

4. The Rural Nexus: Poverty and Productivity

4.1 By 1998/99, 29 million poor people, two-thirds of all Pakistan's poor, lived in rural areas. Within rural areas, poverty in Pakistan remained more or less stagnant during the 1990's, averaging about 36 percent. Although rural households earn their livelihoods from a number sources, most are linked directly or indirectly to agriculture. So, it is indeed puzzling that agricultural productivity actually grew at an annual rate of 4.8 percent during the 90's, far outstripping the population growth rate of 2.5 percent.¹ Clearly, rural poverty is as complex a phenomenon as it is persistent. And, yet, it is important to bear in mind that, despite this growth, productivity in Pakistan's agriculture is, in an absolute sense, very low. Moreover, as argued in this chapter, there is still considerable scope for policy intervention aimed at enhancing agricultural productivity in Pakistan. Increasing the ability of cultivating households to generate income must, ultimately, be the focus of any sustainable poverty reduction strategy in rural Pakistan.

4.2 The focus of the chapter is, accordingly, on understanding the constraints to farm productivity in Pakistan, which is to say: the limitations on access to productive resources; principally, land, irrigation, soil fertility, and credit. The analysis relies largely on new data from the 2001 Pakistan Rural Household Survey (PRHS), a nationally representative survey of rural areas that covers a broad range of issues, including detailed information on farm production. Much of the evidence from the PRHS, it should be emphasized, is of a preliminary nature, and should therefore be viewed as suggestive at this stage. Nonetheless, this chapter does, at the very least, lay out a roadmap for future analytical work on rural Pakistan.

4.3 A recurrent theme of this chapter is that inequality in asset ownership, particularly land, may be far more than a distributional concern; it may affect productivity. There are direct effects of land inequality on productivity resulting from frictions in the land purchase and leasing markets. Because of these problems, inequality in household land ownership translates (though far less than acre-for-acre) into inequality in operated area per household. Since, as will be shown, households with larger operated area have lower yields and are less productive, land inequality leads directly to lower productivity.

4.4 There are also more indirect and subtle effects of land inequality on productivity, some of which receive empirical support in this chapter. For example, corruption on Pakistan's public canal irrigation system is widely viewed as a constraint on agricultural productivity. Large landowners often engage in wasteful rent-seeking behavior, using their influence with irrigation officials to manipulate the water distribution in their favor.

4.5 Land inequality can also lower incentives to invest in land. The skewed distribution of land leads to tenancy, mostly on share basis, which provides lower incentives for investment in soil fertility than under owner-cultivation. Soil degradation, due to waterlogging and salinity, is quite significant in rural Pakistan, particularly in Sindh province and in Southern Punjab. As a consequence of pervasive land tenancy, available medium and longer-term measures to combat soil salinity are rarely undertaken, resulting in loss of cultivated area and low yields.

4.6 Lastly, due to collateral requirements, land-poor households are mostly excluded from the formal credit market, which can finance precisely the long-term productive investments in land and agricultural machinery that can raise them out of poverty. As a result, unequal land ownership may lead to entrenched rural poverty.

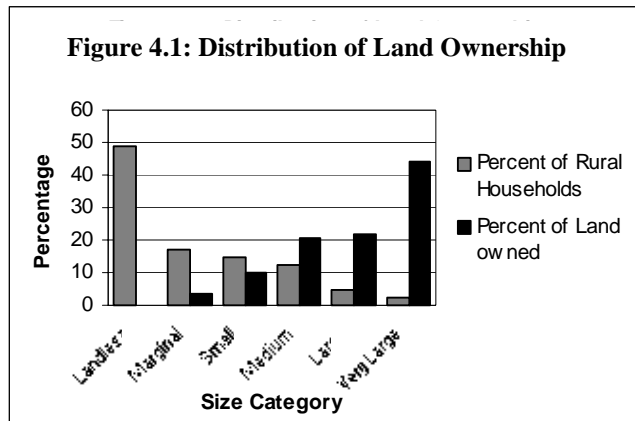
Distribution of Land Ownership and Other Farm Assets

4.7 Asset ownership, or lack thereof, is both a *cause* of poverty – because assets generate income – as well as a *consequence* of it – because ownership is the result of past investment. In light of this, understanding the distribution of asset ownership is a crucial step in understanding rural poverty. Moreover, as elaborated later in this chapter, when rural factor markets are imperfect, asset ownership also has implications beyond income distribution, in terms of its impact on production efficiency, and hence the *level* of incomes.

4.8 As detailed in this section, and further to earlier observations of this report, rural poverty does appear to be linked to unequal land ownership, yet this is clearly also not the whole story. On the one hand, the rural non-farm sector appears to be a significant source of income for many poorer households, and for those households who own land, other factors but outright ownership of land clearly also influence their level of earnings.

Patterns of landownership

4.9 Land is the paramount asset in a rural economy. However, according to the PRHS, almost one-half of rural households own no land. Figure 4.1 shows that around 2 percent of households own more than 40 acres of land and control 44 percent of the land area. Collectively, large and very large farmers control 66 percent of all agricultural land. These inequities are reflected by the Gini coefficient of land concentration, which is 0.78, which is even higher than Pakistan’s overall Gini for land in 1990, which was 0.65.² Moreover, in terms of ownership of land by gender, as Box 4.1 illustrates, stark inequities are also apparent.



Note: Marginal ≤ 2 acres of land, small >2 and ≤ 5 , medium >5 and ≤ 15 , large >15 and ≤ 40 and very large >40 acres.

Box 4.1: Ownership of Land by Women

Women in Pakistan have the legal right to inherit land. Indeed, community level data indicates that in 67% of villages sampled, women do inherit land, and in 57% of villages, women enjoy ownership of land. However, household land ownership estimates tell a very different story. In the PRHS sample, only 2.8% of plots were reported to be owned by women. The evidence therefore suggests that there are gaping inequities in ownership of land across gender, and that the law on inheritance of land by women has failed at the implementation level in Pakistan

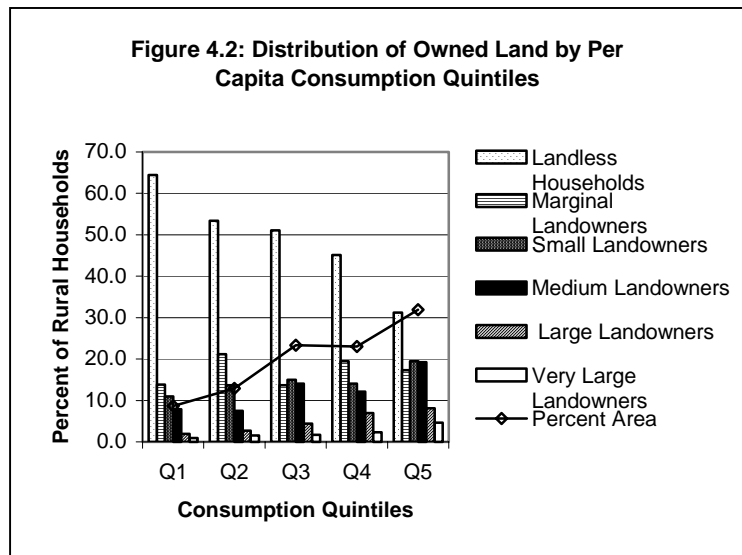
Source: PRHS (2001)

4.10 Data from the village census associated with the PRHS provides a more disaggregated picture of the distribution of land ownership in Pakistan, confirming high levels of inequality, and significant variations across the country’s provinces. Overall, the census data yield a land Gini of 0.82, which is very close to that from PRHS sample itself. Table 4.1 shows the regional breakdown of the land distribution, with Ginis ranging from 0.75 in Balochistan to 0.91 in Sindh. Similar patterns are observed for the coefficient of variation in land ownership. The average landholding size is also largest in Sindh, but smallest in South Punjab.

Table 4.1 Land Inequality by Province (Village Census)

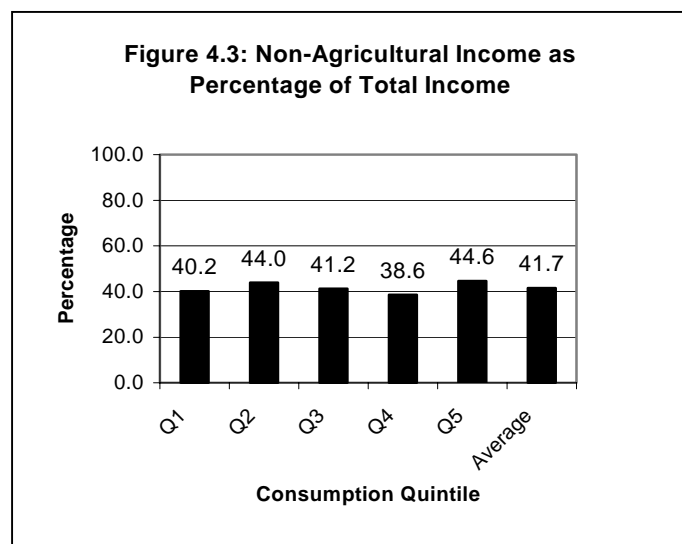
Land Owned (Acres)	Province						Average
	Central Punjab	South Punjab	Barani Punjab	Sindh	NWFP	Balochistan	
Maximum	295.0	122.9	245.9	1967	245.9	201.6	513.1
Mean	2.3	1.8	3.2	6.7	2.7	3.8	3.4
Standard Dev.	6.8	5.5	13.8	51.1	11.3	8.7	16.2
Coefficient of Variation	3.0	3.0	4.3	7.6	4.2	2.3	4.7
Gini	0.82	0.80	0.87	0.91	0.85	0.75	0.83

4.11 One would expect a strong association between poverty and land ownership, as is indeed the case in rural Pakistan. Figure 4.2 shows the distribution of households in different land size category across consumption quintiles. While 64 percent of the poorest households are landless, and own only 10 percent of land area, households in the highest consumption quintile - predominately comprising small and medium farmers, own 32 percent of the area. However, the landless also account for more than half of households in the second and third consumption quintile, and a considerable proportion of the wealthiest households also happen to own no land.



