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TECHNOLOGICAL CHANGE IN WHEAT PRODUCTION IN PAKISTAN: MARKET BEHAVIOUR AND INCOME DYNAMICS

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Introduction

It is now generally accepted that improved seed-fertilizer technologies have succeeded in raising the incomes of farmers in a wide range of production environments. More controversial is the question of how the gains attributable to technological change have been shared among various socio-economic groups and between regions. If high-yielding varieties and associated inputs have disproportionally benefited wealthier farmers and/or people living in favourable production environments, then these technologies may have widened existing income gaps between the rich and the poor, as well as between inhabitants of favoured and marginal areas.

This paper provides an historical overview of the effects of technological change in wheat production in Pakistan over the past 25 years. An attempt is made to examine the impacts of new technologies on various markets for outputs and inputs, and the subsequent consequences that these have had on the incomes of different types of households interacting in those markets. Markets are the primary avenues through which the *indirect* effects of technological change are transmitted (as opposed to *direct* productivity impacts confined to adopting farmers). Thus, the focus on the dynamic behaviour of output and input markets is critical, as it provides understanding of how the benefits of technology diffusion were

This paper was drawn from Chapter 3 of Renkow, 1991.

shared between adopting and non-adopting populations (or between areas of rapid adoption and areas of less rapid adoption).

The analysis of the recent history of Pakistani agriculture provides valuable insights into the sorts of income distributional outcomes that might ensue from enhancing the sector's productivity in the future. Moreover, the discussion calls attention to factors quite apart from wheat production (or even agriculture) that have in some respects dominated the welfare of rural Pakistanis. This has important implications for understanding both the potential and the limitations of technological progress in agriculture as a force for improving the well-being of different socio-economic groups.

Agriculture in Pakistan

Agriculture is the single most important sector in Pakistan's economy, accounting for approximately 25% of gross domestic product. Major crops grown include wheat, cotton, rice, maize and sugarcane. Of these, wheat is dominant, accounting for 45% of total cultivated areas and contributing 30% of total value added in agricultural commodities. It is also the primary food staple for the vast majority of Pakistanis, with average annual per capita consumption ranging from 114 kg in urban areas to 147 kg in rural areas (Hamid *et al.*, 1988).

Wheat is an important crop in nearly every farming system within Pakistan. In irrigated areas, two crops are typically grown each year, usually a rainy season crop followed by wheat. The most common irrigated crop rotations include rice–wheat, cotton–wheat, maize–wheat and sugarcane–wheat. In rainfed areas, farmers generally plant only one crop per year on average, usually wheat followed by a rainy season crop (groundnuts, sorghum, or millet) and one year to fallow.

Due primarily to its relatively more assured water availability, Pakistan's irrigated sector is far more productive than its rainfed sector. Irrigated areas accounted for 63% of total cultivated area, 90% of wheat production, and 94% of value added in other crops in 1980 (Government of Pakistan, 1982). The average yields of irrigated wheat are nearly double those of rainfed wheat.

Approximately 62% of Pakistan's rural population lives in irrigated areas. Seventy-two percent of Pakistan's 105 million inhabitants live in rural areas (Government of Pakistan, 1982). Nationally, the distribution of land ownership is skewed. While three out of every four farms contain less than 5 ha ('small farms'), large farms of over 5 hectares account for over 60% of total cultivated area. Tenant farms account for up to one-quarter of all farms. On average, farms in rainfed areas are somewhat smaller than irrigated farms. Small farms account for just under 80% of all rainfed

farms, while in irrigated areas 72% of farms are small (Maqbool and Smale, 1987).

Technological Change in Pakistani Agriculture

Significant yield improvements have been registered in wheat, cotton, and rice since 1960 (Table 5.1), improvements that are attributable to marked progress in production technologies for these crops. The most important of these technologies are reviewed below.

Along with India and Mexico, Pakistan was one of the early beneficiaries of the Green Revolution. Due to a greater yield potential, as well as a superior response to chemical fertilizers in the presence of an assured water supply, semidwarf varieties had a dramatic impact on wheat productivity in Pakistan. Widespread cultivation of the first of the semidwarf varieties, Mexipak, began in the 1966–1967 cropping season, and by 1971 wheat production had nearly doubled (Hanson *et al.*, 1982).

