

An Empirical Analysis of the Relationship between Land Size, Ownership, and Soybean Productivity – New Evidence from the Semi-Arid Tropical Region in Madhya Pradesh, India

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Executive summary

The intervention of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) at the benchmark site in Madhya Pradesh, India is part of a larger project – “Improving Management of Natural Resources for Sustainable Rainfed Agriculture” funded by the Asian Development Bank (ADB). The main aim of the project is to increase the productivity and sustainability of the medium and high water-holding capacity soils in the intermediate rainfall ecoregions in India, Vietnam, and Thailand. This study examines the relationship between land size and various variables including the soybean productivity relationship among owner-operated and share cropper-operated farms. Primary data was collected using an interview schedule from the villages of Jaoti, Kundhankhedi, Kherkhedi, and Lalatora in Vidisha district, Madhya Pradesh for the 1999 rainy season crop. The productivity of evaluated owner-operated farms is marginally higher at 0.72 t ha^{-1} compared to 0.68 t ha^{-1} in case of share cropped farms. The productivity of evaluated trial farms in Lalatora micro-watershed which is used as a demonstration micro-watershed for evaluating improved management practice has been higher at 1.1 t ha^{-1} . The inverse-relationship between land size and productivity is found for both owner-operated ($r = 0.27$) and share cropper-operated farms ($r = 0.30$). The average profit is higher among owner-operated farms at Rs. 2045 ha^{-1} compared to Rs. 1773 ha^{-1} among share cropped farms. The profitability for the landlords and share croppers is documented and evidence is presented on the exploitative nature of the emerging 20:80 crop sharing contract. The low productivity has been due to waterlogging which occurred due to heavy rains during the sowing period.

The implications of the endemic nature of the low productivity under a liberalized trade regime is analyzed. The Madhya Pradesh Government needs to embark on a proactive policy on tenancy reforms in the mission mode. There is a need for concerted efforts to reduce rainy season fallows in the watershed through appropriate technical interventions. The future intervention needs to examine the equity aspects in selection of trial farmers in other micro-watersheds, and waterlogging problem needs to be addressed in a participatory mode with initiation of experiments in pilot areas. The project implementing agency, Bharatiya Agro-Industries Foundation (BAIF) should play a stronger role in strengthening and linking the self-help groups (SHGs) to the formal credit market and a separate intervention strategy needs to be devised for the landless share croppers.

Introduction

The importance of a well-defined rural development strategy in the growth and development of India can never be overstated. The analysis of the national income statistics reveals that the share of agriculture in the net domestic product has fallen from 54% in 1931 to only 28% in 1993–94, with a marginal decline in the population engaged in agriculture from 71% in 1931 to only 65% (Shah et al. 1998). The ‘big push’ for agricultural development was a delayed effort up to the late 1960s with the launching of the Intensive Agriculture Development Program (IADP – “Green Revolution”) only after the shock of a decline in food production due to the failure of monsoons in 1965 and 1967. The strategy, however, was concentrated in the irrigated areas in selected regions of India; efficiency was given more importance than the equity aspects of the intervention. Commenting on the IADP, Chakravarty (1987, p. 27) stated that “Land reform was considered very important, at least in principle, in practice the issue was largely evaded. . . . It was also openly admitted that it was essential to bet on the strong.” This did not prevent the State to legislate one of the largest body of land reform acts in a short period of time (see Thorner 1976); however, the major problems have been the unenthusiastic implementation of the legislation except in the states of Kerala and West Bengal where leftist governments have been in power for a greater period of time. A recent study using state level data for sixteen states shows that land reforms have led to poverty reduction and the evidence shows that “this is primarily due to land reforms that challenge the terms of land contracts rather than redistributing land” (Besley and Burgess 1998).

This study revisits the land size-productivity relationship debate and provides new empirical evidence of the inverse relationship in owner-operated and share cropper-operated farms in Vidisha district, Madhya Pradesh, India. Share cropping is a form of land tenancy in which the landlord allows the tenant to use the land in return for a stipulated fraction of the output. The importance of understanding the relationship between land size and productivity (across various ownership groups) remains important even today. In India, the average size of land holdings in 1990–91 was 1.57 ha while the average operated area was only 0.19 ha (Singh and Singh 1999). A survey published by the International Rice Research Institute (IRRI) estimates that the arable land per capita would go down to 0.09 ha in 2025. The input decisions and the resultant output at various land sizes needs to be understood for an effective strategy of growth in crop production and productivity to achieve self-sufficiency and compete in a liberalized trade regime. The study intends to contribute to this understanding by undertaking a micro-level study

of farming households who cultivated soybean in the 1999 rainy season in Vidisha district of Madhya Pradesh.

Objectives

The objectives of this study are to:

- (i) Understand the relationship between land size (and various input variables) and soybean productivity among owner-operated and share cropper-operated farms.
- (ii) Examine the profitability for owner-operated farmers, landlords, and share croppers.
- (iii) Suggest policy intervention and intervention strategies for the Government of Madhya Pradesh and the stakeholders.

Methodology

Primary data was collected (in October and November 2000) from farmers and share croppers using an interview schedule for the 1999 rainy season soybean crop. Additional data has been collected from the Agriculture Officer, BAIF, Lateri Watershed in Vidisha district. The villages Jaoti, Kherkhedi, and Kundhankhedi were chosen through purposive sampling to contain both owner-operated farms and share croppers who cultivate soybean (Table 1). The respondents were selected through random sampling. The selected villages belong to Zone 9 according to the ICRISAT typology (ICRISAT 1999). The data has been analyzed by studying the relationship between various variables using the Karl Pearson correlation coefficient technique. In addition to the data in Table 1, information on the crop yields from 13 ICRISAT trial farmers in Lalatora village has been used for a comparative analysis.

Table 1. Details of sample for the study in Madhya Pradesh, India.

Village	Owner-operated farms	Share croppers	Total
Jaoti	18	20	38
Kherkhedi	12	13	25
Kundhankhedi	9	4	13
Total	39	37	76

Review of literature

The discussion on the inverse relationship between land size and productivity in agriculture could be traced back to the work of Chaynov (1966) who examined data of Russian agriculture for the 1920s and 1930s. In India the identification of the relationship came after the analysis of the data on Farm Management Surveys in the mid-1970s (Bhagwathi and Chakravarty 1969, Saini 1969, Bharadwaj 1974).

It was observed that small farms on an average employed more input (per unit area) and as a result had a higher output. The debate was initiated by Sen (1966) who argued that if the market wage rate is imputed to family labor, many of the farms would show losses and profitability increases with the size of the holdings. Sen (1966, 1975) provides an explanation in his theory of 'agricultural dualism' where the traditional small peasant is assumed to be well endowed with plentiful labor with low or zero opportunity cost while facing a severe constraint on credit. It was argued that these farms would employ labor up to the point of zero marginal productivity. Large farms, however, would employ labor up to the point where the wage rate equalled the marginal product. This could explain declining productivity in terms of output (per unit area) but increasing profitability. Srinivasan (1973) argued that if farmers are maximizing the expected utility of their income (and if they are risk averse), then it is optimal for small farms to employ more inputs (per unit area). The major reason for under-investment is the risk-averse behavior of the farmers, the variability of the monsoons being a major factor. Rosenzweig and Binswanger (1993) using ICRISAT data provide evidence to show that wealthier farmers are more likely to undertake riskier investments due to their ex-post consumption smoothing mechanism, whereas poorer farmers would not take that risk, even if they would have to be satisfied with lower but stable incomes.

The serious questioning of the inverse relationship has come from the proponents who argue that the quality of the land is the reason. The studies have noted that adjustment for land quality diminishes the inverse relationship (Khursro 1964, Sen 1975, Bliss and Stern 1982) and it is argued that the inverse relationship is a spurious result caused by the bias due to the omission of land quality in regressions (Bhalla and Roy 1988).

The efficiency of share cropping has been a long debated issue and one of the earliest advocates of the inefficiency hypothesis was Adam Smith. Smith (1776) argued that it was not in the interest of the share croppers to improve the productivity of the land as he got only one tenth of the product. He favored fixed rent contracts and was concerned with the insecurity of the farmers because of the expiration of the lease. He advocated "the law which secures the longest lease against successors of every kind". Commenting on the

metayers (share croppers), Arthur Young who was secretary to the Board of Agriculture in England said:

“There is not one word to be said in favour of the practice, and a thousand arguments that might be used against it. . . . In this most miserable of all the modes of letting land, the defrauded landlord receives a contemptible rent; the farmer is in the lowest state of poverty; the land is miserably cultivated; and the nation suffers as severely as the parties themselves. . . . Wherever this system prevails, it may be taken for granted that a useless and miserable population is found.” (Edwards 1892, pp. 202–203)

Marshall argued that share cropping leads to a Pareto-inefficient allocation of labor. The rental share paid to the landlord was tantamount to an excise tax on the share cropper’s effort and this would induce the share cropper to reduce his output below the wage level where the marginal product of the share cropping is equal to the wage level. This under provision of inputs by the share cropper has been characterized as “Marshallian inefficiency” in the literature. The Marshallian tradition was built on the implicit assumption that the share contract refers to only one variable; however, as pointed out by Cheung (1969) a contract need not contain only one variable. Cheung (1969) argues that many real world contracts (drawing evidence from Taiwan) specify such items as the amount of land to be cultivated, non-labor inputs to be supplied, etc., in addition to the rental share. If the labor intensity of the share cropped land is less than under wage cultivation, the landlord can earn higher rental income either by self cultivation (through hired labor) or by fixed rental tenancy.

On the other hand, if the landlord insists on a higher labor intensity on the share cropped land there would not be any tenant available for share cropping. Therefore, the optimum would require the labor intensity on the share cropped land should be such that the marginal product of labor is equal to the wage level and the rent per unit is equal to the marginal product. This idealistic and artificial analysis has been critiqued. Jaynes (1982) has rightly argued that “The tenant representation in this process is superfluous. Tenants make no real choices as to labor supply, but simply choose the various all or nothing offers made unilaterally by landlords The role of wage in Cheung’s analysis is just to ensure efficiency. The model is adhoc.”

Bardhan and Srinivasan (1971) were the first to extend the conventional unilateral maximization approach to a general equilibrium approach. They allow both the landlord and the tenant to influence in determination of the share rental value while retaining the perfectly competitive labor market assumption of Cheung and Marshall. The share-tenant in the model has the option of leasing in land to cultivate with his own labor or working as a wage labor in some alternative employment. The tenant is assumed to maximize his

utility in terms of income and leisure. On the supply side, the landlord has the option of cultivating his own land or renting it out to the share cropper. The landlord like the tenant is assumed to maximize his utility, which is defined in terms of income and leisure. Combining the demand and supply functions so derived they go on to determine the competitive share-rental rate.

Bhaduri's (1973) contribution has been a significant one in which he shows that a landlord who is a provider of consumption loans to his tenant may have no incentive to adopt yield-increasing innovations, if the landlord's interest from his loans to the tenant does not go down (because the tenant will borrow less as he shares the increased yield). This proposition has been critiqued by Newberry (1974), Ghose and Saith (1976), and Srinivasan (1979) that it is a weak constraint on adoption of technical progress and it is argued that if the landlord has sufficient power to exploit his tenant-borrower and to withhold the innovation, then he ought to have sufficient power to gain from the innovation.