Land ownership, the non-farm sector, and rural poverty

4.12 Accordingly, it is apparent that land ownership distribution is only part of the story of rural poverty in Pakistan. Figure 4.3 brings this point into focus. Overall, rural household derive an average of 44 percent of their income from non-agricultural sources, including non-farm wage earnings, non-farm enterprise income, remittances, and others. This proportion is also remarkably constant across consumption quintiles.



4.13 When households that own no land are considered in isolation, an even starker picture emerges. Landless households in the fourth and fifth consumption quintiles earn practically all their income from non-agricultural sources (Table 4.2). By contrast, those in the lowest quintile receive only about half of their income

from non-agricultural sources. The figures in Table 4.2 therefore seem to belie the typical notion of the prevalence of a vast pool of landless agricultural laborers: only a modest fraction of the total income of landless households, including those in the lowest quintiles, comes from agricultural wage labor. Indeed, wage labor does not even contribute the largest share of agricultural income, let alone total income, for poor households.

Table 4.2: Distribution of Income by Source for Landless Households

Per Capita Exp Quintiles	Non-Agri Income as % of Total Income	Sources of Non-Agricultural Income							Sources of Agricultural Income		
		Wage Income					Enter-prise %	Other %	Wage Labor %	Crop profits %	Livestock, Poultry & Dairy %
		Skilled %	Unskilled %	Govt. %	Private %	Female %					
Q1	49.1	15.5	31.0	5.6	20.6	0.6	13.3	14.0	36.2	55.5	8.4
Q2	69.1	12.6	25.5	3.7	26.7	0.7	20.9	10.7	37.3	46.5	16.2
Q3	71.0	17.8	30.6	6.5	13.8	1.3	14.4	16.9	19.3	63.0	17.7
Q4	91.4	13.5	28.9	6.5	16.0	3.0	13.2	22.0	9.3	79.5	11.2
Q5	100.0	17.3	21.2	14.1	5.7	2.8	21.5	20.1	13.6	65.7	20.7
Total	72.9	15.1	27.8	6.7	17.6	1.6	16.4	16.4	23.0	62.9	13.9

4.14 The distribution of other farm assets among cultivators is described in Table 4.3. Comparing the top and bottom consumption quintile, there is six-fold difference in the overall value of farm capital per acre cultivated, though the distribution is fairly even in the middle quintiles. Exclusive ownership of both tractors and tubewells also rises by consumption quintile, but not as rapidly as one might expect. Partly, this is an artifact of the generally low ownership rates of these assets.

Table 4.3. Distribution of Farm Asset Ownership among Cultivating Households

Consumption Quintiles	Total Value of Assets/Operated area	Percent Owning Tractor	Percent Owning Tubewell
Q1	714	1.4	5.1
Q2	1,526	2.5	9.1
Q3	1,254	3.0	6.1
Q4	1,923	5.8	9.0
Q5	4,445	8.2	11.0
Total	2,056	4.2	8.1

4.15 As shown, the distribution of land ownership is not the only part of the story of rural poverty in Pakistan. It is evident for instance that the non-farm sector can play an important part in providing income support for many poorer households. In rural areas however, most economic activity tends to be linked, whether directly or indirectly, to agriculture. Accordingly, the most important manner in which family earnings can be boosted is by increasing the returns to this sector. The remainder of this chapter therefore focuses on the constraints that cultivating households face in increased agricultural productivity. And as detailed, the interaction of patterns of unequal land ownership with other factors is important also in this regard.

Public Provision of Canal Irrigation

4.16 Cultivation in Pakistan is overwhelmingly dependent on canal irrigation.³ Although irrigation by canal substantially increases productivity, there appear to be strong absolute constraints on the extent to which it can be expanded in Pakistan in the medium to long term. This highlights a number of apparent problems in the misappropriation of existing water resources, which are linked both to the patterns of unequal landownership, as well as outstanding governance problems in the irrigation sector. First it seems

clear that the pricing regime and delivery mechanism for canal water clearly benefits those who have larger holdings. The flat rate for water leads to wasteful usage of a valuable and scarce resource. And the prevalence of rent seeking in this sector, coupled with the disproportionate ability of large land owners to influence officials of the irrigation department, allows those with larger land holdings to skew water distribution in their favor, improving their own yields, but further tightening the constraint that limited water availability imposes on smaller cultivators.

Canal Irrigation: Absolute Resource Constraints and Management Issues

4.17 Direct rainfall contributes less than 15% of the water supplied to crops and other sources of water in Pakistan, including ground water, are scarce. The recurrent drought and flood cycle over the past decade has intensified the problem of water availability and raised concerns about water storage on the one hand, and flood prevention, due to overflows, on the other. Unfortunately, studies suggest that prospects for further expansion in irrigated area through new investment appear to be quite limited. With river flows fully utilized, providing more storage in the Indus river system can increase water availability by about 14 percent at best. However, economic returns to both storage investment and investment required to develop additional canal capacity to utilize this flow, are rather low⁴.

4.18 Water sources outside the Indus system are also largely exhausted, limiting the scope for any major expansion in perennial irrigation outside the Indus basin. Finally, the ground water table in most fresh ground water areas is falling due to the expansion in tubewell use over the 1980's. This limits the potential for further investment in private or public tubewells. The limited scope for major increases in water supply both within and outside the Indus basin implies that the efficient use of currently available water supplies has to be an important component of any strategy to increase the productivity of irrigated agriculture in a sustainable way.

4.19 There are two main issues related to canal irrigation that require attention. First, current water delivery and use patterns are quite wasteful. It is estimated that the delivery mechanism has an average delivery efficiency of only about 35 to 40 percent, from the canal head to the root zone. (World Bank, 1999) Farmers also tend to use wasteful flood irrigation methods instead of drip and sprinkler irrigation, which economizes on the use of water.⁵ Second, there is a perception that there is considerable misappropriation of canal water that leads to distributional inequities and uncertain supplies of available water, imposing substantial productivity losses on the economy.

Technical Delivery Losses in Pakistan's Irrigation System

4.20 The reduction of delivery losses requires improvements in irrigation infrastructure and better maintenance of water channels. However, improvements in physical infrastructure, such as the rehabilitation of canals, the lining of water channels, and land leveling have been undertaken only sporadically, and maintenance efforts have also been quite inadequate. Thus, irrigation infrastructure is growing increasingly dilapidated. This is corroborated by a community survey in which respondents were asked about changes over the past 5 years in the quality of nine public goods and services. In nearly 50 percent of sampled villages, respondents reported deterioration in irrigation facilities, while an improvement was reported in only 11 percent of villages. This is in sharp contrast to all other services, including law enforcement, for which a much smaller fraction of villages reported deterioration over the past 5 years.

4.21 One potential determinant of this problem appears to be the poor incentives provided to provincial irrigation departments to maintain and improve the system. Studies have suggested that the budgets of the provincial irrigation department are inadequate and largely absorbed by the wage and salary costs of their employees. There is also no relationship between budgets and performance in

delivering water. This is further exacerbated by the total disconnect between water charges, water delivery, and the maintenance and upkeep costs of delivering water. *Abiana*, the charge for irrigation water, is extremely low relative to the cost of water delivery, as well as the returns to irrigation.⁶ It is therefore quite likely that this water pricing regime has distorted incentives for the efficient use of canal water resources and encouraged rent seeking behavior among both farmers and irrigation officials, as discussed below.

The Political Economy of Water Misappropriation

4.22 In addition to losses due to technical management problems, there is substantial evidence of water misappropriation. This tends to exacerbate distributional inequities and leads to substantial productivity losses, as discussed in greater detail later on in the chapter. While community participation and collective mobilization appears necessary to allow cultivators to gain access to water, such activity appears to be impeded by proximity to a large landowner, and inequality of distribution of landownership.

4.23 A qualitative survey covering six sample villages provides a broad picture of the problem. Payments to irrigation officials to ensure the delivery of sanctioned water supplies were reported as routine and endemic. Respondents also felt that water shortages for those located downstream on a distributary or minor flow, were considerably exacerbated by the routine misappropriation of canal water by upstream farmers, who paid irrigation officials to enlarge watercourse outlets, *moghas*, or managed to get new watercourses sanctioned upstream (see Box 4.2). It is worth noting that the illegal pumping of water, tampering with the *mogha*, in concert with irrigation department staff, and directly breaching the canal system through the exercise of coercive power also inflicts further physical damages to an already strained canal system.