Mexipak was primarily suited to the irrigated areas of Pakistan, where the assured water supply allowed the full potential of the variety to be achieved. Adoption of high yielding varieties (HYVs) in the irrigated areas proceeded rapidly, starting with the Indus River Basin of the Punjab and Sindh provinces and then moving into other irrigated areas of the country. By 1971, semidwarf wheat was cultivated on 75% of total irrigated wheat areas (Fig. 5.1). A considerable body of evidence indicates that adoption of HYVs and associated technologies occurred first on large farms, but within a few years small farms had 'caught up' in terms of adoption and levels of input use per hectare (Eckert, 1970; Lowdermilk, 1972). At present, practically all wheat cultivated on irrigated land is in semidwarf varieties.

The spread of HYVs to rainfed areas began in the mid-1970s with the release of the variety Lyallpur-73, which was developed and tested in the irrigated areas of the Punjab, but never particularly popular there. Its suitability to the rainfed areas is related to its tolerance to drought stress and to the fact that it is somewhat taller than most of the semidwarf varieties, hence a better source of livestock fodder. Adoption proceeded at a somewhat slower pace in rainfed areas than in the irrigated areas, and yield improvements were considerably smaller in the former (16%) than in the latter (45%) (Nagy, 1984). Rates of adoption varied considerably as well, depending primarily on the amount and variability of annual rainfall. In areas with more assured rainfall, adoption was relatively rapid. In contrast, cultivation of lower yielding but more drought-tolerant traditional varieties is still quite common on a considerable proportion of wheat area in locations with low or variable annual rainfall. According to one recent survey, the primary reason given by farmers in areas receiving less than 500 mm of rainfall per year for growing traditional varieties was

Table 5.1. Percentage growth in area, production and yield of major crops, Pakistan, 1960–1964 to 1985–1988.[a]

	Wheat	Cotton	Rice	Sugarcane
Area	1.6	2.3	1.9	2.2
Production	4.6	5.3	4.0	2.8
Yield	3.0	2.9	2.1	0.6

[a]Average annual percentage change between 1960–1964 and 1985–1988.
Source: Government of Pakistan, Ministry of Food and Agriculture.

superior performance under drought conditions, due primarily to the ability of traditional varieties to germinate when planted at a greater soil depth; consumption preferences and fodder quality were also mentioned as important factors (M. Ahmed, personal communication, 1990).

Subsequent breeding research had led to the release of a large number of varieties since 1971. Following severe rust epidemics in the 1970s, considerable attention was paid to increasing resistance to evolving rust pathogens. Additionally, increased cropping intensities in double-cropped farming systems that caused delays in the planting of wheat encouraged the development of varieties better adapted to late planting. Finally, breeding research in Pakistan and elsewhere has contributed to the continuing enhancement of the genetic potential of post-Green Revolution releases available in Pakistan. The 1.0% annual rate of yield gain in these newer releases, while below the very high rates enjoyed during the Green Revolution period, has been quite respectable by world standards (Byerlee and Siddiq, 1990).

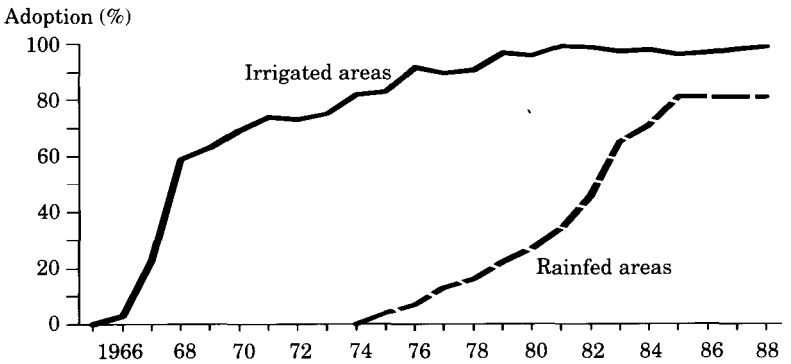

Fig. 5.1. Adoption of semidwarf wheat varieties, Pakistan, 1965 to 1988.

Source: Ministry of Agriculture, Pakistan.

Along with the development and spread of semidwarf wheat, fertilizer was an important component of Pakistan's wheat revolution of the late 1960s. Fertilizer offtake increased dramatically, starting at the time of the introduction of Mexipak. Prior to that time, fertilizer use had been minimal in most parts of the country. Between 1966 and 1976, 90% of chemical fertilizer applied in Pakistan was nitrogenous. Subsequently, use of phosphatic fertilizers increased sharply, and by 1986, phosphatic fertilizers accounted for 40% of total nutrients applied to wheat (Byerlee and Siddiq, 1990).

