animals due to death, etc.).^e Farm equipment, tools, machinery, and handcraft tools.^f Consumer durables—only important items like radios, watches, bicycles and modern furniture included.^g Includes jewelry, cooperative shares, L.I.C. policies, etc. In Aurangabad, only jewelry is included.^h Average per household amount of debts outstanding net of repayments. In Sholapur it excludes old debts imposed on farmers as bunding loans, well loans disbursed under Zaveri Scheme, and Zilla Parishad fodder grants during the past droughts. This amount comes to Rs 723/- per household at 1972-73 prices.

NA: Not available.

Adapted from Jodha (1961).

Table 17.7 Sources of sustenance income in five drought-prone areas of India

Details	Jodhpur (Rajasthan)	Barmer (Rajasthan)	Banaskantha (Gujarat)	Sholapur (Maharashtra)	Aurangabad (Maharashtra)
Drought year	1963-64	1969-70	1969-70	1972-73	1972-73
Sample house- holds (No.)	144	100	100	80	128
Average amount of sustenance income (Rs/ household) ^a	3133	2996	2627	2944	2715
% share of sources in sustenance income					
Cultivation ^b	2.1	—	—	14.4	6.8
Animal husbandry	10.2	7.2	4.8	1.0	NA
Wage income from relief works	24.9	22.4	25.3	46.5	56.2
Institutional help ^c	NA	30.4	6.4	NA	NA
Sale of assets	25.9	12.5	24.9	17.3	13.5
Borrowings (credit) ^d	10.4	12.8	11.7	7.9	6.3
Others ^e	26.5	14.7	26.9	12.9	17.2

^a Sustenance income is defined as total inflow of cash and kind including borrowing, except term loans unrelated to sustenance during the drought. Value of sustenance income is expressed in terms of 1972-73 prices.

^b In Aurangabad villages, income is from all household production including cultivation.

^c This includes free or subsidized supplies of food grain and fodder, including those provided by charitable institutions and the government during the period of migration. In some cases the help also included milk powder, vitamin tablets, medicine, clothing, transport facilities, and water supply, etc.

^d All borrowings—in cash or kind—taken against mortgage or labor or land-lease contract and others. This does not include the credit in terms of postponement or cancellation of recovery of land revenue and other dues from the farmers. This also excludes term loans not related to loss management during the drought years.

^e Includes income from other casual or agricultural wage employment (including during the outmigration), handicrafts, transport, remittances and free help from well-off relatives, etc. In the case of Jodhpur villages it includes value of old stocks of food grain and fodder.

NA: Not available.

different areas. The one-way distance covered ranged from 50-243 kilometers. Outmigration involves both real and nominal costs. An important component of the cost is loss of animals through death, desertion or theft. The extent of animals lost by outmigrants in different areas ranged between 28 and 53 percent of the original number of animals. The practice

of migration is more common among the pastoralists in Africa, but no details are readily available to quantify the situation.

17.3 THE POTENTIAL OPTIONS FOR RISK STRATEGY

Having learned about the farmers' traditional mechanisms to handle climate-induced risk and their strong and weak points, one can proceed to identify some new measures which can potentially strengthen the farmers' methods (Spitz; 1980). The new measures, of course, are not to substitute for the existing mechanisms. Rather they should help generate more options for the farmer to adapt and adjust to the risky environment. The potential options contain technological and institutional measures that share the insurance elements of traditional measures. Their conceivable superiority, however, lies in providing both insurance and increased capacity for the farmers to more easily withstand periodic stress situations.

The new institutional options indicated are also not very new. The focus of institutional measures (i.e., government policies and programs) is on the need for designing them to adapt to the realities of unstable agricultural situations. Most of the current programs and policies need to be more sensitive to the problems created by climate variability before they can complement the farmers' own measures to handle risk (Wisner and Mbithi, 1974; Jodha, 1981).