4.24 These reports are to a large extent substantiated by examining data from the recent rural survey, (PHRS 2001) which contains unique plot-level information on access to canal water, as well as a number of watercourse characteristics, including several “non-economic” ones. The survey contains information on over 1000 watercourses. The data is used to examine how heterogeneity among cultivators on a watercourse affects water availability, as well as their capacity for collective action, and to examine the determinants of canal water availability for the two seasons of the survey – Rabi 2000-01 and Kharif 2000.⁷

4.25 First, it is worth noting that there is considerable seasonal variation in canal water availability. For example, between Kharif 1999 and 2000, ‘good’ availability of canal water falls from 68 percent of plots, to 52 percent. In Rabi 2000, only 27 percent report good availability, as compared to 52 percent in 1998 (Table 4.4).⁸ Moreover, 11 percent of all plots with access to canal water in Kharif 2000 and 25 percent of plots with access to canal water in Rabi 2000-01 reported that they were unable to exploit their turn to use irrigational facilities during the season, due to non-availability of water. Thus access to a canal does not guarantee canal water availability.

Table 4.4: Availability of water in watercourse

	Kharif		Rabi		
	1999	2000	1998	1999	2000
Canal full most of the time	39	22	26	11	10
Canal full half the time	29	30	26	17	17
Canal ½ full most of the time	17	26	16	26	14
Canal ½ full some of the time	13	18	18	27	38
No water available	2	4	14	20	21

Box 4.2 Canal Water Misappropriation: Insights from the Qualitative Survey

The three villages, Akalipur, Shah Alam and Darro are located in Faisalabad, Nawabshah and Larkana, districts respectively. Akalipur and Shah Alam were on perennial canals while Darro was on a six-monthly canal system and was supposed to receive water only during the kharif rice-growing season. In the villages, perceptions about the functioning of the irrigation system on the part of its users could be classified by three broad categories:

(i) It was considered a routine matter that irrigation officials had to be bribed in order to ensure supply of water. This was reported across all survey sites. There was evidence of some collective action on the part of users in ensuring the payment of routine bribes. In the survey site in Larkana, for example, it was reported that there were two separate *beldars* (irrigation official at the water-course level). One of these was an employee of the department. Farmers were obliged to pay him not *for diverting water to them, but for not diverting their water share to someone else*. He was paid, therefore, not to turn up at the water minder or to interfere with its operations. The second *beldar*, an informal worker, was paid by the farmers to be present at the minder, and to manage the water rota.

(ii) There were allegations of local misappropriation by users upstream in the canal system – notably villages further up on the distributary or minor. Irrigation officials were regarded as culprits in these cases also, but the main protagonists were thought to be users in upstream villages. The survey sites in Nawabshah and Faisalabad were both located at the tail end of their respective distributaries. In both cases, the conflict was perceived in inter-village terms. It was not possible to make finer distinctions between individual upstream users, or even between upstream villages. In both Shah Alam and Akalipur, this form of misappropriation was seen as being distinct from the "routine" corruption of irrigation officials, and from the covariate drought-shock or inter-provincial water disputes (see below)

In both cases there were allegations that water had been diverted by upstream users through the payment of bribes or by using political connections with irrigation officials. There had been attempts in both places at protest demonstrations. The "water theft from tail-enders story" was supplemented in both cases with the idea that being at the tail end was not a politically neutral technical outcome. In Akalipur there had been changes in the supply system upstream – such as the lining of watercourses – that had made the situation worse for the tail-enders. In Shah Alam new watercourses had been sanctioned to please villages that had supported local powerbrokers in elections, and the survey villages found themselves further downstream than they had been some years previously.

(iii) In the survey sites in Sindh, there was also the perception that water was being increasingly diverted to regions upstream in the river system. The main reported impact in Darro in Larkana, was a delay in the availability of canal water in the Kharif season, which was thought to be responsible for the spread of a disease known as *ulli* in the rice crop. In Shah Alam in Nawabshah, on the other hand, farmers reported that the upstream diversion of water had reduced land under cultivation.

4.26 Undoubtedly this is due, at least in part, to natural factors. However, water use appears to vary systematically with the location of the watercourse along the main channel as well as the location of the plot on the watercourse. The use of canal water decreases if the watercourse is located at the tail of the distributary or minor and if the plot is located at the tail end of the watercourse. In Kharif 2000, for example, only 5 percent of plots with watercourses at the head of a distributary/minor reported non-use, while 10 percent of those in the middle and 16 percent of those at the tail of a distributary/minor reported non-use (Table 4.5).

Table 4.5: Position of watercourse/plot and water use

		Position of watercourse on main channel			
		Head	Middle	Tail	All
Distribution of Watercourses (%)		12	62	26	...
Plots with canal irrigation that did not use canal water (%)	in Kharif '00	5	10	16	11
	in Rabi '01	25	22	32	25
Distribution of plots (%)		18	38	44	...

4.27 To explore these findings, the determinants of water availability for each season are examined below using regression analysis. In addition to controlling for location effects, it is possible to examine the effects of land ownership inequality at the watercourse and village level, heterogeneity of cultivators at the watercourse level, and the extent to which payment to irrigation officials to ensure delivery of sanctioned supplies affects water availability (Table A-4.1, Annex).

4.28 The analysis indicates that canal water availability declines significantly in both seasons if the watercourse is at the tail of the distributary or minor on which it is located. While this is consistent with the misappropriation of canal water by upstream watercourses, it does not constitute direct evidence of such misappropriation. One could argue that the outcome is also consistent with the kind of well-documented conveyance losses to which the system is subject.

4.29 However, controlling for any location effects, payment to irrigation officials significantly increases the availability of canal water. Thus water availability clearly depends on efforts to bribe irrigation officials.⁹ In addition, water availability increases significantly as the land holdings of the largest cultivators on the watercourse increase. Water availability also increases significantly as the village land gini increases. Since larger landowners are likely to be able to lobby more effectively with irrigation officials and politicians, this also suggests that water availability depends on the ability of cultivators on the watercourse to influence irrigation officials.

4.30 In summary, losses due to the poor maintenance of the infrastructure appear to be compounded by considerable mismanagement and corruption. Such rent-seeking behavior could reinforce distributional inequities and may also lead to substantial productivity losses, an issue that is examined in a later section. What appears to be clear so far is that farmers are willing to pay bribes to ensure water delivery and improved access. This is particularly significant since there is little support among farmers for a higher water rate, perhaps because farmers cannot see any link between their contribution and water deliveries or the maintenance of the system. Moreover, uncertain water supplies and flat-water charges also create an incentive to waste water. This not only constrains an expansion in production, but also penalizes cultivators who are located at the tail end of watercourses and often end up paying for water that they do not get.

4.31 Clearly, this begs the question of the extent to which collective action by cultivators reduces the maintenance and mismanagement problems discussed above. Table A-4.2 (Annex) shows the determinants of participation in the collective activity of watercourse cleaning and maintenance, and the formation of water user's groups. It is indeed found that better water availability in the Rabi season significantly increases participation in the cleaning and maintenance of the watercourse. Larger land holdings and the presence of a politician on the watercourse also increase participation significantly. Interestingly, however, the number of zaats/castes on the watercourse (one measure of heterogeneity) appears to have no effect.

4.32 Turning to the determinants of water user groups, it is found that the presence of a politician on the watercourse significantly reduces participation, as does village land inequality. While these results are quite tentative, and only 11 percent of the watercourses had a water user's group, they suggest that high levels of wealth inequality and power restrict certain forms of collective action while promoting others. In particular, forms of collective action that benefit wealthier cultivators appear to thrive on watercourses with high inequality while forms of collective action that could undermine their influence appear to be discouraged.

Soil Degradation: Waterlogging and Salinity

4.33 Waterlogging and salinity are considered to be a primary cause of low yields and low cropping intensities in rural Pakistan. Combating this growing problem would yield significant productivity gains to many rural households.¹⁰ In addition to the geographical or technical constraints to this— i.e. those that pertain to particular agricultural practices – unequal distribution of land ownership leading to the prevalence of tenancy contracts in certain areas, also appear to be important, by reducing incentives for better stewardship of soil resources among cultivators.

Soil degradation: a reversible problem

4.34 In some parts of Pakistan, notably Sindh and Southern Punjab, the soil is naturally saline and ground water tends to be brackish. However, canal irrigation and tubewell installation have substantially worsened the problem in recent years. Due to its flat topography and the lack of natural drainage in the Indus plain, repeated irrigation has led to a rise in the water table in Pakistan. This is compounded by seepage from the canal system during delivery. In areas where ground water aquifers are fresh, water lost during conveyance can be re-used by pumping, since it simply recharges the aquifer. However, in saline areas such as Sindh, not only is the water permanently lost, it also raises the water table and makes surface soils saline. However, waterlogging and salinity are largely reversible and there are large potential productivity gains from doing so.