An income maximizing landlord will always prefer to self-cultivate rather than employ a share cropper (to escape from Marshallian inefficiency). A modification of the Marshallian tradition is provided by Lucas (1979) who presents a joint optimizing system which is differentiated from others by the feature that wage labor requires monitoring in order to extract full effort. Landlords may prefer share tenancy contracts because in these contracts workers have an incentive to work harder even without supervision. The cost is the monitoring cost for the landlord and for the tenant it is the share tax on the extra output produced. The study found that mixed wage and share tenancy contracts along with share tenancy contracts provides higher social welfare than a wage only contract.

Share cropping is seen as a risk between the landlord and the tenant. Newberry and Stiglitz (1979) have developed an approach drawing on insights from the capital market. Each leasing agreement (share cropping or renting) or self-cultivation is viewed as an asset with specific risk and return characteristics. The landlord's problem is to allocate his land between the assets in such a way as to maximize his expected income. The analysis of the study indicated that incorporating uncertainty provides little rationale for share cropping. It is argued that the mixture of rental and wage agreements provides exactly the same income as share cropping.

Role of tenancy in imperfect rural markets

Tenancy as a mechanism for resource adjustment

Tenancy is a contractual system that enables rural households to adjust their resources, particularly land in relation to their endowment labor and draft power. Thus rural households may find that they are better off in leasing land than seeking wage employment given the limited and uncertain job opportunities in rural areas. Conversely, where labor is scarce, especially during peak seasons, landowners may prefer to lease out land rather than depend on an uncertain supply of labor.

Tenancy and incentives

The argument that tenants have a greater incentive to work than wage laborers is rooted in classical economics in the writings of Adam Smith, J S Mill, and Marshall. Smith argued that in Europe share-tenancy succeeded serfdom which itself gave way to fixed rent tenancy.

Tenancy as a credit system

In developing countries like India where markets for capital and credit are underdeveloped, the only way a person may have access to these resources is to enter into a tenancy contract. This is one of the main incentives in rural India where consumption loans and provision of goods in kind is strong incentive. Braverman and Stiglitz (1980) have argued that there are good reasons for this arrangement as it lowers the cost of credit to the tenant and enables the landlord to monitor the tenant's effort. Landlords also provide credit to the tenants by supplying them inputs, with the tenant's contractual share of the costs being subtracted from his/her share of the output after the harvest.

Tenancy, risk, and entrepreneurship

Agricultural production and its returns are risky and have an important bearing on the contractual system which in turn has a differential effect on the landlord and the share cropper. Cheung (1969) was the first to put forward the hypothesis that the choice between different forms of land tenure arrangements was likely to be affected by the parties' risk aversion under uncertainty.

Tenancy contracts do provide an incentive for effective realization of the entrepreneurial abilities provided the contractual terms are favorable. Rao (1971) noted that share cropping seemed more prevalent in India where crops provided little scope for

decision making by tenants, whereas fixed rent contracts were most often needed when more decision making was required. Also in South India, share cropping dominated the rice-producing areas with assured irrigation, while fixed rents prevailed in tobacco-growing areas. In the tobacco-growing areas the small holders tended to lease out to large holders. Newberry (1975) suggested that fixed rent contracts might be preferred for crops requiring entrepreneurial skills where (i) landlords were more risk averse than the tenants; (ii) tenants had special skills that they did not wish to share with landlords; or (iii) landlords faced the problem of 'moral hazard' that they could not determine whether shortfalls in output were the tenant's fault.

Efficiency of share cropping

Rao (1971) (with evidence from Andhra Pradesh) and Chakravarty and Rudra (1973) (with evidence from five Indian districts) concluded that the behavior of share croppers is basically not different from that of owners. The following studies have reported the Marshallian proposition of higher input and output intensities per unit on owned land relative to share cropped land: Bell (1977) with data from Northeast India, Chattopadhyay (1979) from West Bengal, and Shahban (1987) with evidence from 8 districts in India. Bliss and Stern (1982) have reported mixed evidence in an intensive study in Palampur, Uttar Pradesh. The study found no major differences in crop yields between share croppers and owner-operated farms. Shahban (1987) compared the yield obtained by share croppers on their own land vis-à-vis leased land from eight ICRISAT study villages in Andhra Pradesh, Maharashtra, and Gujarat. The main empirical findings of the study are: (i) output and input intensities are higher on the owned plots of a mixed share cropper compared with the share cropped plots; (ii) the differences in irrigation across tenure status is important in explaining a large fraction of the input and output differences while soil quality variations are not; (iii) when the variation in irrigation, plot value, and soil quality is controlled, no systematic differences between the plots that are owned and those rented could be detected. The study, therefore, argues that sizeable differences in share croppers are caused by the form of contractual arrangements and not tenancy per se.

Soybean production and productivity in India

The post-independence strategy of agricultural development laid a greater emphasis on attaining self-sufficiency in cereals and support in terms of technological and institutional inputs were directed towards it. In this process, pulses, the major source of protein and

edible oil, remained neglected and the country relied on imports to bridge the shortfall in pulses production. The “Yellow Revolution” associated with the quick spread of oilseeds since the 1980s took root in the less irrigated areas of low and erratic rainfall in the semi-arid tropics (SAT) of India. In the mid-1980s, India was importing 30% of its requirement of edible oils bringing a strain on the balance of payment account. The Technology Mission on Oilseeds was launched in May 1986 and this resulted in a gradual but steady rise in the domestic market prices of oilseeds as imports of oilseeds were restricted. This trend was further accentuated in January 1989 when the National Dairy Development Board, serving as the apex agency for oilseeds, was set up. During this period about 7 million ha of additional area came under oilseeds; this area was partly from rainy season fallow, partly through crop intensification, and a substantial part through crop substitution. The shift was largely from coarse cereals, but in some pockets even pulses and wheat were replaced with oilseeds (Gulati and Kelly 1999).

In India the oilseeds sector accounts for 19% of the total global area and 9% of the production; however, the productivity is only 0.93 t ha^{-1} as compared to the world level of 1.63 t ha^{-1} . Oilseeds form the second largest commodity after cereals in India, accounting for 14% of the country’s gross cropped area, nearly 5% of the gross net production, and 10% of the value of all agricultural products. Fourteen million people are involved in the production of oilseeds and one million in processing (Hegde 2000).

Given the deficit in pulses as well as edible oils, soybean assumes great significance as it contains about 45% protein and 18% oil. Though soybean (black) is traditionally grown on the foothills of the Himalayas, Kumaon, and Garwahal regions of Uttar Pradesh and some scattered pockets in central India, the awareness about soybean, the exploitation of its commercial potential, and the introduction of yellow soybean is of recent origin starting with research at experimental stations in the mid-1960s. The prospects of promoting black soybean cultivated traditionally in some parts of India were low due to its low yield, color, hard seed coat, and lack of market. Soybean seeds were introduced from USA and tested between 1963 and 1965 at the Indian Agricultural Research Institute (IARI) in New Delhi, and at Pantnagar and Jabalpur. The University of Illinois, United States Agency for International Development (USAID), and Indian Council of Agricultural Research (ICAR) collaborated in this effort. Experiments suggested that a varietal breakthrough of local conditions might be achieved and the All India Coordinated Research Project on Soybean sponsored by ICAR was initiated in 1967 with its headquarters in Pantnagar. There are 19 centers involved in the project in different agroclimatic regions.

India’s share in the world soybean production in 1998–99 was 5.2%, with production of 6.94 million t out of the total world production of 159.85 million t (Table 2). The

productivity of soybean in India in the 1970s and 1980s varied from 0.54 to 0.75 t ha⁻¹ and increased up to 1.12 t ha⁻¹ in 1997–98 (Table 3). Seventy percent of India's soybean is produced in Madhya Pradesh from the gross cropped area of 7.6 million ha. The average yield for Madhya Pradesh varies from 0.81 to 1.06 t ha⁻¹. ICRISAT (1999) estimated the productivity of soybean for different zones in India. The data given below are the averages of the triennium ending 1993:

Zone 3 (Irrigated wheat zone of central Madhya Pradesh and Uttar Pradesh)	: 1.02 t ha ⁻¹
Zone 8 (Rainfed wheat-chickpea zone of central Madhya Pradesh)	: 0.81 t ha ⁻¹
Zone 9 (Soybean dominant zone of western Madhya Pradesh)	: 1.06 t ha ⁻¹
Zone 10 (Rainy season sorghum-cotton system of western Maharashtra and parts of Madhya Pradesh)	: 0.96 t ha ⁻¹

Table 2. Soybean production and yield in the world.

Country	Production (1999–2000) (million t)	Yield (t ha ⁻¹)
USA	71.93	2.45
Brazil	31.40	2.36
Argentina	20.70	2.42
China	14.29	1.75
Paraguay	2.90	2.52
European Union	1.14	3.12
India ¹	6.94	1.10

1. Estimates for 1998–99 (Source: Agricultural Situation in India).
Source: USDA (2000).

Table 3. Soybean production in India from 1993 to 1999.

Year	Area (million ha)	Production (million t)	Yield (t ha ⁻¹)
1993–94	4.2	4.2	1.08
1994–95	4.0	3.7	0.91
1995–96	4.9	5.0	1.02
1996–97	5.3	5.1	0.99
1997–98	5.8	6.5	1.12
1998–99 ¹	6.3	6.9	1.10

1. Estimates.
Source: Agricultural Situation in India (various issues).

Soybean under a liberalized trade regime

India signed the Uruguay Round Agreement of the General Agreement on Tariffs and Trade (GATT) vested in the World Trade Organization which makes it mandatory for member countries to gradually open their agriculture to world markets.

Market access

Under market access commitments, all member countries of the GATT are required to (i) replace all types of non-tariff barriers with tariff barriers; and (ii) reduce the level of tariffs under a time bound program (these levels are to be reduced by 24% for developing countries). The period within which these restrictions are to be taken up varies from six years in developed countries to ten years in developing countries.

Aggregate measure of support

The aggregate measure of support (AMS) is the annual aggregate value of market price support, non-exempt direct payments, and any other subsidy not exempted from the reduction commitments expressed in monetary terms. If the product specific and non-product specific exceeds 10% of the total value of agricultural production, it is to be reduced by 13.3% of the value that does not qualify for exemption during the implementation period. India has basically two types of support for farmers: (i) market price support, which is in the form of minimum support prices, announced by the Commission for Agricultural Costs and Prices; (ii) input subsidies on inputs such as fertilizers, irrigation, credit, and seeds. The calculations for India shows that AMS for 17 major commodities including soybean is negative. This negative support (or net taxation) is due to the fact that prices of different crops are fixed by the government below international levels.

Export competition

The GATT agreement calls for reducing export subsidies by 24% from their 1986–88 level in developing countries over a period of ten years. The quantity of subsidized export is to be reduced by 14%.