The pattern of adoption of fertilizer by farmers in irrigated and rainfed areas was similar to that of HYV wheat. Widespread ferilizer use occurred in irrigated areas somewhat before rainfed areas. Likewise, large farmers generally were the early adopters of the technology, but small farmers rapidly caught up (Eckert, 1970). Currently, use of both nitrogenous and phosphatic chemical fertilizers on wheat is moderate to high in most parts of Pakistan – in the order of 45 kg ha^{-1} of total nutrients in rainfed areas, and over 150 kg ha^{-1} in irrigated areas (M. Sharif, personal communication, 1990) Only in low-rainfall rainfed areas is adoption less than complete. Hobbs *et al.* (1990) found that 18% of farmers in the low-rainfall zone of the rainfed Punjab do not use any chemical fertilizers.

Between 1964 and 1976, the availability of irrigation water in the post-rainy season doubled. Completion of the Tarbela and Mangla dams led to a 50% increase in canal irrigation water during this period. Even more dramatic was the exploitation of groundwater supply, as the installation of private tubewells skyrocketed. By 1976, groundwater provided nearly half of post-rainy season water supply. Exploitation of groundwater supplies has continued up to the present, though installation of new tubewells slowed during the 1980s. Currently, tubewell water accounts for about 60% of total post-rainy season water supply. About 80% of this water is used on wheat.

The expansion of Pakistan's irrigation infratructure has had important effects on the production of wheat and other crops in a number of ways. Much of the increase in water supply was used to convert rainfed land to irrigated land. It also led to increased water availability for irrigated crops (Byerlee and Siddiq, 1990). Finally, tubewells have had a major impact on cropping intensity in a number of Pakistan's more important farming systems (Tetlay *et al.*, 1990). The increase in cropping intensity has had mixed effects. On the one hand, it has led to an increase in total production of all crops in double-cropped systems. On the other hand, it has also tended to delay wheat planting in some of Pakistan's more important farming systems (especially the rice–wheat and cotton–wheat systems of the Punjab). In these areas, this conflict has had a negative impact on wheat yields.

By the 1980s, tractors had become the dominant power source for land

preparation. Additionally, tractors were used to power stationary mechanical threshers: these currently account for 97% of all wheat threshing (CIMMYT, 1989).

There is no evidence that tractors contributed to yield improvements in Pakistan (McInerney and Donaldson, 1975). However, a number of studies suggest that the use of tractors in South Asia generally led to modest increase in cropping intensity in the order of 10% or less (Binswanger, 1978; Jayasuriya *et al.*, 1986; Tetlay *et al.*, 1990). The most important impact of tractorization was that it increased the amount of land that one farmer could cultivate, at the same time decreasing the amount of labour used per hectare. One consequence of this was that it led to significant displacement of labourers and tenants (McInerney and Donaldson, 1975). This situation was exacerbated by the Agricultural Development Bank of Pakistan's programme of providing loans for the purchase of tractors. A disproportionate share of these loans were made to large farmers; as a result tractor ownership and tractor use were confined to large farmers for a much longer period than was the case for more divisible inputs such as seeds and fertilizers. Over time, tractor rental markets developed, and access to mechanical traction has become more widespread (Hobbs *et al.*, 1990). Currently, tractors are the primary source of land preparation on 75% of all farms in Pakistan (CIMMYT, 1989).

Policy Interventions in the Market for Wheat

The government of Pakistan has traditionally played a major role in the market for wheat, in the process affecting the transmission of indirect effects of technological change to various types of households. Government intervention has taken three basic forms: (i) purchasing wheat at a guaranteed procurement price; (ii) providing subsidies on key inputs used in the production of wheat and other crops; (iii) subsidizing the price of wheat flour to urban consumers. The nature and effects of these interventions are reviewed below.

Producer price and input subsidy policies

A considerable proportion of wheat output in Pakistan, in the order of 55%, is retained on farms for home consumption or seed use, or paid out to labourers (Thobani, 1983). The government of Pakistan typically procures about half of all marketed wheat. The government procurement price of wheat is usually announced at planting time. This is a floor price in the sense that farmers are not legally compelled to sell to the government. Since the beginning of the Green Revolution, the procurement price has

Table 5.2. Trend growth rate (percentage per year) in real procurement price, consumer price, and world price of wheat, Pakistan, 1960 to 1989.[a]

	Procurement price	World price[b]
1960–1989	−0.9*	1.0*
1976–1989	−1.1*	−1.2

[a]Based on a semi-log regression. Asterisk denotes significance at the 5% level.
[b]Price of No.2 hard red winter wheat, f.o.b. Gulf ports.
Source: CIMMYT database.

dominated the market for wheat in irrigated areas; the private (wholesale) wheat price has seldom been markedly different from the procurement price (Pinckney, 1989).