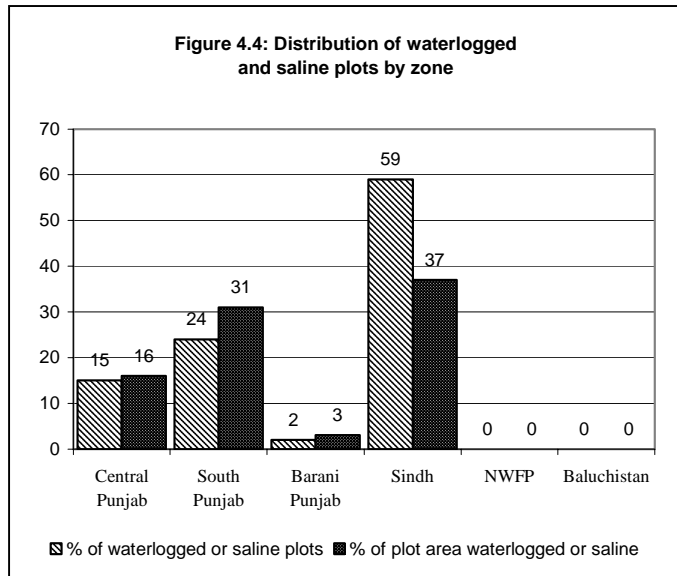
4.35 Measures to reduce soil salinity and waterlogging can be grouped into 3 categories: (1) Activities that must be undertaken collectively, by the government or a community¹¹; (2) Contractible farm level activities¹²; and, (3) Non-contractible farm level activities. The last category is of particular interest since over a third of cultivated area in Pakistan is worked by tenants who may have rather poor incentives to provide the kind of effort-intensive care that problem soils require. There are four main types of non-contractible on-farm activities: (i) Irrigation practices such as the use of more canal water, more frequent irrigations, use of better quality ground water, and pre-sowing irrigation for leaching salts; (ii) Cropping practices like the removal of a salt encrusted top layer, the planting of soil tolerant crops like Berseen, Jantar and varieties of rice, continuous cropping or leaving land fallow, and using a higher seed rate; (iii) Land preparation practices such as deeper/more ploughing, adding sand, and minor leveling to remove high spots and salt deposits; (iv) Chemical/organic practices such as the application of higher quality chemical fertilizers, use of green manure and plant stems, and the use of gypsum.

4.36 Some of these practices tend primarily to mitigate the effect of salinity on current crop yields (e.g., changing irrigation practices, leaving affected area fallow), while others have the longer term objective of solving or alleviating the underlying problem not only for the current season but also for the future (e.g., land levelling, gypsum application, manure application). These latter, 'curative' measures are more easily viewed as a form of investment¹³.

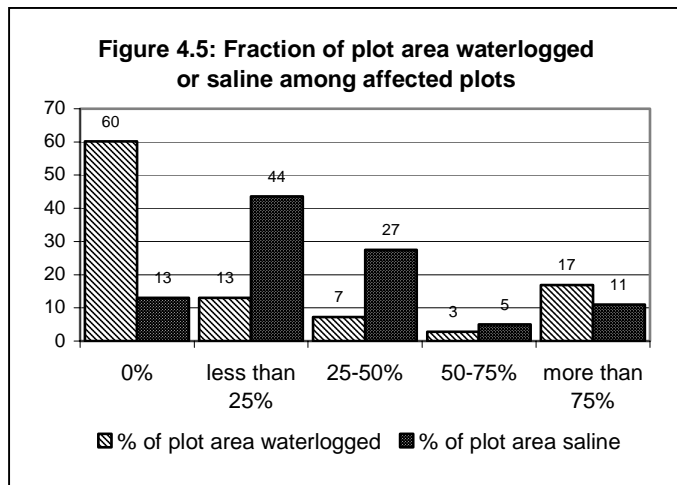
Mapping Soil Degradation in Pakistan

4.37 The PRHS 2001 collected data on salinity and waterlogging for each plot owned or cultivated by sample households. For each plot, information is available on the fraction of area affected by salinity, how long the problem has existed, the acuteness of the problem (subjectively evaluated using local terminology), and any major investments undertaken, either singly or collectively by the household to deal with it. The cultivators of each saline (or sodic) plot were also asked about their use of 26 separate farming practices (noncontractible farm level activities under items (i)-(iv) above) in the two seasons preceding the survey.

4.38 Overall, about 17% of the plots in the sample were affected by waterlogging and/or salinity/sodicity. Waterlogging and salinity are, as expected, particularly acute in Sindh and Southern Punjab. In the former, some 59% of all plots were affected by some salinity or waterlogging and 40 percent of plot area was affected on average. In the latter 24% of plots were affected and about 31% of plot area was waterlogged or saline on average (Figure 4.4).



4.39 While waterlogging was less frequent than salinity, it affected a higher proportion of plot area when it existed. In terms of the distribution of waterlogging vs. salinity problems, 60% of affected plots did not suffer from waterlogging while only 13% of affected plots were not saline. On about 43% of affected plots, 25% or less of the plot area was saline. Only 13% of affected plots had less than 25% of plot area waterlogged. At the other extreme, about 17% of plots have more than 75% of their area waterlogged, while 11% of affected plots have 75% of the area saline (Figure 4.5).



Determinants of soil degradation

4.40 Waterlogging and salinity in the Indus basin region are clearly caused by a complex of factors, ranging from poor drainage and generic salinity, to canal irrigation and poor on-farm water use. Thus, efforts to mitigate the adverse effects of waterlogging and soil salinity must be undertaken at several levels. First, a substantial investment in sub-surface drainage and the lining of distributaries is required in order to reduce the water table and protect and maintain the natural resource base of agriculture. However, drainage, as opposed to irrigation, is essentially a public good, since individuals cannot be excluded from the area-wide benefits of lowering the water table. Therefore, it appears that the public sector will have to take a leading role in developing and maintaining an integrated drainage system.

4.41 Second, large investments such as the lining of watercourses, or the reconstruction of earthen watercourses, also have a public good component and require community effort. One concern therefore is how communities can be mobilized to maintain and improve local irrigation structures. Finally, there are numerous farm level investments that can substantially reduce soil degradation. However, such investments will be made only if the structure of incentives is such that private returns to such investment justify the costs incurred. In this respect it is worrying to note that the data suggest the overall level of private on-farm investment is quite low.

4.42 Major on-farm or community-level investments were reported for 16% of affected plots. Among these, land leveling is by far the most common form of investment, accounting for 31 percent of all major

investments over the past 10 years on affected plots. This is followed by drainage, tree planting and tubewell installation (Figure A-4.1, Annex). Most investments were undertaken either by individual farmers, a large farmer in the area, or a farmer's group.

4.43 In addition, regular farm level measures - termed non-contractible since they are effort -intensive and require costly monitoring, were carried out on 22% of affected plots (Figure A-4.2, Annex). Among these measures, 11 percent of all affected plots undertook some irrigation-related measure, 16 percent implemented a specific cropping technique to mitigate salinity, and 13 percent undertook some type of land preparation practice. The data also includes information for all plots on the use of chemical and organic practices, including the application of green manure. The use of organic manure is particularly beneficial, and effects of an application last up to 3 years. Organic manure is used in over a third of all cultivated plots.

4.44 Importantly, it is worth noting that waterlogging and salinity problems and the efforts undertaken to solve them are related to the land holding status of cultivators. About 27 percent of saline plots were cultivated by tenants, however, while some sort of salinity/waterlogging mitigating practice was carried out on 85% of owner-cultivated plots, only 12% of affected sharecropped plots and 4% of affected fixed rent contract plots undertook any deliberate salinity reducing measures. This suggests that incentives to invest are considerably dampened by moral hazard problems and insecure tenure. Preliminary analysis suggests that the use of organic manure is significantly lower among tenants. In the context of ongoing rural sector work for Pakistan, the data will be used to more rigorously examine the relationship between land tenure and land degradation suggested here.

Access to Credit

4.45 A well functioning rural financial market plays a critical role in both agriculture and rural development by enabling deposit mobilization, financing production activity and investments,¹⁴ and assisting with consumption smoothing in response to production and other risks. In a world of perfect information, credit markets would obviate the impact of initial asset inequality on productivity, since all projects with sufficiently high returns would be funded by creditors. In real world credit markets, however, enforcement of repayment is always a major problem and collateral, often in the form of land, is typically required to obtain large loans. As a consequence, initial inequalities may be entrenched or exacerbated, contributing to the development of 'poverty traps'.

4.46 Specialized credit surveys, such as the Pakistan Rural Credit Survey (1985) estimate that between 40 and 50 percent of all rural households in Pakistan borrow regularly, and that farm households borrow more than non-farm households. This pattern is broadly corroborated in the PRHS 2001. Among farm households, more than three-fourths had outstanding loans during the reference period of the survey (Table 4.6). However, the distinction between formal and informal credit is extremely important. While formal loans have collateral requirements, most often in the form of land, informal lenders, enforce loan contracts largely through reputation, the interlinking of contracts and the use of family/social ties. Thus the asset poor are able to participate in informal markets much more easily.