Domestic policy on liberalization

In February 1995 almost all edible oils (except coconut oil) have been put under the Open General License (OGL) with an import duty of 30%. In July 1996 it was reduced to 20% and in July 1998 the effective duty on edible oils was 15%. Under the market access clause, members are required to convert non-tariff barriers and submit ceiling tariff

bindings for all commodities. For oilseeds in general the government committed a maximum tariff rate of 100% although the prevailing rate in April 1996 was 40–50% in order to protect the oilseeds sector.

ICRISAT (1999) projected the resource cost ratio (RCR) and the profitability rates of soybean (Table 4). The RCR was calculated from the domestic resource cost (DRC). DRC is defined as the value of domestic resources needed to save a unit of foreign exchange.

$$\text{RCR} = \text{DRC}/\text{Shadow Exchange Rate}$$

Table 4. Resource cost ratio (RCR) and profitability of soybean under a liberalized trade regime.

Land	RCR	Private profit (Rs. ha ⁻¹)	Social profit (Rs. ha ⁻¹)	Subsidies (Rs. ha ⁻¹)
Irrigated	1.07	4389	-1129	2091
Rainfed	0.98	6390	230	903
Average	0.99	6150	-109	

Source: ICRISAT (1999).

The RCR for irrigated soybean is 1.07, which means the country has to spend Rs. 1.07 to save Rs. 1.00 of foreign exchange whereas for rainfed soybean, the country has to spend Rs. 0.98 to save Rs. 1.00 of foreign exchange. The private profit is also higher with a positive social profit (due to lesser subsidies). The cost of subsidies of irrigated soybean is Rs. 2091 ha⁻¹ in comparison with only Rs. 903 ha⁻¹ for rainfed soybean (Table 4). If all subsidies were abolished, the profitability of irrigated soybean will suffer by 48% and induce a shift away from the crop under irrigated conditions.

Therefore, the policy implication is quite clear that research priority should be given to rainfed soybean and attempts should be made to bring an increase in area of rainy season fallow under soybean or the replaceable crops of cotton, sorghum, or maize.

Study area

Madhya Pradesh is the largest state in India, spread over an area of 443,446 km² (13.5% of the total area of the country; data predates the formation of Chattisgarh state). The total population of Madhya Pradesh was 66.14 million in 1991, accounting for 7.8% of India's population. The state comprises 14.6% of scheduled castes and 22.3% of scheduled

tribes. Ninety percent of the rural population is engaged in agriculture, 52% of the main working population in the state are cultivators, and 23.5% are landless laborers (TARU 1999). The Planning Commission estimated that in 1995, 42.5% of the state's population lived below the poverty line with the national average at 33.5% (Government of Madhya Pradesh 1998). However, it is estimated that in Vidisha district, the poverty head count ratio is below 10%. According to the Ninth Five Year Plan, per capita income in Madhya Pradesh was Rs. 6,597 as against the national average of Rs. 9,321. Although 90% of the rural population is engaged in agriculture, the contribution of the primary sector to the state domestic product is only 43% with 25% from secondary sector and 32% from tertiary sector.

Vidisha district

Vidisha district is ranked 30th in the Human Development Index (HDI), 1998 out of 45 districts in Madhya Pradesh, with a HDI of 0.481 and ranked 37th in the Gender Development Index (GDI) with GDI of 0.523. About 1.5% of Madhya Pradesh's population lives in Vidisha district with a population of 20.3% of scheduled caste and 4.4% of scheduled tribe. Literacy is 58% in males and 27.8% in females (Government of Madhya Pradesh 1998). The Gini coefficient of operational holding is 0.555.

Irrigated area is 71,900 ha while the unirrigated area is 4,448,800 ha. The average fertilizer consumption is 29.9 kg ha⁻¹. The land ownership in the district is: wholly owned area, 0.9%; wholly leased in holdings, 63.1%; and wholly otherwise operated area, 31.2% (Government of Madhya Pradesh 1998). The definition of 'wholly otherwise operated' is not mentioned and it is hypothesized that this refers to land cultivated on government and common lands illegally. Also, lands operated by households above the land ceiling act is included in this category.

Intervention of ICRISAT and BAIF

The intervention of ICRISAT in Lalatora micro-watershed in the 1999 rainy season is part of a larger project titled "Improving Management of Natural Resources for Sustainable Rainfed Agriculture" funded by the ADB. The participating member countries of the project are India, Thailand, and Vietnam.

The objectives of the project are to: (i) increase the productivity and sustainability of the medium and high water-holding capacity soils in the intermediate rainfall ecoregion; and (ii) develop environment-friendly resource management practices that will conserve soil and water resources. The project focuses on the intermediate rainfall ecozone in central India, northeastern Thailand, and northern Vietnam where the annual rainfall is about 800–1300 mm and where soils have a relatively high water-holding capacity.

The rationale for the interventions is due to the temporal variability in amount and distribution of rainfall (which creates highly uncertain agricultural environment), which results in food insecurity of poor farmers in SAT and discourages them to make productive investment in agriculture. The “cycle of unsustainable agriculture and soil degradation in the Asian tropics can be stalled by the application of low-cost scientific rainfed agriculture” (ICRISAT website: www.icrisat.org/nrmp/). The project aims at intensification of crop production in the target environments through efficient use of natural resources including efficient water use so that rainfall use efficiency for crop production is increased and land degradation is minimized.

The intermediate rainfall zone in Asia receives rainfall between 800 mm and 1300 mm annually and has black soils (Vertisols, associated soils, and Alfisols). The main crops in the region are rainfed cash crops such as soybean, cotton, and groundnut in addition to food crops such as mung bean, maize, pigeonpea, and sorghum. In India, 72 million ha is covered by Vertisols and associated soils. The area under soybean has increased from 3% to 5% annually over the last 10–15 years due to the greater profitability of the crop and in 1999, 5.8 million ha was under the crop as compared to 10,000 ha in 1981. The potential simulated analysis of potential yields of soybean ranges from 2.3 t ha⁻¹ in Bhopal to 4.3 t ha⁻¹ in Raisen district (ICRISAT 2000) as against the current productivity level of 0.94 t ha⁻¹ in India. The project intends to achieve increased production of soybean that might brighten the prospects of export of soybean and bring down the import of edible oils and pulses (ICRISAT 2000).

BAIF, a non-governmental organization (NGO) is working in the Lateri Watershed area, Lateri Block, Vidisha district. The average rainfall in the area is 1020 mm. The soil in this area is medium to deep black. The Lateri Milli watershed in Vidisha district comprises an area of 7900 ha in 11 micro-watersheds covering 25 villages. In the rainy season the cropping pattern in the area as reported by the implementing agency BAIF is: soybean, 54.8%; fodder (grass), 19.8%; small millets, 20.8%; maize, 4.0%; and others, 0.6%.

The Rajiv Gandhi Watershed Mission of the Government of Madhya Pradesh funds the watershed program. The program comprises 11 micro-watersheds covering 15 villages. The project was initiated in November 1997 with a total estimated cost of Rs. 42.3 million rupees covering 7900 ha. A total area of 3693 ha (government land, 2395 ha; private land, 1298 ha) was treated for soil and water conservation until 21 July 2000. Plantation work has been undertaken in 0.33 ha of government land and 57 ha of private land, while fuel wood plantation has been undertaken in 1300 ha of government land and 47 ha of private land.

Jaoti (800 households), Kherkhedi (200 households), and Kundhankhedi (13 households) were selected as the sample villages. These villages are connected by road to the nearest market place, Anandpur. The villages are electrified except for a part of Kherkhedi village. Although schools are prevalent in Jaoti and Kherkhedi villages, the drop out rate for both the boys and girls is high. The nearest banks are the Land Development Bank and the Cooperative Bank in Anandpur village, which lends to farmers with the collateral of the land documents. A small river flows near Kherkhedi village. Jaoti village has a pond, whose desiltation from the watershed program has helped in the recharge of groundwater. The nearest hospital is in Lalatora village, which is run by the Sadguru Seva Trust. Child marriage is prevalent in the area. Incidence of tuberculosis is high, especially among young women, who give birth at an early age, become anemic and are prone to tuberculosis. The villages are located in the radius of 25 km from Lateri Block of Vidisha district, which is 150 km away from the state capital, Bhopal (Fig. 1).

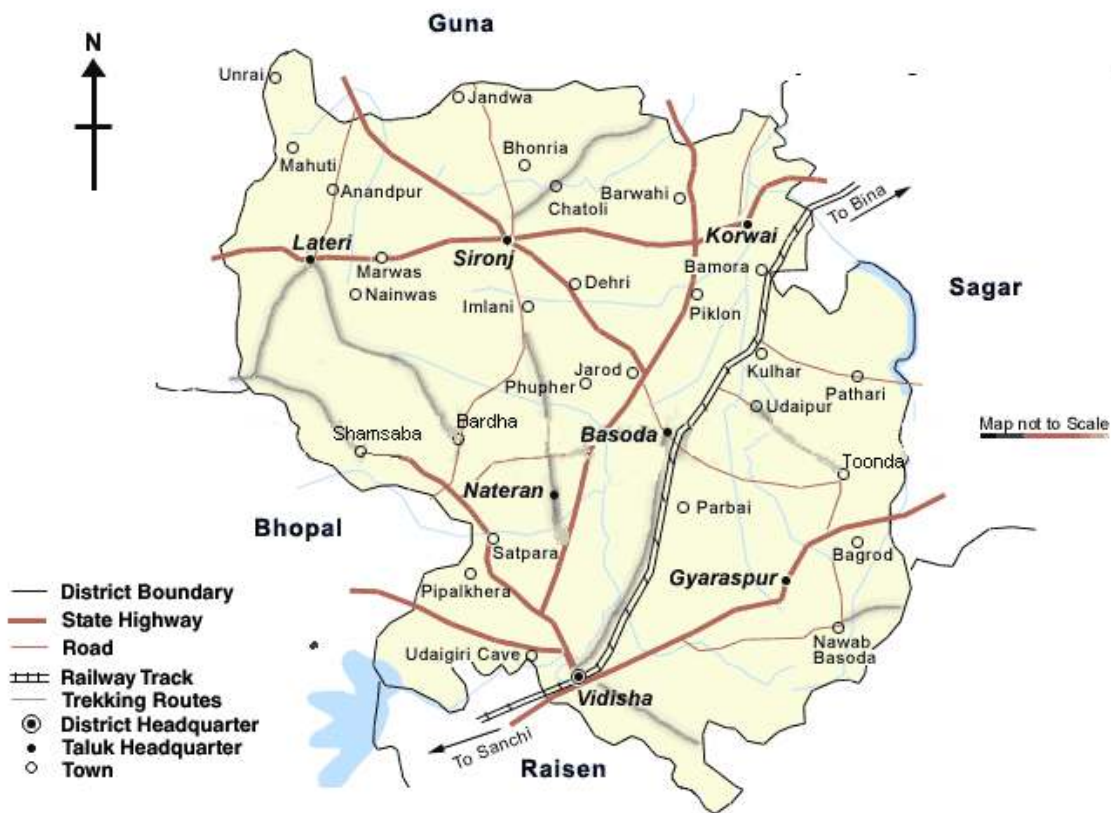


Figure 1. Map of Vidisha district, Madhya Pradesh, India.