The procurement price is determined each year by the government on the recommendation of the Agricultural Price Commission (APC). Several factors are involved in the final determination of this price, including the cost of production, expected trends in world prices, levels of wheat stocks, and, presumably, the level of available government fiscal resources. Some authors contend that of these, cost of production is the dominant consideration (Thobani, 1983; Momon, 1988). By this view the procurement price is largely based on an estimate of the average cost of production plus a certain amount meant to represent a 'fair' return to farmers.

Real procurement prices in Pakistan also appear to have reflected prevailing conditions in the world wheat market, particularly in the post-Green Revolution period. Throughout the post-Green Revolution period (1976–1989), both the real procurement price and the world price (No. 2 hard red winter wheat, f.o.b. Gulf ports converted to rupees at the official exchange rate) have trended downward at the rate of about 1% per annum, and a fairly strong positive correlation between the two prices (equal to 0.66) exists (Table 5.2). The procurement price has consistently been below the world price, however, with the exception of two years in the mid-1980s. Furthermore, because imports and exports of wheat are exclusively controlled by the government, private traders are barred from engaging in arbitrage on world markets to facilitate the transmission of world prices to producers. This explains the persistence of the differential between the procurement and world prices since 1976.

Producers in Pakistan have benefited from subsidies on fertilizers, credit, irrigation water and electricity, as well as government investment in irrigation infrastructure. The distribution of the benefits of these have been uneven. Obviously, subsidies and government investments related to irrigation have not benefited farmers in rainfed areas, except in those cases where irrigation was provided to areas where it previously did not exist. Much of the subsidized credit supplied by the Agricultural Development

Bank of Pakistan was tied to tractor loans. As mentioned earlier, a disproportionate share of these loans went to large farmers, particularly in the early days of the programme. Subsidized fertilizer is nominally available to all farmers, although there are generally some problems with distribution and timely availability.

Generally, the subsidies on inputs have not compensated wheat producers for the taxes represented by the below-parity government procurement price and an overvalued exchange rate. Webb *et al.* (1990) estimate that between 1982 and 1987 the net tax on wheat producers equalled 30% of the average price that they received. Even disregarding the implicit tax from overvaluation of the rupee, the net tax on wheat producers during that period amounted to about 14% of the procurement price.

Consumer price policy

Until 1988, the government of Pakistan operated a system of ration shops offering wheat flour at highly subsidized prices. Households received quotas for a specific quantity of rationed flour which could be purchased each month. The rationed flour was predominantly purchased by urban consumers with easier access to ration shops (Alderman *et al.*, 1988). The ration shop system was dismantled in 1988.

Prior to 1988, household consumption of wheat flour in excess of the ration quota was purchased in retail markets at government-controlled prices; since 1988, nearly all flour consumed by urban consumers has been purchased in retail markets.[1] Retail flour has traditionally been subsidized in several ways. The marketing costs of wheat procured in Pakistan – including transportation, milling and distribution – is borne entirely by the government. Flour milled from imported wheat is also explicitly subsidized when, as has been the case in nearly all years, the retail price is held below import parity levels. Maintenance of an overvalued exchange rate has implicitly subsidized consumers as well.

Webb *et al.* (1990) estimate that between 1982 and 1987, the subsidies passed on to Pakistani wheat consumers equalled 45% of the price that consumers paid. Of this amount, 69% is attributed to exchange rate overvaluation, 18% to the cost of operating the ration shops, and the remaining 13% to government marketing and distribution expenses. Thus even after the dismantling of the ration shop system, significant levels of consumer subsidies remain. Moreover, having expended a considerable amount of political capital in the recent derationing of wheat, it would appear unlikely that much latitude for further lifting of consumer subsidies is available to the government, at least in the near term.

[1] Rural consumers generally purchase flour in uncontrolled village markets.