Table 4.6: Credit Status by Farm Size Category

Farm Size Category ¹⁵	Hholds	Percent Taking Loans			Percent Constrained			Loan Amount	
		Loan	Informal	Formal	Informal	Formal	Both	Informal	Formal
	%	%	%	%	%	%	%	%	%
Landless	46.7	77.8	77.2	1.5	10.3	57.0	4.0	91.3	8.7
Marginal	18.3	73.6	72.2	5.0	7.6	33.0	2.5	74.6	25.4
Small	15.2	80.5	78.3	13.2	7.4	26.1	1.9	57.5	42.5
Medium	12.4	71.4	66.3	18.5	7.7	23.2	1.0	44.6	55.4
Large	5.1	77.7	71.9	24.0	6.6	26.4	0.0	21.1	78.9
Very Large	2.3	63.0	46.3	20.4	9.3	27.8	1.9	24.0	76.0
Average	100.0	76.3	74.2	7.6	8.8	41.5	2.8	59.1	40.9

4.47 The data show that while most borrowing households obtained informal loans, only 8 percent borrowed from the formal market. Formal loans were also concentrated among larger owners. While only 1.5 percent of households without land obtained any formal credit, more than 20 percent of large and very large owners obtained loans from formal sources.¹⁶ Moreover, the fraction of informal sector borrowers is remarkably stable across landholding size. Thus all farm households still borrow in the informal market to a substantial degree, this despite the expansion of institutional credit (see Box 4.3 for a description of the main sources of rural credit). It is worth noting, however, that the share of the formal market is quite substantial for those who succeed in getting loans. Close to three-fourths of the credit needs of borrowers who were large cultivators, and about a fourth of the credit needs of marginal cultivators, were supplied by the formal market.

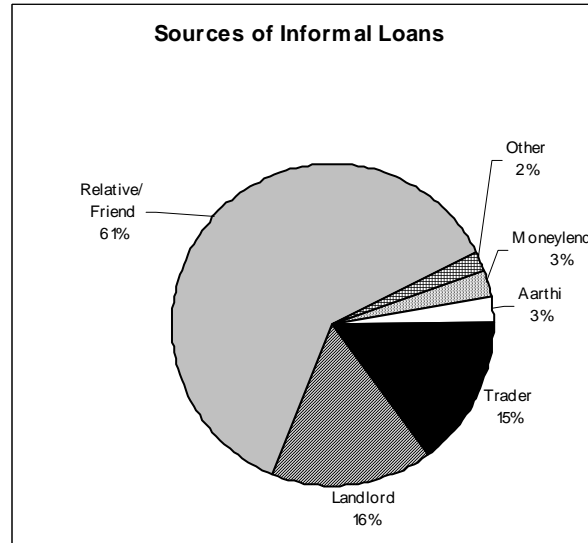
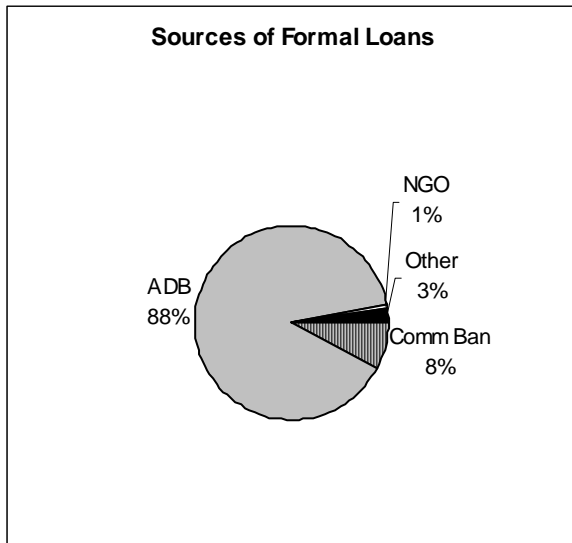
4.48 The PRHS survey also asks detailed questions aimed at uncovering the extent to which credit constraints are important. Farm households who participate in credit markets are not necessarily unconstrained, nor are those that do not participate necessarily constrained. Lack of borrowing may merely indicate lack of demand for credit, and borrowers may not get all the credit they want at the going interest rate. In practice, however, it is extremely hard to assess whether a particular household is credit constrained. A household without collateral may report that it prefers to borrow from the informal market, or it may not need credit simply because it forgoes opportunities to invest that might have been taken up if credit were available. A picture of self-reported credit constraints is presented in Table 4.6. A non-borrowing household in the formal (informal) credit market, is defined to be credit unconstrained in the formal (informal) market if it (a) did not need or demand credit at the going rate of interest, or (b) preferred to borrow from the other market.¹⁷ Among borrowers in the formal (informal) market, a household is defined to be constrained in the formal (informal) market if its demand for credit at the going rate of interest was greater than the amount of credit obtained.

4.49 The data indicate that very few farm households (about 9%) were constrained in the informal credit market. In contrast, 42% were constrained in the formal credit market. This is broadly consistent with other studies in developing countries. The distribution of constrained households is also quite unequal across farm size categories when one looks at the formal market. While 57% of landless farmers report that they are constrained in the formal market, only 28% of very large farmers report being similarly constrained. There appears to be no such pattern in the informal market. Overall, it seems reasonable to conclude that access to institutional credit is severely restricted and that the formal credit market specializes in 'prime' risks. So is it possible to go further and conclude that informal credit markets function well?

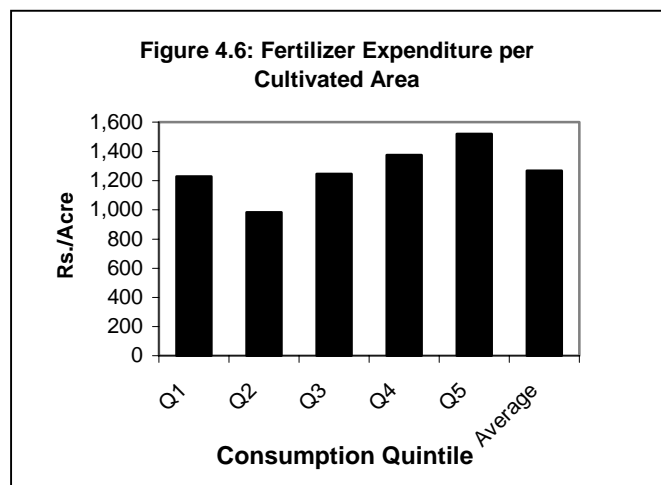
Box 4.3: Formal and Informal Sources of Credit in Rural Pakistan

Formal sector credit for agriculture in Pakistan comes largely from the State Bank of Pakistan (SBP) and flows through three major channels: the Agricultural Development Bank of Pakistan (ADBP), the Nationalized Commercial Banks (NCBs), and the Federal Bank for Cooperatives (FBC). The ADBP is by far the largest formal lender for agricultural purposes. The figures below indicate that 88% of all formal loans were obtained from ADBP.

The informal credit market is characterized by a multiplicity of differentiated lenders and loan contracts. There appears to be three major types of non-institutional lenders in the area studied: landlords, traders, and friends and relatives. Of these, friends and relatives are the most important source of credit, with farmers reporting 61% of informal loans from this category. It is important to note, however, that most loans from friends and relatives do not appear to be reciprocal in nature. Over two-thirds of households who borrowed from friends and relatives reported that they had never given credit to their lender. The second most important category was landlords, who provided 16% of all informal loans. With the intensification of agriculture, new types of informal lenders such as middlemen traders have also become a critical presence in the rural economy, both as marketing intermediaries and as financiers of cultivation. In addition, shopkeepers, input suppliers, mills, and wholesale buyers of agricultural commodities also supply credit to informal intermediaries and farm households. The traders and shopkeepers together provided about 18% of the loans. Professional moneylenders also retain a small but important presence in the rural economy, and accounted for about 3% of informal loans.



4.50 The answer may well be both yes and no. First, if credit constraints were a serious problem, one would expect to see large differences in purchased input use across farmers at different wealth levels. Yet, this does not appear to be the case in Pakistan, at least for fertilizers. Figure 4.6 shows that fertilizer expenditures per acre cultivated vary little by consumption quintile. This finding is consistent with that above, showing farmers are generally able to get informal loans when they need them. This is important and worth emphasizing since it indicates that small and marginal farmers can obtain production credit for some uses at least, from informal sources. On the other hand,



however, very little land is taken on fixed rent leases and there is virtually no land sales market. The paucity of fixed rent leases, which require upfront rent payment, is quite marked in an environment where over a third of all cultivated area is leased-out. This suggests that the informal credit market is by no means adequate. This is also corroborated by the data: There is virtually no informal lending for investment or land improvement/purchase. The bulk of informal loans are in fact small consumption loans from friends and relatives and average loan size is very small. To the extent that landless tenants opt for share tenancy contracts due to credit constraints, the adverse productivity implications of inequitable land ownership become more entrenched.