A total of 46 SHGs have been initiated with 380 members. In Jaoti, there is one SHG with three male members and another group of women also comprising three members. In Kherkhedi, there are two male SHGs comprising 19 members and two women's groups comprising 21 members. No group has been formed in Kundhankhedi. There is scope for improving the functioning of the SHGs which are not functioning to the desired levels. The patriarchal society and the prevalence of the 'purdah' system among the women inhibits the free interaction of women in society and is a major constraint faced by any intervention strategy.

Cost of cultivation

The concept of productivity used in this study refers to yield per hectare. The cost of cultivation of soybean is as follows:

- Land preparation cost - The cost of hiring a tractor is Rs. 200 h⁻¹.
- Seed cost - Rs. 12 kg⁻¹.
- Diammonium phosphate (DAP) - Rs. 10 kg⁻¹.
- Single superphosphate - Rs. 2.70 kg⁻¹.
- Average wage rates (per day) prevalent in the village:
 - Sowing - Rs. 40.
 - Weeding - Rs. 40 to Rs. 50.
 - Harvesting - Rs. 50 (up to Rs. 75 in peak demand).
- The imputed labor costs of the landlord (share cropper is not computed in calculating the costs).
- The cost of threshing is Rs. 3 to 5 for 100 kg of threshed soybean.

ICRISAT provided technical support through the NGO during the first year and recommended best bet option treatment to trial farmers. The best bet option includes:

- Thiram:bavistin - 1:2 ratio. Thiram and bavistin seed treatment (at 3 g kg⁻¹ seed) helps in healthy crop stand.
- *Rhizobium* - 1.25 kg ha⁻¹.
- Phosphate solubilizing bacteria - 1.25 kg ha⁻¹.
- Murriate of potash - 50 kg ha⁻¹.
- Urea - 50 kg ha⁻¹.
- DAP - 125 kg ha⁻¹.

Owner-operated farms

The study of owner-operated farms involved the collection of primary data from 39 farmers in the villages of Jaoti (Middle Zone of the watershed), Kherkhedi (Lower Zone), and Kundhankhedi (Middle Zone) (Table 5). The data collected by the BAIF Agriculture Officer on the yield of 13 ICRISAT trial farmers from Lalatora village (Lower Zone) was also used to compare the yield between the trial and non-trial farmers in other villages.

Table 5. Land holding of soybean owner-operated farms.

Village	Sample size	Dryland (ha)	Irrigable land (ha)	Total (ha)
Jaoti	18	68.06	30.62	98.68
Kherkhedi	12	47.50	33.99	81.49
Kundhankhedi	9	57.00	20.25	77.25
Total	39	172.56	84.86	257.42

Land utilization

The rainy season sown area in Jaoti, Kherkhedi, and Kundhankhedi consisted predominantly of irrigable land signifying that the soybean crop is predominantly grown on irrigable land and lands without irrigation facilities are kept for growing the post-rainy season crop. The percentage of total area that is uncultivated in rainy season is 71.85% which is predominantly dryland (Table 6). Although Vidisha district has an average rainfall of 1200 mm which seemingly is “assured rainfall”, the variation during the crop cycle is an important factor. Foster et al. (1987) stated that the main problem during rainy season in Begumgunj village in Madhya Pradesh is erratic rainfall. Although total annual rainfall is adequate compared to other semi-arid tropical areas, the pattern of onset, cessation, and distribution within the season is unpredictable and creates high risk of crop failure.

The dryland farmers in the study villages do not prefer to cultivate the land in the rainy season and instead prefer to lease-out to share croppers, as in Jaoti village. This has important implications as the farmers prefer to grow soybean in irrigable area. The intervention strategy to reach out to dryland farmers who leave the land uncultivated in the rainy season needs to be considered seriously. The major reason stated by the farmers for leaving the land fallow is that growing soybean would delay the cultivation of the post-rainy season crop which is a more assured crop for the dryland farmers.

Table 6. Land utilization and output of soybean owner-operated farms.

Village	Sown area (ha)	% of sown area irrigable	% of total area uncultivated	Production (t)	Gross output (Rs.)
Jaoti	31.22	98.07	67.46	24.2	178811
Kherkhedi	21.24	92.93	73.93	15.1	112355
Kundhankhedi	20.00	98.76	73.78	13.3	106375
Total	72.46	-	-	52.6	397541
Average		96.58	71.85		

Therefore, there is a need to promote short-duration varieties so that the farmer has a better incentive and is at a lesser risk when he attempts to cultivate soybean in the dryland. Waterlogging is another constraint which strengthens the risk-averse behavior of the dryland farmer (excess rains during the 1999 rainy season caused waterlogging). Broad-bed and furrow (BBF) technique needs to be supplemented with an overall intervention for improving the drainage system in the watershed.

Productivity

The average productivity among the 39 farmers is 0.72 t ha^{-1} which varies from 0.66 t ha^{-1} to 0.78 t ha^{-1} in the three villages in comparison to ICRISAT trial farmers who obtain an average productivity of 1.1 t ha^{-1} (Table 7). The productivity obtained by farmers from the other villages ranges from 0.12 t ha^{-1} to 2.40 t ha^{-1} (see Tables 8 and 9 for input intensity of highest and lowest productive farms). The average land operated size is 2.11 ha .

The highest yield obtained by the farmer in Jaoti in 0.5 ha of irrigable land, involved no input of fertilizers (compared to the average of 46 kg ha^{-1}) with cost of cultivation of $\text{Rs. } 5432 \text{ ha}^{-1}$ (against the average of $\text{Rs. } 3100 \text{ ha}^{-1}$). The labor input was 136 days ha^{-1} of which 70% comprised of own labor which was highest among all owner-operated farmers. In comparison the lowest yield of 0.12 t ha^{-1} sown in 0.25 ha of irrigable land involved application of 15 kg of DAP with no weeding undertaken and with cost of cultivation of $\text{Rs. } 3044 \text{ ha}^{-1}$. The labor input was 54 person-days, which was entirely of the farmer and his family. The yields obtained by three farmers who utilized farmyard manure (FYM) are given in Table 10.

Table 7. Yield and profit of soybean owner-operated farms.

Village	Cost of cultivation (Rs. ha ⁻¹)	Yield (t ha ⁻¹)	Benefit-cost ratio	Profit (Rs. ha ⁻¹)	Loss making farmers	Loss amount (Rs)
Jaoti	3100	0.78	1.86	2636	2	3017
Kherkhedi	4035	0.71	1.31	2166	3	2595
Kundhankhedi	3285	0.66	1.84	2444	0	0
Average	3320	0.72	1.63	2045		
Total					5	5612

Table 8. Input intensity of five high productivity owner-operated soybean farms.

Village	Yield (t ha ⁻¹)	Labor (person-days ha ⁻¹)			% of own labor in total labor	% of hired labor in total labor	Land size (ha)
		Own	Hired	Total			
Jaoti	2.40	136	58	194	70	30	0.50
Kherkhedi	2.00	56	0	56	100	0	0.25
Jaoti	1.94	122	97	219	56	44	0.62
Jaoti	1.34	41	32	73	86	14	0.50
Kherkhedi	1.20	77	0	77	100	0	0.75

Table 9. Input intensity of five low productivity owner-operated soybean farms.

Village	Yield (t ha ⁻¹)	Labor (person-days ha ⁻¹)			% of own labor in total labor	% of hired labor in total labor	Land size (ha)
		Own	Hired	Total			
Kherkhedi	0.12	52	0	52	100	0.00	0.25
Jaoti	0.36	28	0	28	100	0.00	0.25
Kherkhedi	0.40	8	20	28	20	28.57	2.50
Jaoti	0.46	7	5	12	57	43.00	8.75
Kherkhedi	0.50	0	48	48	0	100.00	5.00

Table 10. Yield of soybean obtained by farmers who used farmyard manure (FYM).

Village	Area (ha)	FYM (t)	Yield (t ha ⁻¹)
Jaoti	0.25	0.96	1.20
Kherkhedi	0.62	0.64	0.56
Kundhankhedi	0.25	1.00	2.00

Land size productivity relationship

The relationship is found to be inverse with the overall r of -0.27 and the r for Jaoti and Kherkhedi being -0.27 and -0.38 respectively; however, in Kundhankhedi village the correlation was found positive at 0.27 (see Figures 2, 3, and 4). Among ICRISAT trial farmers the relationship has been found inverse and the r at -0.36 .

Fertilizers and labor inputs

The relationship between land size and fertilizer usage is positively correlated but is not significant at 0.17 . The correlation for the three villages Jaoti, Kherkhedi, and Kundhankhedi is 0.22 , 0.08 , and 0.30 respectively (Table 11).

Table 11. Correlation between land size and variables in soybean owner-operated farms.

Village	Fertilizer use	Total labor input	Hired labor input	Yield
Jaoti	0.22	-0.45	-0.17	-0.27
Kherkhedi	0.08	-0.32	0.92	-0.38
Kundhankhedi	0.30	0.30	0.58	0.27
Average	0.17	-0.37	0.44	-0.26

Labor

The relationship between land size and labor invested in cultivation of a hectare of land is found to be inversely related with the correlation being -0.37 . The correlation for Jaoti and Kherkhedi is -0.45 and -0.32 respectively. However, for Kundhankhedi the relation is positive at 0.30 , but not significant (Table 11).

The productivity of the five highest productive farms in Jaoti involved an average labor input of 130.8 person-days ha^{-1} (own labor 63.45%), compared to 21.89 person-days ha^{-1} among the five lowest productive farms of which 90.93% comprised own labor. The productivity of the five highest productive farms in Kherkhedi involved an average labor input of 85.57 person-days ha^{-1} of which 90.26% consisted of own labor. The average labor input of the five lowest productive farms involved an average of 17.15 person-days ha^{-1} of which 56.41% consisted of own labor. The productivity of the two highest productive farms in Kundhankhedi involved input of 43 and 36 person-days ha^{-1} compared to 19 and 21 person-days ha^{-1} for the lowest productive farms.

The rationale for the farmers to underinvest inputs is due to the variability of an important variable, i.e., rainfall. In the 1999 rainy season the problem was excess rainfall, particularly during the sowing period. The farmers reported that it rained continuously for two days around June 20, 1999. An important determining factor, therefore, was the slope and drainage of the land in escaping from waterlogging. The risk-averse farmer therefore consciously underinvests his inputs to minimize the risk. Among the sample of 39 farmers, 5 farmers suffered losses amounting to Rs. 5196 without adding the imputed market value of their own family labor. Rosenzweig and Binswanger (1993) in their study attribute the risk-aversiveness in smaller farmers with fewer assets to their lesser ability for obtaining post-ante consumption smoothing mechanisms.