The Agricultural Labour Market

Schultz (1975) has pointed out that technological change in agriculture results in a period of disequilibrium, as producers and labourers move from one set of production relations to another. In the case of Pakistan, the Green Revolution represents one such disequilibrium episode, one that had profound effects as rural labour markets adjusted to changing conditions. This section investigates the dynamic behaviour of the agricultural labour market over the past 25 years. First, the profound impacts of the widespread adoption of biochemical and mechanical technologies during the Green Revolution period are examined. Next, the effects of the post-1976 foreign employment boom are discussed. Finally, interregional differences in wage rates and rural–rural migration are considered. Throughout this discussion, the period extending from 1966 to 1975 will be referred to as the Green Revolution period, while the term post-Green Revolution refers to the period since then (1976 to the present).

The Green Revolution period

Considerable evidence indicates that the biochemical technologies surveyed earlier led to an increase in labour use per hectare (Eckert, 1970; Lowdermilk, 1972, Chaudhry, 1982). The tremendous yield increases on fields planted with semidwarf wheat entailed significantly greater use of labour for crop care, harvesting, and threshing activities. Increased fertilizer and water use entailed greater demands for labour to apply them. The increases in cropping intensity facilitated by new varieties and the expansion of tubewell irrigation boosted labour demand for all operations. Chaudhry estimates that in irrigated areas labour input her hectare of wheat increased at the rate 2.6% per year between 1964 and 1976. Roughly half of these increases were due to increased cropping intensity, with the other half resulting from the higher labour requirements associated with seed-fertilizer technologies.

The effects on labour demand of agricultural mechanization are more controversial. It is well-documented that in the initial stages of the diffusion of tractors there was a considerable amount of displacement of tenants as landowners were able to cultivate greater amounts of land themselves (McInerney and Donaldson, 1975). There is also evidence that a substantial shift in the composition of the agricultural labour force occurred during the Green Revolution, whereby casual hired labour and family labour supplanted permanent hired labour (Chaudhry, 1982). These are reflected by the fact that real wages of permanent hired labour fell between 1966 and 1974 (Table 5.3). This has been linked to mechanization by some authors (e.g. Irfan and Amjad, 1986), although the 1972 land reform

Table 5.3. Real daily wages for casual labour and permanent hired labour in the Punjab, Pakistan, 1966 to 1987.

	Casual labour		Permanent hired labour[c]		
Year	irrigated areas[a]	Pakistan (index)[b]	irrigated areas	rainfed areas	ratio
1966	n/a	n/a	6.35	4.93	0.78
1967	n/a	n/a	5.22	4.44	0.85
1968	n/a	n/a	6.14	4.77	0.78
1969	n/a	n/a	5.95	4.86	0.82
1970	10.38	100	5.93	4.93	0.83
1971	10.33	n/a	6.11	4.79	0.78
1972	9.82	105	7.17	5.84	0.81
1973	13.47	151	6.27	5.10	0.81
1974	15.07	160	5.69	4.63	0.81
1975	11.73	n/a	n/a	n/a	n/a
1976	11.10	121	7.65	n/a	n/a
1977	11.95	129	6.87	n/a	n/a
1978	12.44	134	8.98	n/a	n/a
1979	12.82	138	8.82	n/a	n/a
1980	13.30	145	7.32	n/a	n/a
1981	17.61	191	8.28	3.41	0.41
1982	17.47	186	10.78	n/a	n/a
1983	16.34	215	n/a	n/a	n/a
1984	16.16	n/a	7.33	7.88	1.08
1985	17.17	n/a	7.75	8.31	1.07
1986	n/a	n/a	10.12	12.78	1.26
1987	n/a	224	10.31	9.88	0.96
Trend growth rate (% per year)[d]					
	3.5*	4.4*	2.6*	3.4*	

All values expressed in 1980 rupees per day.
[a] *Source*: Jose, 1988.
[b] *Source*: Husain, 1990.
[c] Punjab only. *Source*: PERI, *Farm Accounts and Family Budgets*.
[d] Based on a semi-log trend regression. Asterisk denotes significance at the 1% level.

restricting the amount of land that could be operated by absentee landlords was probably responsible for the shift as well.[2]

The direction of causality between changing tenancy and contractual arrangements on the one hand and the rapid diffusion of tractors on the other hand has been the subject of a contentious debate in Pakistan. At the

[2] Whether this is reflective of actual changes in land use and farm tenure patterns or differences in sampling techniques used to collect the data is a moot point.

risk of oversimplification, it appears that the debate features two camps, one regarding the diffusion of tractors as having been induced by exogenous shifts in labour demand, and one viewing tractors as having been induced by policies that distorted the relative prices of capital and labour. There appears to be some truth in both of these views. An alternative perspective containing elements of each is offered here, one relating to differing rates of adjustment of land rental and labour markets to the disequilibria created by the rapid productivity increases. At the time of the Green Revolution, share tenancy was the dominant land rental arrangement, with landlords and tenants receiving fixed shares of output, typically 50% for each party. Over time, an increasing proportion of rental contracts was put on a cash basis. However, the evolution of rental arrangements from share tenancy to fixed contracts occurred relatively slowly, presumably because they were based on long-standing tradition.