17.3.1 Potential Technological Options

Potential technological measures are summarized in Tables 17.8, 17.9, and 17.10. Specific practices and their attributes in terms of potential adaptation and adjustment benefits are indicated, as well as the relevance of the measures to farmers' past experience and resource capacity, helpful in facilitating adoption of the techniques. In keeping with the classification of traditional measures, the new technological measures, which can significantly add to the flexibility and productive capacity of the farming system, can be broadly classified under three groups: Table 17.8, resource measures; Table 17.9, crop measures, and Table 17.10, management practice measures. These measures are at different stages of development and availability to the farmer. Moreover, they are of a general nature and specific changes may be necessary to suit local circumstances in different areas.

17.3.1.1 Resource Measures

These include all the measures in dealing with the improvement, management and manipulation of the resource base—particularly the natural resource base—of farming. Variability of rainfall is the principal source of instability of farming in tropical arid and semi-arid areas. Agricultural scientists maintain

that the moisture available in most years, if properly utilized, is sufficient for raising one or (in some areas) two rainfed crops. The main problem is intraseason temporal distribution of rains. It is not uncommon to witness severe flooding and extreme moisture stress for crops in different parts of the same crop season. The distribution of the rains cannot be controlled, but its use pattern can be manipulated to increase its effective availability for crop production. This is attempted through storage of water on the soil surface (in tanks, etc.) and in the profile of the soil. This helps generate the following options to adapt the environment (moisturewise) to the crops planted (see Table 17.8).

Table 17.8 Potential technological options: resource measures

Resource measures: relating to conservation, management of soil and moisture	Attributes									
	Long-term adaptation through:		Short-term adjustment through:	Relevance to:						
	Growth-induced cushion/stability	Flexibility-based options	Salvage operations Adjustment to intra- season weather	Farmers' experience		Farmers' resource capacity		Specific agroclimatic conditions	Reference for experimental evidence	
India				Africa	India	Africa				
1. <i>Runoff collection and recycling</i>	X	X		P				R	1,2	
2. <i>Soil/moisture conservation through</i>										
- contour bunds	X	X	X	P		P		R,Bm	3	
- graded bunds	X	X		P				R,B	3	
- broad bed and furrows	X	X	X	P				B	1,2,4,5	
- broad-based terraces	X	X						Bd,R	3	
- mulching	X	X	X	P	P	P	P	R,B	3	
- contour cultivation	X	X			P	P	P	Bd	3	
- tie-ridging	X	X	X		P		P	Bm,R	6	

References: 1. Ryan *et al.*, 1979; 2. Binswanger *et al.*, 1980; 3. Randhawa and Rao, 1981; 4. Ryan and Sarin, 1981; 5. Virmani *et al.*, 1981; 6. Le Mere, 1972.

Abbreviations: P, partial; R, red soils; Bd, deep black soils; D, dependable rainfall; Bm, medium black soils.

1. *Runoff collection and recycling of water.* By means of proper layout of the landscape on a watershed basis, the facilities for drainage of excess water into small tanks can be arranged. The water thus harnessed during not

infrequent heavy storms can be utilized for supplemental or life-saving irrigation during the midseason drought, or for raising post-rainy season crops. The evidence from experimental work at ICRISAT and the national institutes in India indicates that this measure can make a significant contribution towards the stability and growth of rainfed agriculture in Alfisols (red soil) areas (Ryan *et al.*, 1979; Binswanger *et al.*, 1980). However, the measure may face some problems of an institutional nature as it involves soil and water management on a watershed basis, and even a single small watershed involves a number of small farmers who may or may not agree to a collective decision (Doherty and Jodha, 1979).

2. *Soil/moisture conservation measures.* In addition to traditional field border bunding, experimental work on soil/moisture management has developed further options to suit different soil type and rainfall conditions. A few that have shown promise are graded bunds, broadbeds and furrows, broad-based terraces, land smoothing, contour bunds, tie-ridging, contour cultivation, furrows (in grasslands) and mulching (for details see Le Mere, 1972; Ryan *et al.*, 1979; Binswanger *et al.*, 1980; Randhawa and Rao, 1981; Virmani *et al.*, 1981). Some of these measures, when used with other components of modern technology such as improved seed and fertilizer can raise production substantially. In areas where water stagnation rather than moisture stress operates as a main constraint, the above-mentioned measures help in better drainage to improve crops.