4.51 Moreover, low/no interest loans from friends and relatives are obtained largely by better-off households. Marginal and small owners and landless tenants have the bulk of their credit needs met by lenders other than friends and relatives (who account for over a third of all informal credit). For example, the data also show that landless share tenants get over two-thirds of key production inputs on credit and over a half of this is from their landlords. Interest rates charged by landlords, traders and moneylenders in rural Pakistan range from 80 to over 150 percent and are often tied to the marketing of crops. Thus the poor are paying substantially more for credit than the rich, which is likely to reduce their net returns from farming.¹⁸

4.52 As the above evidence indicates, there is a clear need to reform the rural financial sector in Pakistan. However, accomplishing this in an environment where asset inequality is severe is by no means easy. One approach that many countries have adopted, and that Pakistan is moving towards, is microcredit. While this presents considerable opportunities, experience elsewhere also suggest that it can be a mistake to see microcredit as a solution for all credit problems. Rather, it is necessary to understand carefully the strengths as well and constraints of micro-finance institutions (MFIs), of which there are many types. Notably, many of these have not been able to solve the credit needs of poor farmers; in fact, very few micro-credit schemes lend for production inputs or for investment in land, a problem that certainly deserves further study. It should also be noted that Pakistan like other countries has made large investments in a village banking network. The question may be asked - does this now need to be abandoned? It is also important to ascertain if linkages between MFIs and Banks could produce more fruitful results, as discussed later in Chapter 5. In sum, the problem of rural credit in Pakistan raises a complex set of issues that require country specific analysis.

Rural Factor Markets

4.53 As noted earlier in this chapter, there is considerable inequality in the ownership of agricultural assets, notably land, in rural Pakistan. And as discussed through the earlier sections, this often accentuates constraints on agricultural productivity, such as access to irrigation. A crucial step in understanding the policy remedies that may be available to address this distributional pattern of asset ownership, is understanding the nature of leasing markets for these assets. Theoretically, if all leasing markets are unconstrained, then the distribution of productive assets across households (i.e., endowments) should be irrelevant for productivity; households with relatively large endowments of particular assets can rent them out to households with relatively small endowments. Thus, the marginal product of asset services will be equated across households - the definition of efficient markets. This is not the case however in Pakistan, where weak factor markets seem to considerably accentuate the iniquities of unequal land distribution, in part for lack of adequate legal, or institutional provisions.

4.54 To establish this, this section summarizes a series of tests of rural factor market efficiency using the PRHS data. All the analyses are based on the premise that if a household can freely lease an asset in or out (including the labor services of its own members), then ownership of the asset (household composition) should not affect factor use intensity, conditional on the market price of the factor. If there is a significant ownership effect, then its magnitude indicates the size of the factor market distortion.

Table 4.7 summarizes the ownership effects uncovered in the five most important factor leasing markets; those for land, labor, groundwater, tractor services, and thresher/combine harvester services. The results are discussed below.

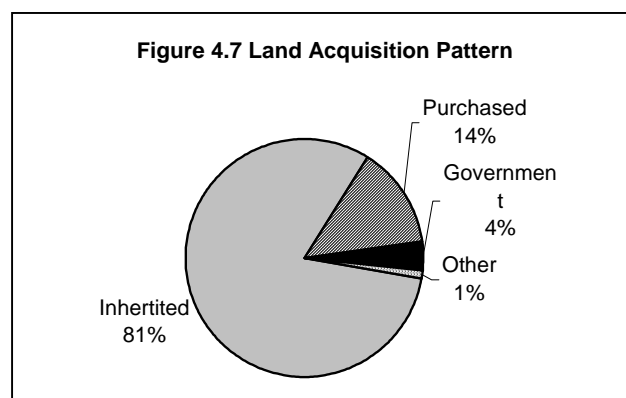
Table 4.7: The Effect of Asset Ownership on Factor Intensity

Input:	Experiment :	% change in input use	
		Kharif	Rabi
Cultivated land area	Double owned area	22	26
Labor (on-farm)	Add 1 Male age 14-59	7	5
	Add 1 Female age 14-59	3*	4*
Groundwater	Add 1 tubewell	17	15
Tractor services	Add 1 tractor (large or small)	17	16
Thresher/combine harvester services	Add 1 thresher or combine harvester	0*	0*

Notes: All inputs (except land itself) are per unit cultivated area. * Not statistically significant

Land leasing markets

4.55 One need only observe the paucity of land sales in Pakistan to realize that this market is hardly capable of bringing household landholdings into alignment with labor and other asset endowments. As Figure 4.7 indicates, the vast majority of individual plots were acquired via inheritance rather than through purchase. However, the thinness of the land sales market, so typical of the developing world, does not seem to arise from a lack of well-defined property rights. Most land is legally titled (though titles are less common in the less developed provinces of NWFP and Balochistan), and, more importantly, the owners report that they have the right to sell most of their land (see Table 4.8). More likely, land sales are scarce due to the absence of a well-developed credit market and, more fundamentally, of a supporting legal system, to provide for instance, enforcement of foreclosure, that would allow mortgage financing of land purchases.

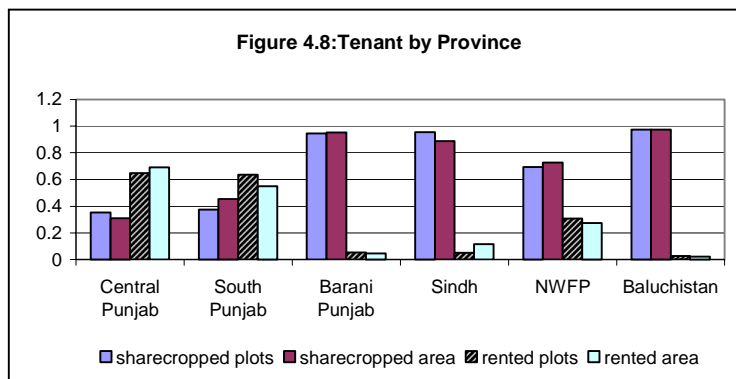


4.56 Absent an active sales markets, farmers can turn to land leasing markets, which is clearly important in rural Pakistan: of those households that own land, about one-third do not cultivate crops (this excludes uses such as orchard and pasture). Conversely, a third of households that cultivate cropland own none of it, being pure leasers. However, this does not mean that the land-lease market functions efficiently. Indeed, there is a very strong relationship between cultivated area and owned area, whether one looks at all farmers, or just those owning land. The first row of Table 4.8 indicates that, on average, for every additional acre of land owned, about one-quarter of an acre additional land is cultivated. These figures are for land owners only, though results for all farmers are similar, and are derived from regressions that also control for household composition, the value of farm equipment, and for village fixed effects, which, in particular, capture variation in the rental price of land. These results suggest significant limitations on households' ability to lease land in, or to lease it out.

Table 4.8: Property Rights over Land

Province	Ownership of Legal Title (% Area)	Right to Sell (% Area)
Central Punjab	69	87
South Punjab	93	87
Barani Punjab	80	93
Sindh	81	89
NWFP	50	99
Balochistan	59	82
National	72	88

4.57 This might be expected, given the nature of land tenancy in rural Pakistan. As Figure 4.8 indicates, sharecropping is the dominant contractual form, although not in parts of Punjab. Share-contracts typically give half, and sometimes more, of the crop output to the landlord, which attenuates the tenant's incentives to supply effort. As is well known, against this disadvantage, sharecropping does provide the tenant partial insurance against crop failure, not to mention the opportunity to cultivate without having to pay cash up front. While landlords can supervise their share-tenants to elicit higher effort (and, indeed, the data show that they do so, often intensively), supervision is costly and must therefore be counted as a disincentive to lease out. From the landlord's perspective, leasing on fixed rent is perhaps more convenient; because the fixed rent tenant is the residual claimant, he has strong incentives to supply effort, at least in the short run. However, tenants both willing to take a plot on fixed rent and able to make the up-front cash payment, are clearly few and far between.



4.58 The argument that incentive problems surrounding tenancy constrain land-leasing decisions makes sense, up to a point. Above a certain landholdings, however, a household cannot cultivate its own land without hiring in farm labor, and hired workers have even lower effort incentives than sharecroppers. Given rising marginal costs of supervising hired workers, there should be a level of land ownership beyond which area owned and area cultivated are unrelated. The data shows that this switching point occurs at an owned area of about 50 acres (Figure A-4.3, Annex). Providing additional land to households with landholdings above 50 acres would not increase their area cultivated.

Rural labor markets

4.59 Absent a perfectly functioning land leasing market, the natural question that arises is whether, through the labor market, land-labor ratios might be equated across farms, thereby restoring productive efficiency in the face of high land ownership inequality. Underlying this proposition are two critical assumptions: (1) constant returns to scale in production, and (2) all other factor markets, besides those for land and labor, are frictionless. Granting these assumptions (for now at least), it is then important to consider the issue of labor market efficiency.

4.60 Analogous to the analysis of the land leasing market, the question is whether labor used per acre on a family farm is dependent on the labor endowment of the household? During the *rabi* season, 24 percent of cultivating households hire labor, a share that rises to about 39 percent during the cash-cropping *kharif* season. Is this labor market activity sufficient to break the link between household demographic composition and farm labor usage? The answer, as reported in the second and third rows of Table 4.7, is "almost". Households with more prime-age males do apply significantly more labor to a given acre of cultivated land, but the effect is not particularly large. The effect of an additional prime-age female on labor intensity is even smaller, and not statistically significant.