In contrast, labour markets adjusted quite rapidly, as evidenced by sharp increases in real wages (see below). The implication here is that in this period of disequilibrium, landowners facing institutional rigidities in the land rental market began cultivating more land themselves, partly by using greater amounts of hired and family labour and partly by substituting mechanical labour for human and bullock labour.[3] Mechanization was no doubt expedited by policies such as subsidized tractor loans that encouraged the purchase of tractors. However, it seems likely that policy distortions merely speeded the process, as opposed to inducing it.

While labour demand was growing at an annual rate of 2.6% per year during the Green Revolution period, labour supply was increasing at about 1.7% per year. The result was an upward pressure on real wage rates. Chaudhry presents data indicating that real wages for casual labourers grew by 8% per year between 1964 and 1969, and by 6.3% between 1969 and 1974. He also reports that by 1974 labour shortages had made it difficult for cultivators to hire sufficient labour for various operations.

The foreign employment boom

Beginning in the mid-1970s, large numbers of Pakistanis began migrating to oil-producing countries in the Middle East. Estimates of the number of overseas migrants vary. Irfan *et al.* (1982) surveyed a number of these, concluding that 1.8 million Pakistanis had worked abroad as of 1979, and

[3]Data from the 1960 and 1972 Agricultural Censuses (Government of Pakistan) indicate that the total number of pure tenant farms declined by over 35% during that 12-year period, while the total number of owner-operated farms declined by about 21% during the same period. These data are consistent with the contention that resumption of farming by absentee landowners was significant during the Green Revolution period. However, due to differences in sampling methodologies, the data from these two censuses may not be comparable.

that 2.3 million Pakistanis were working overseas in 1981. The flow of outmigrants appears to have increased through the mid-1980s, judging from the level of remittances from abroad (IMF, 1990).

According to official estimates, remittances from abroad averaged $2.5 billion per year between 1979 and 1988, or 8.5% of GDP. The official estimates almost surely understate the true level of remittances, as they only cover cash remittances through official channels. The massive infusion of foreign exchange resulting from the foreign employment boom had profound effects on all sectors of Pakistan's economy. Approximately 60% of all migrants were from rural areas (Irfan *et al.*, 1982). Even though the majority of remittance income was used for consumption expenditure and the purchase of durables, considerable resources flowed into the agricultural sector in the form of investment in agricultural machinery and purchase of land-improving inputs. In the Punjab, an estimated 13.4% and 3.4% of remittance income was used for these purposes in irrigated and rainfed areas, respectively (Rahman, 1981).

The outflow of workers from rural areas exacerbated existing shortages in the supply of agricultural labour. This is reflected in the steady increase in real wages received by casual labourers from the mid-1970s onward (Table 5.3). Importantly, this growth in real wages in the post-Green Revolution period probably occurred after the labour market had adjusted to the disequilibrium conditions created during the Green Revolution; that is, it is chiefly attributable to a shock that was entirely exogenous to the agricultural sector. Coupled with the inflow of investible funds, the outflow of labourers no doubt contributed greatly to the diffusion of tractors and threshers.

Rural–rural migration

An issue that deserves some consideration here is the extent to which interregional differences in the growth of agricultural productivity contributed to rural–rural migration in Pakistan. In particular, it would be of interest to determine the extent to which significant migration of labourers from rainfed areas to irrigated areas occurred during the Green Revolution period, when adoption of seed-fertilizer technologies was largely confined to the irrigated areas.

Data on internal migration in Pakistan is limited. The best source on the subject is a study conducted by the Pakistan Institute of Development Economics (PIDE) in 1979 (Irfan *et al.*, 1982). This study collected data on internal migration, including rural–rural, rural–urban, urban–urban and urban–rural migration. Interestingly, it was found that rural–rural migration accounted for the largest share (about 40%) of internal migration during the periods 1965–1973 and 1972–1979. Excluding migration of females

for marriage purposes, 62% of rural–rural migration was within districts, while 33% was between districts and only 5% crossed provincial boundaries.