17.3.1.2 Crop Measures

The new crop technologies offer better and more crop options to the farmer. Certain crops can now be developed, improved or adapted to the environment through scientific research. In some cases the alternative crops available mean the substitution of the traditional crops of one region by traditional crops from other regions. The variety of perennial and annual crops recommended for different agroclimatic zones (Kassam 1976; Spratt and Chowdhury, 1978; Anon., 1979; De Vries and Mvena, 1979; Mukuru, 1980) offer choices for crops to suit different weather conditions, for example, early rain, late rain, inadequate or excess rain, midseason drought, and the like. Depending on their various characteristics, the crops may offer possible stability and higher yields (see Table 17.9).

17.3.1.3 Management Practice Measures

Based on agronomic trials involving knowledge of new crops and their physiology in relation to varying types and levels of inputs, scientists have evolved a range of management practices (De Vries, 1976; Monyo *et al.*, 1976; Keregero *et al.*, 1977; Krishnamoorthy *et al.*, 1977; Virmani *et al.*, 1981). Many

Table 17.9 Potential technological options: crop measures

Crop measures: crop choice/substitution based on crop characteristics*	Attributes							
	Long-term adaptation through:		Short-term adjustment through:		Relevance to:			
	Growth-induced cushion/stability	Flexibility-based options	Salvage operations	Adjustment to intra- season weather	Farmers' experience		Farmers' resource capacity	
					India	Africa	India	Africa
1. Insensitivity to temporal variability of rains (e.g. perennials)	X	X			P	P	P	P
Resistance to drought	X	X	X		P	P	P	P
3. Varying maturity periods	X	X	X	X	P	P	P	
4. Responsive to fertilizer (+ moisture)	X				P		P	
5. Moisture use efficiency	X			X	P	P	P	
6. Adapted to new agronomic practices	X	X		X			P	P
7. Resistant to pests/insects	X			X	P	P	P	P

* For experimental evidence see Kassam (1976); Collinson (1977); Krishnamoorthy *et al.* (1977); Spratt and Chowdhury (1978); Anon. (1979); Mukuru (1980), Randhawawa and Rao (1981).

P = partial.

of them involve only changes in husbandry practices rather than substantial input costs. The practices relate to operation at various stages of crop seasons and they are designed to effect efficient use of the environment—soil, moisture, and the like (see Table 17.10).

For instance, the practice of dry seeding eliminates the loss of time involved in traditional systems, where crops are planted after the rains when fields are ready. This period may be as long as 10 days or more in many areas. Dry sowing has several favorable implications for plant stand and growth. The variety of crops with different physiological habits has facilitated the manipulation of

Table 17.10 Potential technological options: management practice measures

Measures relating to management practices*	Attributes							
	Long-term adaptation through:		Short-term adjustment through:		Relevance to:			
	Growth-induced cushion/stability	Flexibility-based options	Salvage operations	Adjustment to intra-season weather	Farmers' experience		Farmers' resource capacity	
					India	Africa	India	Africa
1. Dry seeding	X	X		X	P		P	P
2. Flexible sowing time		X	X	X	P	P	P	P
3. Transplanting some crops		X				P	P	P
4. Plant population and manipulation practices		X		X	P	P	P	P
5. Varying level and selective use of fertilizer	X	X			P	P	P	P
6. Intensive weed management	X		X	X	P	P	P	P
7. Midseason thinning, ratooning, gap filling		X	X	X	P	P	P	P
8. Intercropping with HYVs	X	X				P		
9. Sequential/relay cropping	X	X		X	P			P
10. Post-harvest tillage		X				P		

* For experimental evidence, see footnote to Table 17.9.

? = partial.

sowing dates to suit the timings of rainfall. This has obvious flexibility-implications.

Practices relating to plant population, spacing, and midseason changes therein also help better adjustment to emerging weather conditions. Similarly, intensive weed management and the selective use of fertilizer also help to bring about high and stable crop production.

Practices such as intercropping and sequential and relay cropping, involving crops with varying capacity to benefit over time and space from the environment, also add to higher and more stable production.