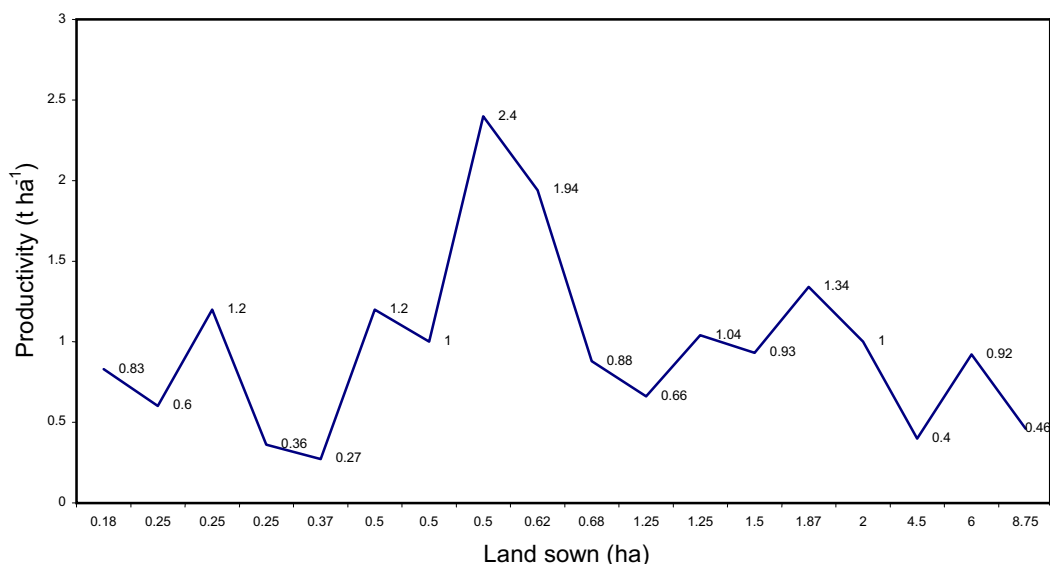


Figure 2. Land size-yield relationship in owner-operated farms in Jaoti, Madhya Pradesh, India.

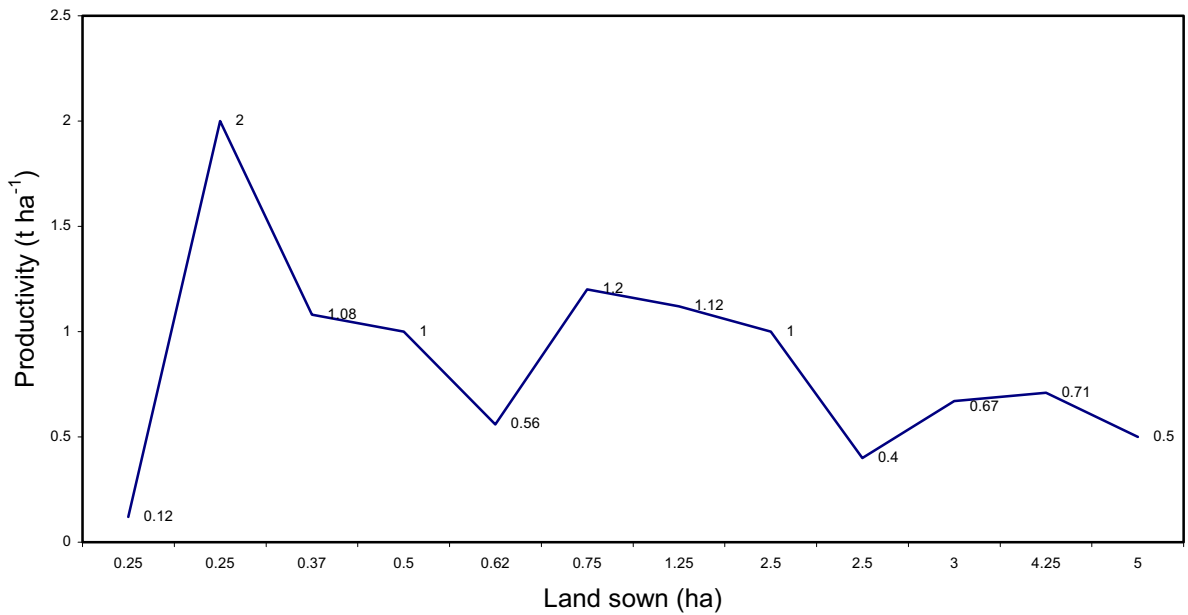


Figure 3. Land size-yield relationship in owner-operated farms in Kherkhedi, Madhya Pradesh, India.

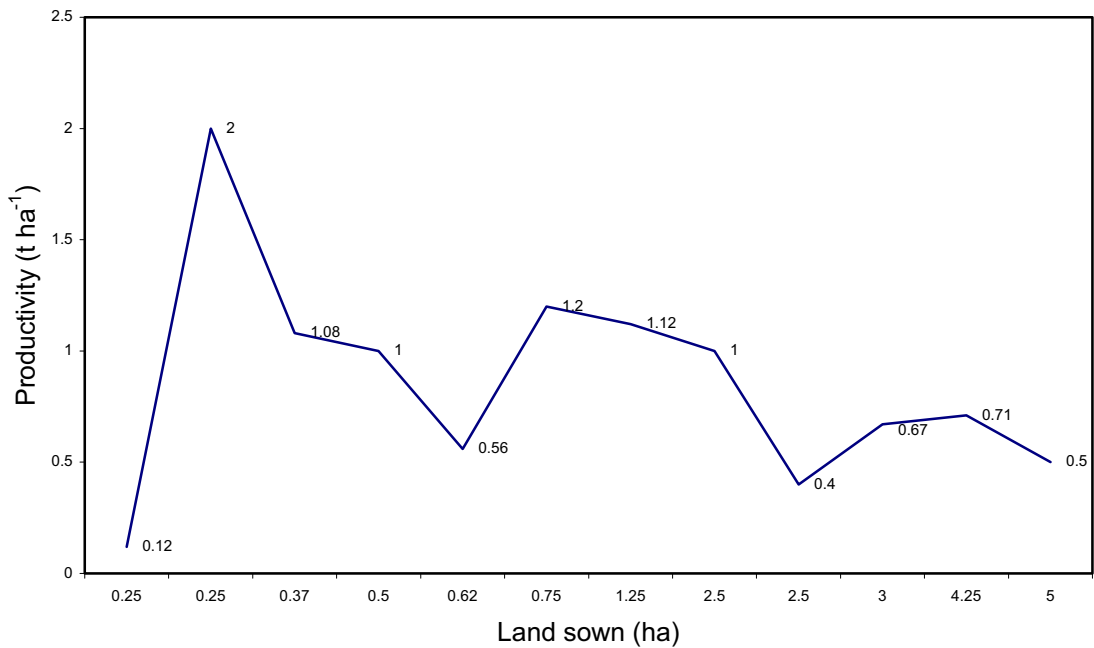


Figure 4. Land size-yield relationship in owner-operated farms in Kundhankhedi, Madhya Pradesh, India.

Profitability

The average profit of owner-operated farms in the three villages is Rs. 2045 ha⁻¹ (range Rs. 2166 to Rs. 2636 ha⁻¹) (Table 7). The profit for the ICRISAT trial farmers from Lalatora village is Rs. 5575 ha⁻¹ (non-trial farmers had a profit of Rs. 4688 ha⁻¹). Five farmers suffered a total loss of Rs. 6102.

The relationship between land size and productivity is found inverse with a negative correlation of -0.27 providing additional support for the existence of the inverse returns to scale relationship. During the first year of the experiment due to better input practices ICRISAT trial farmers have been able to attain better yield of 1.1 t ha⁻¹ (range 0.51–1.60 t ha⁻¹) but have not been able to escape the inverse returns phenomenon which has become endemic in Indian agriculture. The role played by the monsoon rains has proved to be an important factor and in this particular year, excess rainfall has caused the variability in the yield of different farms and the waterlogging potentiality of the land has been an important determinant. The farmers who have underinvested inputs had done so voluntarily to minimize the risks. This factor has been recognized as a significant variable in an earlier study by Rosenszweig and Binswanger (1993) for 10 ICRISAT study villages using data for ten years from 1975/76.

Share cropper-operated farms

A large proportion of land holdings, 79.4% in Vidisha district is reported to be leased-in with only 1.7% classified as wholly owned and self-operated and 18% classified as 'otherwise operated', which refers to cultivation on government and common lands (Government of Madhya Pradesh 1998). This reflects the presence of an inequitable land holding structure, which encourages the active operation of the lease market. The study involved the collection of data from 37 share croppers in the three sample villages. There are three forms of share cropping in these villages:

1. 20:80 Under this contract, the landlord undertakes the activities of sowing the seeds and the share cropper undertakes application of fertilizers and the rest of the activities. The output is shared in the ratio 20:80 between the share cropper and landlord. There are eight share croppers (21.6% of the sample) under this contract in the sample.
2. 33:66 All the activities are undertaken by the share cropper and the monetized costs and output are shared in the ratio 33:66 between the share cropper and landlord respectively. The landlord invests on seeds and fertilizers and the cost is shared. Twenty share croppers (54% of the sample) are under this contract in the sample.

3. 50:50 All the activities are undertaken by the share cropper and the monetized costs and input are shared in the ratio 50:50 between the share cropper and landlord. The landlord invests on seeds and fertilizers and the cost is shared. Nine among the sampled share croppers (24.3% of the sample) are under this contract.

The supervision of the share croppers by the landlords is done intensively. The landlord does the investment of seeds and fertilizers initially. The labor inputs in terms of hired labor to be engaged is decided mutually. The landlord periodically visits the plots and instructions are issued to the tenant for accomplishment of activities within a given time.

The duration of the lease period normally does not exceed two consecutive seasons. Although leasing is prohibited in Madhya Pradesh, its enforcement is non-existent, but farmers due to risk-averse behavior do not take risks and shift the tenants periodically. The emergence of the 20:80 contract wherein the landlord undertakes the sowing and fertilizer operation should be seen under this risk-averse behavior of the landlord to escape the legislation where the tiller is the owner. This contract is usually between the small and marginal farmers who do not have capital and have only their labor to offer.

The resource adjustment due to inequitable resource endowment, inequitable distribution of land holding, and the banning of tenancy have helped in the emergence of the 20:80 contract. The 33:66 contract is also a mechanism for resource adjustment between the better endowed landlord and the less endowed tenant. The 50:50 contract is perceived by the landlords and even the share croppers as one which leads to a loss to the landlord as he has to share a greater proportion of the output. Under this contract, generally the tenant is obliged to loan without interest to the landlord. Only the principal is returned when the share cropper does not do any further leasing-in. Another reason is the non-availability of draft power with the landlord.