The PIDE study does not report reasons for migration; neither does it contain information on migration from rainfed to irrigated areas. Alternatively, comparison of wages in rainfed and irrigated areas to determine if wage differentials narrowed over time would shed light on interregional labour market equilibration. Disaggregated data on wage rates for casual labour are also unavailable; however, data compiled by the Punjab Economic Research Institute in annual farm management surveys do contain information on the wages of permanent hired labour in rainfed and irrigated areas of Punjab (Table 5.3). Between 1966 and 1974, real wages for permanent hired labourers trended downward in both areas, with wages in rainfed areas remaining at about 80% of those in irrigated areas. In the post-Green Revolution period, interregional differences in wages of permanent hired labourers essentially disappeared, as wage growth in rainfed areas exceeded wage growth in irrigated areas.

Combined with the evidence that substantial rural–rural migration occurs in Pakistan, the equalization of wage rates for permanent hired labour across regions offers limited support for the hypothesis that labour migration served to distribute the benefits of differential productivity growth from more productive to less productive areas. Lacking information on the wage rates of casual labour, this evidence must be regarded as suggestive at best. At least two additional factors may well have accounted for the dynamics of the wage rates of permanent hired labourers. First, the post-Green Revolution period corresponds to the period of diffusion of seed-fertilizer technologies in rainfed areas. The growth of real wages in rainfed areas may have mirrored labour market changes occuring in the irrigated areas during the Green Revolution period. Second, the effects of the foreign employment boom on real wages in both areas are likely to have dominated the effects of agricultural labour demands in determining agricultural wage rates. It is widely held that the largest share of overseas workers originated from rainfed areas (Rahman, 1981). If this is true, then one would expect that labour shortages and associated increases in real wages would have been more pronounced in rainfed areas for all categories of workers.

Finally, it is instructive to compare the dynamic behaviour of real agricultural wages in Pakistan with that of India. In India, rapid productivity improvements in the irrigated areas of the wheat producing states of Haryana and the Punjab during the Green Revolution induced large movements of temporary migrant labourers from other parts of the country (Dhar, 1980). While real wages grew substantially in the Punjab and Haryana during the early stages of the Green Revolution, real wages have remained constant (or even fallen) between 1970 and 1984 (Jose, 1988;

Acharya, 1989; Sidhu and Byerlee, 1992). Presumably, this is due in large measure to the inflow of temporary migrants. This contrasts markedly with the Pakistani case, where real wages have been steadily increasing in all areas since the mid-1970s. In all likelihood, the most important reason for this difference has been the profound effect of the foreign employment boom on Pakistani labour markets.

The Dynamics of Rural Income in Pakistan, 1965–1987

The preceding sections of this chapter outlined the nature of technological change in agriculture and the behaviour of key agricultural markets in Pakistan over the past 25 years. In this section, attention is focused on the impacts that these have had on the incomes of rural households. The analysis uses data contained in annual farm management and family budget publications issued by the Punjab Economic Research Institute (PERI). These contain information on costs and returns of crop production for small and large farms in both the irrigated and rainfed areas of the Punjab. They also allow computation of household income from various sources, such as crop production, family labour, and other activities, for both landed and landless households. As such, the PERI data provide valuable insights into the evolution of rural incomes across both production environments and household types.

Profits from crop production

Real profits per hectare (in 1980 prices) from crop production between 1965 and 1987 were calculated as the value of total crop production less all variable costs. Variable costs included all purchased inputs plus the imputed value of family labour and farmyard manure produced and used on-farm. The imputed rental value of farmers' own land was not included in variable costs. Thus, the profits represent per hectare returns to land and management.

While profits per hectare exhibited considerable variability for all groups – no doubt largely attributable to annual variations in weather – some clear trends are evident (Fig. 5.2). For the entire 1965 to 1987 period, per hectare profitability grew at an annual rate of 2.7% for large farms in both irrigated and rainfed areas. These positive trends were statistically significant for irrigated farms, but not for rainfed farms. Profits per hectare trended downward slightly for irrigated small farms, and considerably for rainfed small farms, although neither of the estimated trends was significantly different from zero at the 10% level.