Post-harvest plowing is one practice which helps weed and moisture control and prepares soil well for effective dry seeding. In some areas this is a traditional practice, but it is often done much after the crop has been harvested. By then soil is completely dry, weeds have already matured and scattered their seeds, and animals are very weak, since it is the dry season.

17.3.2 Potential Institutional Options

Most of the institutional measures discussed below are not new. What is new is renewed emphasis on their reorientation to become more relevant to the situations in areas with drought hazard. The potential institutional measures—public policies and programs conducive to increased effectiveness of farmers' mechanisms to handle weather-induced risk—are summarized in Table 17.11. They are subgrouped under three categories.

1. *Contingency support facilities.* These measures are directed to supplement farmers' own efforts to manage the crisis situation generated by drought-induced scarcities. They are largely short-term measures.
2. *Area-based infrastructure.* This includes long-term and permanent measures to facilitate growth of the regions often hit by droughts.
3. *Schemes supporting adoption of new technology.* These measures include the infrastructure and other support facilities essential for adoption of the new technological options discussed in the preceding section.

The long- and short-term consequences of the measures under the aforementioned three categories are also indicated in Table 17.11. For detailed discussion of the potential role of these measures in helping farmers' traditional adjustment mechanisms see Wisner and Mbithi (1974); Dandekar (1976); Mascarenhas (1979); and Jodha (1981).

17.4 CONCLUSION

Subsistence farmers, through trial and error over a period of generations, have evolved various mechanisms to handle drought-induced risk. The strongest component of these risk-handling mechanisms is the diversification and consequent flexibility of the farming systems. Farmers in low and unstable rainfall areas are faced with very limited production alternatives. They try to multiply the total options by manipulating crop combinations and varying methods of resource use and farm practices. In the process they gain stability in production but do sacrifice the more remunerative opportunities occasionally

Table 17.11 Potential institutional options

Institutional measures: programs/policies*	Attributes in terms of support to:			Relevance to current ex- perience of the countries	
	Adaptation	Adjustment		India	Africa
	Long-term growth and flexibility	Loss minimization	Loss management		
1. <i>Contingency support facilities:</i> Relief (employment) works Consumption credit Fodder banks Seedling nurseries Custom-hire services		x	x	x P P P P	x P
2. <i>Area-based infrastructure:</i> Diversified credit Marketing and transport Price support for crop and stock Crop/stock insurance Non-farm employment	x x x x x		x	P P P P	P P P
3. <i>Support for new technology:</i> Village/farm centered Conservation measures Self/community-managed irrigation Local level input/distribution	x x x	x x x		x P P	x P P

* For detailed discussion and/or evidence on these and related measures see Mascarenhas (1973, 1979); Wisner and Mbithi (1974); Jodha (1981).

P = partial.

presented by the rainfall pattern. In other words, farmers' production strategies are geared largely towards handling the negative aspects of climate such as droughts, rather than concentrating on positive aspects. This is because climate is recognized more as a source of distress than as a positive resource for production activities.

These mechanisms, which show considerable similarity across geographical, cultural and demographic contexts in the tropical underdeveloped world, have lost part of their effectiveness. Group-based measures to handle risk are fast losing their effectiveness due to increased demographic pressures, commer-

cialization or market orientation of farming, and a number of institutional changes initiated by governments. If, however, climate is considered as a positive factor of production rather than as a mere source of distress and new technological options supported by relevant institutional measures are adopted, the farmers' adjustment mechanisms probably can become stronger than they have ever been.

Although evolved over generations, the traditional structure of options to handle climate-induced risks is fairly static and does not include several new options based on modern scientific advancements in agricultural technology. Traditional technology can at best ensure the balancing of losses and gains at the end of a famine cycle. It does not offer enough scope for generating a surplus for reinvestment and growth to ensure stronger internal cushions for the farmers effectively to sustain the impacts of subsequent droughts. Public relief programs have assumed a significant role in complementing the farmers' own attempts to handle climate-induced risk. Many new options, both technological and institutional, exist in experimental settings or limited practice to assist them also. The best of these options are elaborations of traditional measures and draw inspiration from the underlying principles of diversification and insurance. But they also build up the farmers' long-term capacity to withstand periodic stress and break the cycle of drought pauperization.

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