4.61 While this evidence indicates that, on average, marginal products of labor on the farm do not deviate greatly from market wages, it does not necessarily imply overall productive efficiency. As mentioned, the latter conclusion requires both constant returns to scale in production and perfectly functioning markets in other factors. Though it is beyond the scope of the present analysis to test the

constant returns assumption, some evidence against the second assumption is provided below. What can be reasonably concluded from this investigation is that interventions in the rural labor market would not appreciably enhance farm productivity.

Groundwater markets

4.62 Over the past two decades, farmers in Pakistan have increasingly relied upon groundwater extracted from private (largely diesel) tubewells for irrigation, though there are stark regional differences, due largely to variation in groundwater availability. In Punjab, 74 percent of cultivating households used groundwater during the 2000-01 agricultural year, and 29 percent owned a tubewell; whereas, in Sindh, these figures are just 9 percent and 1 percent, respectively. Given the high costs of tubewell installation (about a year's income for the average farm household), it is not surprising that the rate of tubewell ownership among cultivating households—even among the two-thirds that own land—is low (around 16 percent nationwide). Consequently, groundwater markets are active, at least in Punjab. Overall, almost 30 percent of the groundwater used is purchased from other farmers.

4.63 The fourth row of Table 4.7 summarizes the analysis of efficiency in the groundwater market. Unlike the other markets studied here, groundwater use per acre is examined at the plot level rather than at the household level. This is because of the importance of location. Since it is not feasible to transport irrigation water very far through unlined field channels, access to both a tubewell and an irrigation canal is crucial in determining groundwater use. Two plots owned by the same household may have very different access to these irrigation sources. The regression analysis controls for the availability of canal irrigation and position along the watercourse, for the availability of a tubewell (regardless of ownership) near the plot, as well as for soil type and topography of the plot. However, even conditional on tubewell availability, plots cultivated by tubewell-owning households receive significantly more groundwater per acre than plots cultivated by non-owners. The misallocation of groundwater is not trivial; tubewell owners have a 15 percent higher utilization rate in *rabi* season and 17 percent higher rate in *kharif*. Of course, given the high transport cost and low density of tubewells, some imperfection in the groundwater market should be expected. The more important question, one that will be taken up later, is whether tubewell owners are more *productive* than non-owners?

Rental markets for farm machinery

4.64 Like tubewells, the vast majority of cultivating households do not own large farm machinery, yet most access the services of such machinery through rental markets. The remaining two rows of Table 4.7 report on the efficiency of these important rental markets.

4.65 Virtually all plowing is now done by tractor in Pakistan. However, only 8 percent of cultivating households own either a small tractor (under 12 horsepower), or a large one. On the other hand, well over 90 percent of these households plowed their land with a tractor during *kharif* and *rabi* seasons 2000-01. Regressions of tractor usage per acre, along the lines of the previous analyses, reveals that tractor owners employ 16-17 percent more hours of tractor services than non-owners. One possible explanation for this finding is that poorer cultivators are constrained in their ability to pay for tractor services up front, and hence do too little plowing. Alternatively, tractor rental markets may be somewhat thin, especially at certain times of the year. In this case, tractor owners, facing idle capacity, plow their own land more intensively than non-owners; more plowings are generally beneficial for yields, but there are obviously diminishing marginal returns. Once again, the salient issue is the magnitude of the impact of tractor ownership on productivity. Some productivity effect is indeed likely, as shown, though it may be too small to detect in practice.

4.66 The case of threshers and combine-harvesters is relatively clearer. These expensive machines are owned by a scant 2 percent of cultivating households. Nonetheless, in *rabi* season, when wheat is harvested, 82 percent of these households - most, but not all, of whom cultivate wheat - use threshers/combine-harvesters. There is no evidence that ownership of one of these machines affects usage, which stands to reason. After all, in contrast to plowing, one can only thresh wheat once, so owning a thresher should not lead to more intensive threshing on one's own plot.

4.67 In summation, it seems that asset ownership, in general, seems to matter for factor usage in Pakistani agriculture. Imperfections in the land leasing, groundwater, and tractor rental market suggest that a redistribution of these assets could improve productivity. Evidence of a reasonably efficient rural labor market does not belie this point. Given misallocation in three important factor markets, a perfectly functioning labor market, even with constant returns to scale, would not lead to efficient production. As already noted, however, the crucial question is how economically important are these factor market imperfections? Answering this question requires analyzing the impact of asset ownership on the profits from farming. This is the topic of the next section.

Farm Productivity

4.68 Several constraints on farm productivity in Pakistan have been identified in this chapter. Particular emphasis has been placed on the scarcity and mismanagement of canal irrigation, the problem of soil degradation, and the consequences of farm asset inequality when rural factor markets are imperfect. Credit has also been discussed, but in this case the evidence tentatively suggests that lack of access to credit does not seriously constrain input expenditure. At any rate, because of the difficulty of isolating the "exogenous" component of credit constraints, it is difficult to do more at this point.

4.69 Further to these analyses, this section analyzes the plot-level production data from the PRHS to quantitatively assess the role of canal irrigation, soil degradation, and asset inequality. The results reported in Table A-4.3 (Annex), use regressions to identify the main determinants of net revenues for *kharif* and *rabi* 2000 - with revenue from orchards and livestock excluded - as well as of yields for the major seasonal crops, rice in *kharif* and wheat in *rabi*.¹⁹

4.70 Evidence has already been uncovered of serious friction in the land leasing market. The results confirm the importance of leasing limitations for productivity. A doubling of total operated area by the household lowers per acre net revenue by 22 percent in *kharif* season, and by 38 percent in *rabi* season. Where is this large farm-size productivity effect coming from? The wheat yield regression suggests that, at least in *rabi* season, much of it is coming from variation in cropping intensity rather than allocative efficiency. In particular, a doubling in farm size reduces wheat yields by "only" 10 percent, which is far less than the 38 percent reduction in net revenue for the same season. Similar, but less dramatic, results emerge in *kharif* season, where the farm-size effect on rice yields is just 13 percent, compared to the 22 percent net revenue effect.

4.71 Evidently, households with larger operated area are leaving a larger fraction of their land fallow, especially during *rabi* season. The question is, why? One possibility is that cultivation is constrained by the availability of irrigation, so that at some point part or all of a plot is simply not worth cultivating by the owner, and certainly not by a tenant. However, the regressions hold constant the supply of irrigation to the plot. Indeed, both the availability of canal irrigation during the season and access to a tubewell are important determinants of productivity. Yet, the farm-size productivity effect remains. Of course, it is still possible, if not likely, that these variables do not capture all aspects of irrigation supply, especially in light of the fact that 2000 was a year of unprecedented drought in parts of Pakistan. If one takes these results, along with those on the land leasing market above, at face value, the policy implications are quite profound. In principle, a redistribution of land would have a sizeable positive effect on farm productivity,

both by increasing yields and by increasing land use intensity. Of course, as with all the preliminary results from the PRHS survey reported in this chapter, these findings should only be viewed as suggestive. There may be other factors, not taken into account in the regressions, that are being conflated with the farm-size productivity effect. These factors need to be investigated further in future work.

4.72 Turning now to other farm assets, tractor ownership significantly increases net revenue in *kharif* season;²⁰ the effect in *rabi* is also positive but not significant. Since the imputed cost of services from owned tractors is deducted from revenue, these findings mean that imperfections in the tractor rental market are appreciably constraining farm productivity, at least in the cash-cropping season. Once again, this might be the result of credit constraints that limit the ability to pay for such pre-harvest inputs up front, though there may be other reasons as well.

4.73 Somewhat the opposite situation prevails for tubewells, where the productivity effects of ownership are very large and highly significant only in *rabi* season. Ownership of a tubewell, holding constant access of the plot to a tubewell (whether owned or not), raises wheat yields by 30 percent and overall *rabi* season net revenues by a whopping 83 percent. The lower impact of tubewell ownership in *kharif* probably reflects the fact that groundwater is a relatively less important source of irrigation during this season.

4.74 Whereas considerable inefficiencies were detected in the tractor and groundwater markets in Section 2, this was not the case for labor: rural labor markets in Pakistan are reasonably flexible. Hence, it is not surprising that, in contrast to these other household assets, endowments of labor are unrelated to farm productivity. In particular, the number of prime-age household members, whether male or female, has no effect on net farm revenue in either season.

4.75 Results concerning soil salinity and waterlogging problems indicate very clearly their importance for agricultural productivity in Pakistan. First off, the regressions show that productivity is higher on plots with access to good quality groundwater, compared to plots with access to brackish water. This finding confirms the role of groundwater pumping in exacerbating soil salinity. As discussed earlier, farmers were also asked directly to assess the proportion of each plot affected by waterlogging and salinity. Often plots are affected by both of these problems, so the variable in the regressions is the proportion of the plot affected by *either* waterlogging or salinity. The results: a 10 percentage point increase in plot area affected by waterlogging and/or salinity leads to a 11 percent decline in productivity in *kharif* and a 12 percent decline in *rabi* seasons. Interestingly, the effect of soil degradation on wheat yields is much smaller, though still negative, suggesting that the main affect of soil degradation in *rabi* season is to limit the area of the plot that can be cultivated. Meanwhile, waterlogging/salinity have a very significant negative effect on rice yields (but not on cotton yields; these results are not reported here). This probably reflects the fact the rice tends to be grown on more saline land; first, because salinity is more pervasive in rice-growing areas and, second, because rice is more resistant to salinity.