Productivity

The average soybean productivity of share cropped farms is 0.68 t ha^{-1} and is marginally lesser than that of owner-operated farms (0.72 t ha^{-1}). The average productivity in the three villages of Jaoti, Kherkhedi, and Kundhankhedi varied from 0.54 t ha^{-1} to 0.99 t ha^{-1} (Table 12). The highest productivity of 1.05 t ha^{-1} in Jaoti involved an input of $41 \text{ kg of DAP ha}^{-1}$ compared to an average of 36.5 kg ha^{-1} for the village and labor input of $29 \text{ person-days ha}^{-1}$. The lowest productivity of 0.16 t ha^{-1} involved a higher input intensity of $80 \text{ kg of DAP ha}^{-1}$ and labor input of $49 \text{ person-days ha}^{-1}$ (see Tables 13 and 14). Therefore, the significant variable determining soybean productivity is the land quality and the waterlogging potentiality of the land, although input practices do play an important role as the evidence of higher productivity in farms of ICRISAT trial farmers

demonstrates. The lowest yield of 0.40 t ha⁻¹ had inputs of 100 kg seed ha⁻¹, 50 kg DAP ha⁻¹, no weeding, and 70 person-days of labor ha⁻¹.

Profitability

The average profit per hectare of the landlords varied between Rs. 494 and Rs. 2672 compared to that of share croppers which varied between Rs. 131 and Rs. 693. The profitability for the landlords is higher. This is despite the non-inclusion of the non-monetized input costs of the share cropper (cost of the labor by the share cropper and his family and interest on the production loans incurred by the share cropper), which demonstrates the exploitative nature of the share cropping contracts. Eight landlords incurred a loss of Rs. 7021 compared to twelve share croppers who incurred a loss of Rs. 6027 (Table 15). Under the 20:80 contract while five share croppers incurred a loss, only one landlord had a loss reflecting the inequitable nature of the contract (Table 16). In the 33:66 contract, 5 landlords and 4 share croppers incurred a loss. Under the 50:50 contract, 2 landlords and 3 share croppers incurred a loss.

Table 12. Yield and profit of soybean share cropped farms.

Village	Cost of cultivation (Rs. ha ⁻¹)	Share cropper cost (Rs. ha ⁻¹)	Labor (person-days ha ⁻¹)	Benefit-cost ratio	Yield (t ha ⁻¹)	Gross output share (t ha ⁻¹)	Profit (Rs. ha ⁻¹)
Jaoti	2813	1087.00	24	1.35	0.54	0.18	133
Kherkhedi	4552	1772.00	20	1.59	0.99	0.24	258
Kundhankhedi	3867	1933.50	34	2.24	0.66	0.33	693

Table 13. Input intensity of five high productivity soybean farms of share croppers.

Village	Yield (t ha ⁻¹)	Seed rate (kg ha ⁻¹)	DAP (kg ha ⁻¹)	Weeding operations undertaken	Labor (person-days ha ⁻¹)	Profit (Rs. ha ⁻¹)	
						Landlord	Share cropper
Kherkhedi	2.53	287	172	Nil	86	6361	3369
Kherkhedi	1.80	100	60	Nil	20	9300	820
Kherkhedi	1.75	100	50	Hand	48	8150	295
Kherkhedi	1.67	83	0	Hand	67	9000	165
Kherkhedi	1.20	100	100	Hand	40	3467	1758

Table 14. Input intensity of five low productivity soybean farms of share croppers.

Village	Yield (t ha ⁻¹)	Seed rate (kg ha ⁻¹)	DAP (kg ha ⁻¹)	Weeding operations undertaken	Labor (person days ha ⁻¹)	Profit (Rs. ha ⁻¹)	
						Landlord	Share cropper
Jaoti	0.16	100	80	Hand	49	-987	-57
Jaoti	0.17	86	49	Hand	27	-417	-48
Jaoti	0.20	90	33	Hand	17	-414	-42
Jaoti	0.36	100	40	Nil	8	-357	-357
Jaoti	0.40	120	96	Nil	19	46	-20

Table 15. Loss incurred by share croppers in three sample villages.

Village	Loss making share croppers	Loss amount (Rs.)
Jaoti	5	2080
Kherkhedi	6	3873
Kundhankhedi	1	74
Total	12	6027

Table 16. Loss incurring landlords and share croppers under different contractual arrangements.

Contractual arrangement	No. of landlords	No. of share croppers
20:80	1	5
33:66	5	4
50:50	2	3
Total	8	12

Land size-productivity relationship

The relationship between land size and productivity is inverse with a correlation of -0.30. The correlation is -0.30 for Jaoti, -0.19 for Kherkhedi, and -0.62 for Kundhankhedi.

Fertilizer use-land size relationship

The relationship between fertilizer use and land size is inverse with a correlation of -0.32. The correlation is -0.45 for Jaoti and -0.03 for Kherkhedi whereas for Kundhankhedi it is positively correlated at 0.46.

Labor-land size-yield relationship

The relationship between landlord labor and land size is inverse with a correlation of -0.37 . Similarly the relationship between share cropper labor and land size is inverse with a correlation of -0.51 . In Jaoti, two share croppers hired out both weeding and harvesting operations, while two farmers hired out harvesting operations and one farmer hired out weeding operations. Eleven of the twenty share croppers have hired-in-labor during the peak harvest seasons as the work has to be accomplished in a short period of time (Figs. 5 and 6).

Six farmers who did not do weeding in Jaoti had yields of 0.56 , 0.36 , 0.20 , 0.33 , 0.64 , and 0.40 $t\ ha^{-1}$ with four farmers having yield lesser than the average of 0.54 $t\ ha^{-1}$. In Kherkhedi, only one farmer hired out the harvesting operations; two farmers did not undertake weeding operations and had yields of 2.53 and 1.80 $t\ ha^{-1}$ which are the highest yields among all the share croppers. Both the above farmers had a higher seed rate and the input of DAP was also high. In Kundhankhedi, one farmer who did not do weeding had an yield of 0.69 $t\ ha^{-1}$ lower than the average yield of 0.91 $t\ ha^{-1}$.

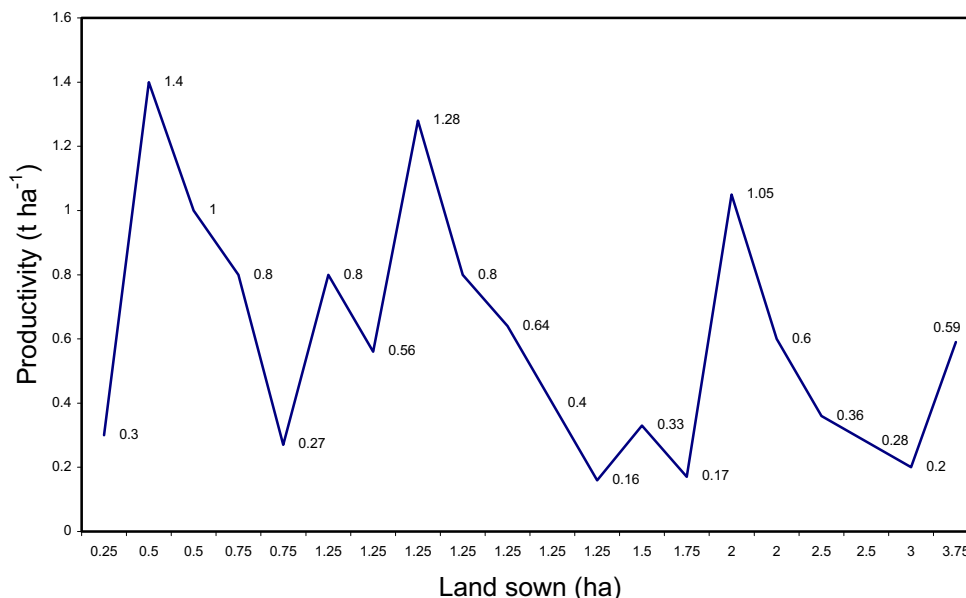


Figure 5. Land size-yield relationship of share cropped farms in Jaoti, Madhya Pradesh, India.

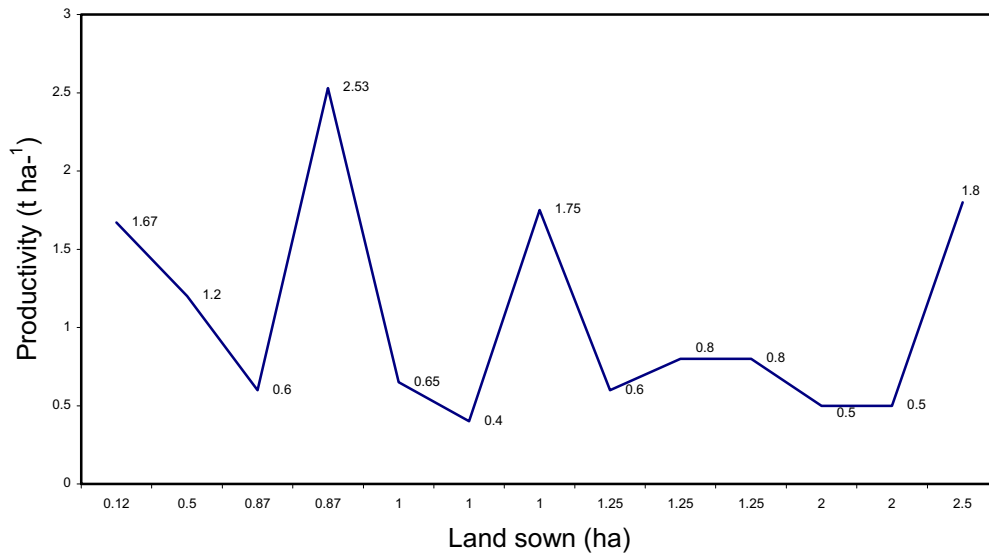


Figure 6. Land size-yield relationship of share cropped farms in Kherkhedi, Madhya Pradesh, India.

Interlocking transactions

The cash and kind (wheat) loans are incurred by the tenant at the sowing period in July and the landlord repays the tenant's share after deducting the principal soon after the threshing operation is completed in November. The interest charged is 36% on cash loans. In Jaoti village, 10 of the 20 share croppers borrowed cash of which four of them also borrowed wheat. One share cropper lent Rs. 1500 to the landlord for which no interest was charged (50:50 contract). Two share croppers only borrowed wheat. Three share croppers reported working on the landlord's own operated land of which two worked without getting wages. In Kherkhedi, four of the 13 share croppers reported borrowing both cash and wheat from the landlords and three of them reported working on land owned by the landlords. In Kundhankhedi where all the four share croppers have been engaged in the 50:50 contract, three of them loaned Rs. 3000, Rs. 2000, and Rs. 10,000 to the landlord without interest. Among the share croppers, the labor locking with landlord has been found weak (two share croppers in Jaoti, three in Kherkhedi, and none in Kundhankhedi) although borrowing for production and consumption loans is relatively stronger.

Comparison of owner-operated farms with share cropper-operated farms

Jaoti village

The total land sown by the 18 owner-operated farms in Jaoti village was 31.22 ha of which 30.62 ha was irrigable land whereas the 20 share croppers cultivated 30.5 ha of land of which only 3.5 ha was irrigable. The input intensity is higher in the irrigable land (owner-operated) farms. The correlation between land size and DAP application is positive but not significant in owner-operated farms ($r = 0.22$) whereas it is negative in the case of share croppers ($r = -0.45$). The average labor input is 27.6 person-days ha^{-1} in owner-operated farms in comparison to a marginal lesser input of 26.2 person-days ha^{-1} in share cropped farms. The cost of cultivation per hectare is Rs. 3100 in owner-operated farms compared to Rs. 2813 in tenant-operated farms. The average per hectare profit in owner-operated farms is Rs. 2636 as compared to Rs. 966 in share cropped farms. The difference in soybean yield is substantial (0.78 t ha^{-1} in owner-operated farms in comparison to 0.54 t ha^{-1} in share cropper-operated farms); the correlation between land size and yield is negative at -0.27 and -0.30 in owner-operated farms and share cropped farms respectively.

Kherkhedi village

The total sown area of the 12 owner-operated farms is 21.24 ha which is entirely irrigable. In the farms of the 13 share croppers, 10.99 ha of the 15.81 ha is irrigable. The correlation between land size and DAP is positive ($r = 0.08$) in the case of owner-operated farms but not significant compared to a negative correlation among the share croppers ($r = -0.03$). The cost of cultivation per hectare in owner-operated farms is Rs. 4035 compared to Rs. 4452.24 in share cropped farms. The investment of labor is also lower at 40 person-days ha^{-1} in owner-operated farms in comparison to 57.52 person-days ha^{-1} among share croppers. The profit per hectare is Rs. 2444 for owner-operated farms compared to Rs. 3188 for share cropper-operated farms. The higher profit in share cropped farms is due to the higher yield (0.99 t ha^{-1}) compared to 0.71 t ha^{-1} in the owner-operated farms. The correlation between land size and yield is negative at -0.38 in owner-operated farms in comparison to -0.19 in share cropped farms.

Kundhankhedi village

The total sown area of the nine owner-operated farms is 20 ha which is irrigable in comparison to four share croppers who leased-in 9.5 ha of irrigated land. The correlation between land size and DAP is positive in owner-operated farms ($r = 0.30$) and share cropped farms ($r = 0.46$) but not significant. The investment of labor is 35.45 person-days ha^{-1} in owner-operated farms in comparison to lower input of 28.10 person-days ha^{-1} in

share cropped farms. The cost of cultivation in owner-operated farms is Rs. 3285 ha⁻¹ in comparison to Rs. 3867 ha⁻¹ in share cropper-operated farms. The yield is higher in share cropped farms at 0.91 t ha⁻¹ compared to 0.66 t ha⁻¹ in owner-operated farms. It is, however, important to realize that the sample is 4 share croppers compared to 9 owner-operated farms and the results have to be interpreted with caution as the sample size is smaller (the total sample of the village constitutes the total population of the village).

Overall analysis of the three study villages

The input intensities of tenant-operated farms need not be lesser than owner-operated farms as usually documented in the literature. On the contrary, the labor input is 31.78 person-days ha⁻¹ in share cropped farms compared to 21.22 person-days ha⁻¹ in owner-operated farms (Table 17). The difference in fertilizer (DAP) input is significant with the input being more than double in share cropper-operated farms. The cost of cultivation of share cropper-operated farms is marginally higher than owner-operated farms, whereas the profit per hectare is higher by Rs. 272 in owner-operated farms. The difference in the average land size is not significantly different among the ownership categories. The average land sown is 1.73, 1.77, and 2.22 in owner-operated farms compared to 1.52, 1.21, and 2.37 in share cropper-operated farms in Jaoti, Kherkhedi, and Kundhankhedi respectively.

Table 17. Comparison between owner-operated and share cropper-operated soybean farms in Jaoti, Kherkhedi, and Kundhankhedi villages in Madhya Pradesh, India.

Category	Cost of cultivation (Rs. ha ⁻¹)	Benefit-cost ratio	Profit (Rs. ha ⁻¹)	Yield (t ha ⁻¹)	Labor input (person-days ha ⁻¹)	Fertilizer input (kg ha ⁻¹)
Owner-operated farms	3320	1.63	2045	0.72	21.22	19.81
Share copper-operated farms	3443	1.54	1773	0.68	31.78	46.76

1. Data is average of values for the three villages.

The reason for the higher input intensity in share cropped farms could be due to the incentive structures of the contractual arrangement. Thirty of the share croppers were engaged either in a 33:66 or 50:50 contract. The cost of inputs (seed and fertilizers) is borne by the landlord for which the tenant has to pay an interest (either 33% or 50% of the cost). It is, therefore, rational for the landlord to invest more inputs; if the output is higher, particularly in the 33:66 contract, greater returns would accrue to him. If the returns are poorer as in the 1999 rainy season, the tenant has to pay the interest on the production inputs (seed and fertilizers) and since the input intensity is higher, particularly

of fertilizer, the landlord gains through greater interest earnings. The above argument is supported from the following evidence of the landlords under the 20:80 contract. The cost of inputs (seed and fertilizers) is borne by the landlord and the data from Kherkhedi village reveals that the average investment of fertilizers is less when the landlord fully bears the cost. The input of the fertilizers by the six landlords under the 20:80 contract was 0, 0, 60, 60, 50, and 50 kg ha⁻¹, and in all the cases the input was less than the average (63.25 kg ha⁻¹) for the Kherkhedi share croppers. The contracts entered into are not sacrosanct and due to the unequal bargaining power, a reduced output would be interpreted by the landlord as lack of effort by the share cropper and reduced share would be given to him.

The profit rate of owner-operated farmers being higher than the landlords who leased-out land gives support for the argument made by the share croppers that poorer quality land is leased out. The evidence in terms of profitability suggests that if the land was of better quality, the landlord would prefer to cultivate it on his own. However, one also needs to consider that the profitability for the landlord is not just restricted to the monetized returns on the crop output; extra income is earned from the interest charged to the share cropper. The maximization of his leisure especially under the 33:66 and 50:50 contracts wherein all the operations are leased-out adds to the profitability of the contract. The argument proposed by Bhaduri (1973) of the landlords exploiting the tenants through usury and they being more interested in higher income through the money lending than higher outputs which would reduce the dependence on the landlords still remains relevant.

The ICRISAT trial farmers have been able to achieve 52.8% higher yield of 1.1 t ha⁻¹ compared to the average yield of 0.72 t ha⁻¹ in the three study villages, but have not been able to escape the waterlogging problem.

The additional benefits for the landlord is that the supervision costs are less under a share cropping contract as the incentive for the share cropper to work hard is high. This is due to the inequitable nature of the contracts, which requires a higher output to be realized for the realization of sufficient returns, which would enable him to at least earn the wage labor costs for the family. The penalty clause is another equally determining factor for a greater effort.

The difference in productivity between the owner-operated farms (0.72 t ha⁻¹) and share cropped farms (0.68 t ha⁻¹) is not substantial (Table 18). The proportion of dryland area in the share cropped farms is 72.90%, while it is only 5.85% in owner-operated farms (Table 19). Despite a higher proportion of irrigable land, which hypothetically is of better quality, the yield differences between the irrigable land and the dryland have been

quite minimal. The determining factor has been the high input intensity in terms of labor and fertilizer application in the share cropped land.

Table 18. Comparative yield of soybean in owner-operated and share cropped farms.

Village	Average yield (t ha ⁻¹)	
	Owner-operated farms	Share cropped farms
Jaoti	0.78	0.54
Kherkhedi	0.71	0.99
Kundhankhedi	0.66	0.91
Average	0.72	0.68

Table 19. Composition of dryland and irrigable land in the owner-operated and share cropped farms.

Village	Share cropped		Owner-operated	
	Dryland (ha)	Irrigable land (ha)	Dryland (ha)	Irrigable land (ha)
Jaoti	27.00	3.50	68.06	30.62
Kherkhedi	13.69	2.12	47.50	33.99
Kundhankhedi	0.00	9.50	57.00	20.25
Total	40.69	15.12	172.56	84.86

The results of this study provide evidence on the variation in productivity across farms caused due to waterlogging in addition to other variable factors. The variability in the productivity of soybean strengthens the risk-averse behavior of the farmers, more in the case of the dryland farmers, which leads to non-optimum input allocation. The study provides empirical support to the ‘monitoring’ approach of Cheung (1969), i.e., the landlords stipulate and effectively monitor the share croppers’ activities. It also provides evidence of the resulting unequitable distribution of output and ‘credit-locking’ of the tenant which strengthens the bargaining power of the landlord in deciding the output share contract.

Implications of low productivity under a liberalized trade regime

The average soybean productivity in India for the year 1999–2000 was 0.94 t ha⁻¹ compared to 1.75 t ha⁻¹ in China, 2.45 t ha⁻¹ in USA, and 3.12 t ha⁻¹ in the European Union. In February 1995 almost all the edible oils have been put under the OGL with an import duty of 30% and in July 1998 it was reduced to 15%; however, recently on November 21, 2000 this has been again increased to 35% with demand coming from the industry for protection. ICRISAT (1999) estimated the subsidy per hectare on irrigated soybean at Rs. 2091 compared to Rs. 963 for rainfed soybean (Table 20). The subsidy component includes the subsidy on fertilizers as well as the subsidy on credit. It is estimated that if all the subsidies were abolished, the profitability of irrigated soybean would suffer by 48% and this would induce a shift away from the crop.

Table 20. Private and social profitability of soybean in irrigated and rainfed land.

Land	Private profit (Rs.)	Social profit (Rs.)	Subsidies (Rs. ha ⁻¹)
Irrigated	4389	-1129	2091
Rainfed	6390	230	963
Average	6150	-109	

Source: ICRISAT (1999).

It is therefore argued that:

“Since this zone (zone 9, including M.P.) is dominated by a crop that is inefficient in resource use and low in generating social returns, it seems that policies that correct for distortions in domestic prices would have their desired effect, i.e., a shift away from soybean towards sorghum, maize, and pigeonpea to achieve. This must be qualified if soybean possesses specific double-crop advantages relative to other rainy season-crops.” (ICRISAT 1999, p. 68)

It is, however, important to realize that a proactive strategy focused on improving the productivity of soybean has a greater scope for welfare enhancement, as the private profitability of the crop is higher compared to the above crops. However, this should not be at the cost of efficiency; a gradual reduction in subsidies; particularly of fertilizers is warranted (a large part of the subsidy is a producer subsidy; in effect the inefficiency of the public sector units and private sector units are being subsidized, and freer imports would result in their procurement at a lesser cost). This requires not only programs for improving management practices for achieving higher productivity but also wider reforms in the rural factor markets in credit, insurance, and in the land markets relating to leasing.

Conclusions

Summary

The average yield of the owner-operated farms in the three sample villages is marginally higher at 0.72 t ha^{-1} in comparison to 0.68 t ha^{-1} from sharecropper-operated farms. The yield of owner-operated farms in Jaoti village is higher than share cropped farms whereas in Kundhankhedi (0.66 t ha^{-1} in owner-operated farms compared to 0.91 t ha^{-1} in share cropped farms) and Kherkhedi (0.71 t ha^{-1} compared to 0.99 t ha^{-1} of share cropped farms), the yield of owner-operated farms is lesser than share cropped farms. The investment of labor, however, is less in owner-operated farms ($40 \text{ person-days ha}^{-1}$ compared to $57.5 \text{ person-days ha}^{-1}$ among share croppers).