4.76 Finally, the importance of irrigation, both canal and tubewell, for crop yields and farm profits cannot be emphasized enough. The PRHS was not designed to measure actual water usage at the farm or watercourse level, but relied rather on information from farmer recall. Despite this fact, and the relatively crude measure of canal water availability (a qualitative index ranging from zero to five), the supply of canal irrigation is found to be a significant constraint on productivity. Refining these estimates using more sophisticated survey instruments is a clear priority for future research, one that would allow the efficiency losses from the current system of canal water delivery to be adequately quantified.

Policy Conclusions

4.77 As noted in this chapter, there is considerable scope for policy intervention to improve efficiency and agricultural productivity. Particularly in remedying land ownership inequality and concomitant inequality in farm assets in rural Pakistan, which have substantial negative impacts on agricultural productivity and reinforces poverty.

4.78 First, the land leasing and land purchase markets function poorly, despite very secure ownership rights. This appears to be due to friction in a number of other markets, including quite significantly, the market for credit. As a consequence, the land rich under-use their land while the land poor cannot obtain sufficient land. This not only substantially lowers agricultural productivity, it also restricts the redistribution of wealth through markets, so that poverty can become entrenched. This suggests that the scope for market based land reforms might be quite limited since such reforms require well functioning land lease and purchase markets. On the other hand, other avenues for reform need to be explored. In particular, innovative mechanisms for improving access to credit and land for the poor need to be explored.

4.79 Second, land inequality in rural Pakistan also reinforces inequities in access to critical resources like canal irrigation. Although canal irrigation substantially increases productivity, the pricing regime and delivery mechanism for canal water clearly benefits those who have larger holdings. The flat rate for water leads to wasteful water use in a situation where irrigation water is an extremely valuable and scarce resource. In addition, the ability to influence officials of the irrigation department to divert water to the highest bidder allows those with larger land holdings to skew water distribution in their favor. This imposes three-fold costs on the poor: They must pay water charges whether or not they get water, pay bribes to get the water which is their right, and suffer lower productivity due to uncertain and low water supplies.

4.80 Finally, the analysis also shows that soil degradation, due to waterlogging and salinity, is quite significant in rural Pakistan, particularly in Sindh province and in Southern Punjab. These regions are also characterized by extremely high land inequality and large land leasing markets. As noted above, share tenancy is the dominant form of land leasing and all available evidence suggests that share tenants, particularly in an environment where tenure is insecure, have few incentives for investments in the preservation of soil quality. Thus sustainable agricultural growth in these regions may depend on reforms that increase the rational and equitable use of land resources as well as on public and private investment to reduce soil degradation.

4.81 There are numerous avenues for policy intervention in canal irrigation, drainage and soil quality preservation. The analysis suggests that reforms that aim to rationalize the water-pricing regime and change the performance incentives of irrigation officials are necessary. New public investment in irrigation infrastructure and drainage is also important. Water conservation and new investment could bring vast tracts of Barani (rain fed) land under cultivation. In addition, policies that increase incentives for private investment in soil quality preservation, both at the farm and community level, are likely to be quite important. Constraints on such investment both at the farm and community level need to be better understood.

4.82 Finally, it is important to note, as detailed early in the chapter, that more than a third of rural households now work outside the agricultural economy, or at least do not derive their income mainly from agriculture. The non-farm sector could therefore provide a potentially important avenue for poverty reduction efforts. An increase in wage and self-employment in the sector could not only provide alternative income earning opportunities for the poor, it could also improve the bargaining position of agricultural wagedworkers and tenants by pushing up wages. Stagnant poverty rates suggest inadequate

growth in the non-farm sector over the past decade. Improving opportunities in the labor-intensive non-farm sector should be a priority area for public policy since this sector is a major source of livelihoods and an important means of diversify incomes for the poor.

¹ Agriculture is the single largest sector in Pakistan's economy. It contributes a quarter of the country's Gross Domestic Product and employs almost half of the labor force.

² Agricultural Census for Pakistan (1990)

³ Nearly 80 percent of total cropped land is irrigated by the Indus Basin Irrigation system (IBIS) and ground water resources. Of the 18 million hectares of irrigated land in 1999-2000, about 41 percent was irrigated by canals, 39 percent by a combination of canal and tube wells and 17 percent by tube wells alone. Pakistan's irrigation system is the largest contiguous canal irrigation system in the world. It has over 1.6 million kilometers of canal, branches, distributaries, field channels and watercourses. The major source of water for irrigation is the Indus Basin Irrigation system (IBIS), to which 106 million acre feet (MAF) of water is diverted annually (at the canal heads); around 38 MAF or so is pumped from groundwater. Increases in the irrigated area were mostly achieved before 1980 when the irrigated area went from 9.25 million hectares in 1950 to 15.4 million hectares in 1983. Since the 1980s, the area irrigated by canals has remained around 8 million hectare while the additions in irrigated area have mainly come from groundwater tube wells.

⁴ Water Sector Investment Planning Study

⁵ Seepage during water delivery also compounds problems of waterlogging and soil salinity. We take up this issue in the next section.

⁶ According to a recent World Bank (1999) study the marginal returns from irrigation, as measured by the value of water in the private water market, is estimated to be as much as 10 times the water charge).

⁷ About one-half of all plots in the sample had access to canal irrigation, and the analysis in this section is restricted to those plots. For each plot farmers were asked whether the plot had access to canal irrigation, the position of the plot on the watercourse, and a number of watercourse characteristics. In particular, the data obtained also covers the availability of canal water over the past three seasons; the position of the watercourse on the distributary; whether any payments were made to irrigation officials to ensure water supply; the existence of a water user's group on the watercourse; and a number of variables that reflect something about the extent of landownership inequality among cultivators on the watercourse, as well as other dimensions of heterogeneity - such as the number of different caste/zaat groups cultivating land on the watercourse.

⁸ Floods in late monsoon in 1998 increased water availability in Rabi 1998-99.

⁹ It is worth noting that although the payment of bribes significantly affects water availability, the fraction of watercourses that report regular bribes to irrigation officials is if anything much smaller than we expected, given our pre-test results and the findings of the qualitative survey. However, our field teams have reported that many respondents were quite reluctant to acknowledge their own participation in such payments although they maintained that such irregularities were routine.

¹⁰ Waterlogging refers to the rise of the water table into the root zone of the soil profile at the point where it can asphyxiate the root system. Salt concentration affects seedling germination and vegetative growth. Agronomists have found that above a certain threshold of salinity depending on soil quality, climate and cultivation practices, yields are considerably decreased.

¹¹ These include large investments such as sub-surface drainage schemes, lining of distributaries and watercourses, and reconstruction of earthen watercourses.

¹² These include the installation of irrigation tubewells, planting of orchards, the lining/cleaning/repair of on-farm water channels, and improved surface irrigation via land leveling and the use of bed and furrows irrigation methods. Since these activities are easy to observe, someone can be paid to do them for the farmer (hence they are contractible).

¹³ Manure application improves soil structure, leading to higher crop yields. The use of gypsum restores the chemical balance of the soil, and is particularly beneficial for moderately to strongly saline-sodic root zone soils. In both cases, the impact of one application can last for several years. Land levelling is a preventive measure since it reduces the pooling of water and the formation of saline patches.

¹⁴ Given the timing of crop income, short-term (i.e., seasonal) borrowing allows farmers to finance expenditures on inputs such as seed, fertilizer, and tractor services, while longer term credit facilitates the acquisition of agricultural machinery, tubewells, and even land, as well as major land improvements.

¹⁵ Farmers were classified into size categories as follows: a) Marginal farmers with landholding > 0 & ≤ 2 acres, b) Small with > 2 & ≤ 5 acres c) Medium with > 5 & ≤ 15 acres d) Large with > 15 & ≤ 40 acres c) Very large with > 40 acres.

¹⁶ Overall, some 60 percent of ADBP debt and 45 percent of NCB debt goes to large farmers and non-cultivating landowners.

¹⁷ Households that reported borrowing from informal or formal sources were asked if they would borrow more at the going rate of interest. If farmers responded yes to this query, they are classified as constrained. Farmers who did not borrow were asked the reasons for not borrowing. The farmers who said they did not borrow because they did not need credit, or preferred alternate sources of credit or because they found the rate of interest too high, are classified as credit constrained.

¹⁸ Reinforcing this is the fact that large farmers often see access to cheap institutional credit as a rent to land ownership. Default rates have been high and substantial funds have been used to purchase urban property or additional agricultural land.

¹⁹ All of the dependent variables are in logarithms, so that the coefficients can be interpreted as percentage changes. There are numerous cases of negative net revenue on a given plot (14 percent of the plots in *kharif* and 25 percent in *rabi*), which must be dropped from the samples. Qualitatively similar results are obtained, however, using the full samples with the level of net revenues as opposed to the logarithm.

²⁰ Controlling for village-level tractor rental prices has no effect on this coefficient.