It needs to be emphasized that among the owner-operated farms only 4.0 ha (5.52%) of the total 72.46 ha sown is unirrigated land constituting 5.52% of unirrigated land in comparison to share cropper-operated farms where 40.7 ha (72.90%) of the total sown area of 55.81 ha is unirrigated. Although the problem faced by the farmers in the 1999 rainy season was excess rain and consequent waterlogging, generally dryland is used only for one crop in the postrainy season and rest of the year it is left fallow. The growing of soybean under rainfed land is generally perceived as an unviable proposition as it delays the sowing of the postrainy season crop which is perceived as a more assured crop. The correlation between land size and yield is negative in all the cases, except in Kundhankhedi owner-operated farm ($r = 0.27$) (Table 11).

The lack of weeding by farmers has been a significant reason for lesser soybean yields. The lack of efforts in doing so is due to the perceived risk of a lesser output due to waterlogging during the early growth period, which has made the farmers to be risk-averse and not invest own and hired labor in the weeding operations. The farmers who did take the investment risk and weeded their fields were able to get better soybean yields. Farmyard manure application played an important role in increasing the yields. Even in the absence of DAP, application of FYM increased yields suggesting deficiency of plant nutrients other than nitrogen and phosphorus. Subsequent soil analysis confirmed this and boron and sulfur were found deficient in the soil. Increased DAP input and increased seed rate also contributed to increase in soybean yields. The seed rate of 287 kg ha^{-1} resulted in an yield of 2.53 t ha^{-1} even without weeding in the farm of a Kherkhedi share cropper. This indicates that increased plants oppressed the weeds.

The cost of cultivation per hectare of owner-operated farms is high in Jaoti (Rs. 3100 in comparison to Rs. 2813 for share cropped farms). In Kherkhedi and Kundhankhedi the cost of cultivation per hectare of share cropped farms is marginally higher than that of owner-operated farms (Rs. 4552 compared to Rs. 4035 and Rs. 3867 compared to Rs.

3285 respectively). The profit for owner-operated farms in comparison to leased-out farms is as follows: The profit per hectare is higher among owner-operated farms in Jaoti (Rs. 2636 vs. Rs. 966, taking the average profit of landlords and share croppers) and Kundhankhedi (Rs. 3285 in comparison to Rs. 1386). In Kherkhedi the tenant-operated farms have a higher profit (Rs. 3188) compared to Rs. 2444 among owner-operated farms. The profit (per hectare) of the tenants in all cases has been lesser than that of the landlords; Rs. 133 compared to Rs. 833 in Jaoti and Rs. 258 compared to Rs. 2930 in Kherkhedi whereas in Kundhankhedi both have an equal profit of Rs. 693 (50:50 crop sharing contract). While 8 landlords incurred loss amounting to Rs. 7021, 12 share croppers incurred a loss of Rs. 6979. The evidence from the study suggests that the input intensity has been higher in the case of share cropped farms for both labor (31.78 person-days ha⁻¹ in share cropped farms compared to 21.22 person-days ha⁻¹ in owner-operated farms) and fertilizer (46.76 kg ha⁻¹ among share croppers compared to 19.81 kg ha⁻¹ among owner-operated farms). This is due to the nature of the contract, wherein there is strict supervision from the landlord who also gains from interest earnings due to a higher investment (either 50% or 33% costs are borne by the tenant).

The more important variables have been the waterlogging potentiality of land and the quality of land. The lesser profit per hectare leased-in by the share croppers has been primarily due to the unequal nature of the share cropping contract, the yield differentials not being significantly high. The ICRISAT trial farmers have been able to achieve high yield of 1.1 t ha⁻¹ (52.8% higher yield) in the 1999 season but have not been able to escape the waterlogging problem and the land size-yield relationship is also found inverse ($r = -0.39$).

The inverse relationship between land size and productivity remains both among the owner-operated and the share cropped farms and the evidence presented here is additional evidence to prove the endemic nature of this relationship in Indian agriculture. The emergence of the newer forms of share cropping contract (33:66 and 20:80) provides additional evidence on the exploitative nature of the share cropping contracts.

Policy implications

The policy suggestions put forth in the literature to reduce the inverse relationship between land size and productivity include imposition and enforcement of land ceiling, and transfer of ownership right to tenants (Junankar 1976) accompanied by provision of factor inputs (Cornia 1985). Recent studies suggest that the evidence in enforcement of land ceiling and in redistributing land has been poor. Ceiling laws have transferred less than 1% of agricultural area to the target group in all except three states. Loopholes in the law allowed most of the landlords to avoid expropriation by distributing surplus land to relatives and dependents (Appu 1996, Mearns 1998).

An important area wherein reform has to progress at a faster pace is in rural credit sector, where the National Bank for Agriculture and Rural Development (NABARD) has started to play a proactive role in promoting and strengthening SHGs. This process has to be strengthened and enhanced to reduce the market imperfections in the credit market and help the farmers, tenants, and landless laborers in accessing credit at reasonable rates of interest. This would help in reducing the problem of under investment of inputs in agriculture. The guidelines on this issue have been formulated under the 'Common Principles for Watershed Development' by the Department of Agriculture and Cooperation (GOI 2000).

A recent study by Besley and Burgess (1998) using data from sixteen main Indian states from 1958 to 1992 find that there is a robust link between land reform and poverty reduction and the impact on poverty is mainly through reforms that affect production relations rather than by altering the distribution of land. It is argued that the benefits in land reform therefore have largely been due to reform in the tenancy contractual relations and the rise in agricultural wages.

There have been major design flaws in the legislation as well. In Madhya Pradesh, the ceilings have been legislated at a higher limit of 10.12 ha from 1960–72 and in the range 4.05–21.85 ha after 1972 according to the Ceilings on Agricultural Holdings Act of 1960. Although, leasing is prohibited under the Land Revenue Code of 1960 (the evidence of its existence is established with additional recent empirical evidence), the effect of the legislation has only made the contractual arrangements more exploitative with the emergence of the 20:80 and 33:66 contracts replacing the more equitable 50:50 contract. The lack of implementation of the land ceilings act has only maintained the inequality in land holding and due to greater demand for leased-in land. Due to low wages and lesser availability of labor in the lean seasons, the labor-locking of the landless and the small and marginal farmers due to the share cropping contract has been maintained and the exploitative 20:80 contract has emerged as a newer form of exploitation of marginal farmers and landless laborers.

Commenting on Madhya Pradesh, Besley and Burgess (1998) opine that "implementation of reform (is) inefficient, one reason being that the sharecroppers and tenants are not recorded" which is due to the lack of political and administrative will. Therefore, in the case of Madhya Pradesh neither the reforms in land redistribution nor tenancy reforms have been beneficial, due to design flaws and lack of political and administrative will in their implementation.

The recent policy initiatives of the Government of India on land reforms is in contrast to the earlier legislations. The new draft national agricultural policy states that its approach on land reforms will focus on 'development of lease market for increasing the

size of holdings and by making legal provision for giving private lands on lease for cultivation and agri-business'. It also advocates that private sector participation will be promoted through contract farming and land leasing arrangements to allow accelerated technology transfer, capital inflow and assured market for crop production, especially oilseeds, cotton, and horticultural crops (Saxena 2000).

In a recent discussion paper of the Planning Commission, Saxena (2000) argues for open leasing in developed agricultural markets which would help the share croppers to get better rents. It is suggested that the selective open leasing be implemented in a pilot mode in selected districts and calls for the enforcement of the existing rigorously undeveloped markets even when maintaining that the bureaucracy is corrupt and not interested in enforcement of the laws. As argued rightly by Mearns (1998, p. 36) “. . . rental markets are an important means by which poor gain access to land. However, deregulation of rental markets will benefit the poor only when there is a credible threat of ceilings enforcement and where there is possibility of clearly defined and enforceable contracts.”

A radical suggestion is also put forth by Saxena (2000, p. 4) that ‘unless the land hunger of the poor is mobilised into a militant movement to neutralize the property instinct of the rich farmers, long-term security in law to tenants does not seem to be feasible.’ The way forward is the need for political and administrative will to reform the design flaws in laws, reform the bureaucracy, and take proactive steps in enforcement of land ceilings and initiate tenancy reform measures. The Madhya Pradesh Ceilings on Agricultural Land Holdings Act fixed the ceiling at 7 ha for irrigated land, which is at a higher limit, but the enforcement is weak even at this limit. The prohibition of leasing has only made tenancy to go underground and the study has pointed out to the exploitative contracts that have arisen in the rural areas (33:66 and 20:80 crop sharing contracts emerging as the widely followed than the earlier, more equitable 50:50 contracts). If equitable development has to be achieved land and tenancy reforms need to be given utmost importance by the politicians, policymakers, and bureaucrats in Madhya Pradesh. The success achieved by the Rajiv Gandhi Watershed Mission in developing watersheds since 1996 have to be viewed with caution and it is important to understand the equity of the distribution of benefits among the owners, tenants, and the landless laborers.

Policy guidelines for the Madhya Pradesh government

The banning of leasing according to the Land Revenue Code, 1960 has been unsuccessful, and the Madhya Pradesh Human Development Report, 1998 admits that in Vidisha district, more than 70% of the land holdings are leased-in holdings. Share cropping and tenancy should be accepted as a reality, and tenancy reform measures should be introduced on contractual terms. Such a reform is possible, with political and administrative support. The proactive policy of the current government provides an opportunity for the politicians, policymakers, and bureaucrats to initiate changes in the legislation and concurrently work with bureaucracy to ensure implementation of the legislation. The machinery instituted under the Rajiv Gandhi Watershed Mission, which has proactively worked in implementing programs, could be used to act as catalysts of change in the mission mode.

Lessons for the stakeholders in Lateri watershed for the future intervention strategies

- Lalatora micro-watershed which is selected on technical aspects consists of large farmers (landlords) who are engaged in the exploitative 20:80 contract with the tenants from the adjoining tribal hamlet. It is suggested that future interventions in other micro-watersheds should address the equity aspects.
- In the villages studied soybean is predominantly grown in irrigable area, while most of the dryland is left fallow during the rainy season. This aspect needs to be studied further covering other areas in Madhya Pradesh. The introduction of short-duration varieties along with the promotion of efficient rainwater management and input practices needs to be considered so that the dryland farmer's risk in cultivating soybean could be reduced. Research and extension work through the national agricultural research systems (NARS) and NGOs should work towards reducing the rainy season fallow in Madhya Pradesh.
- Waterlogging remains a major problem in this region, which could be one of the significant causes of under investment of inputs due to the risk-aversion of the farmers. Technical solutions to this problem have to be found through farmer participatory approaches.
- The availability of the promoted inputs in the local markets needs to be ascertained and efforts should be made to coordinate with the local agricultural agencies to ensure the availability.

The strengthening and linking of the dormant SHGs with rural banks needs to be initiated and the recently initiated Swayam Siddha Project gives an opportunity. There is

a need to develop a program to reach out to landless share croppers, particularly those who enter into the more exploitative 20:80 share cropping contract.

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