Per hectare profits grew for all groups between 1965 and 1971. For

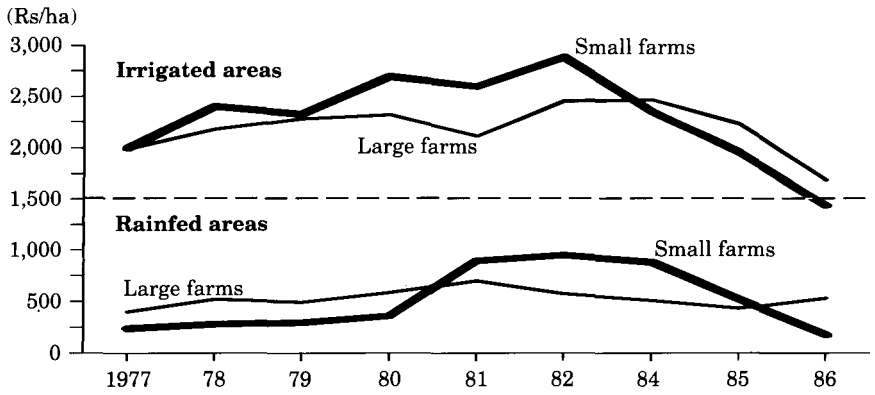

Fig. 5.2. Real farm profits per hectare, the Punjab, Pakistan, 1976 to 1987.

Source: PERI.

irrigated farms, this accords well with the conventional wisdom that the Green Revolution had a positive impact on the farm profitability. That farm profits grew in rainfed areas during that time is puzzling because this period predates the diffusion of seed-fertilizer technologies, and real procurement prices were relatively constant over these years. This phenomenon was noted by Chaudhry (1982); he attributed it to mechanization and favourable weather in rainfed areas during those years.

In rainfed areas, real profits per hectare peaked in 1971; by 1976 they had fallen considerably. Annual inflation of 18% between 1972 and 1976 no doubt contributed significantly to the erosion of real farm profits. For small rainfed farms, the high profitability levels of the 1966 period were achieved only occasionally during the post-Green Revolution period. Conversely, following the downswing in profitability between 1971 and 1976, per hectare profits of large rainfed farms generally grew during the post-Green Revolution period.

In irrigated areas, per hectare profitability has been quite variable since 1976. Until 1981, real profits of small farms were in most years greater than or equal to those achieved during the Green Revolution period, with the exception of 1971, an outlier year in which extraordinarily high profits were reported. Profitability has trended downward during the 1980s. During the 1976–1987 period, real profits per hectare for large irrigated farms have generally been above the levels achieved during the Green Revolution. Profitability rose steadily up to 1979, remained relatively steady between 1980 and 1984, and dropped considerably after 1984.

That per hectare profitability has declined during the 1980s is vividly illustrated in Fig. 5.2. Declining farm profitability in the Punjab during the 1980s has been attributed to the combination of declining real prices for

agricultural commodities, a rise in the general price level, and slowdowns in the rate of technological progress (Ahmed and Chaudhry, 1987). The per hectare profitability of small farms has fallen more steeply than that of large farms during the 1980s, particularly in irrigated areas. A possible explanation for this is that more labour-intensive small farms were more negatively affected by increases in wages that accompanied the foreign employment boom during this period.

Rural household income

Table 5.4 presents time-series data on real household income for six types of households – landless, small farm, and large farm households in rainfed and irrigated areas. In irrigated areas, incomes of large farm households exceeded incomes of other household types by a wide margin in all years. Likewise, incomes of small farm households have consistently been larger than the incomes of landless households, although this difference has narrowed in the post-Green Revolution period.

In rainfed areas, the relative levels of real income across household types mirrored those in irrigated areas during the Green Revolution period. The picture is entirely different in the post-Green Revolution period. Since 1976, the income levels of landless households have generally been as large as, or larger than, small farm households, and in some years have even exceeded the incomes of large farm households. Interestingly, since 1982 incomes of both small and large farm households and, in most years, landless households in rainfed areas have exceeded the incomes of irrigated small farm households.

Between 1965 and 1987, landless households in both rainfed and irrigated areas registered the largest annual growth rates of real income (6.6% and 4.6%, respectively). Real incomes grew by a considerable amount for rainfed small farm households as well (4.4% per year), while the incomes of large farms in both irrigated and rainfed areas grew at a relatively slower rate. Only in the case of irrigated small farms did real income trend downward.

The growth rates for the post-Green Revolution period indicate striking interregional differences. Between 1976 and 1987, real incomes of households in rainfed areas grew at rates ranging from 5.1% per year for landless households to 14.9% for small farm households. During the same period, real incomes of landless and small farm households in irrigated areas were falling, while incomes of large farm households grew slowly.

There were distinct regional differences in the time paths of incomes for landless households (Fig. 5.3). In irrigated areas, the incomes of landless households grew during the Green Revolution period, but have remained fairly constant since 1976. Conversely, real incomes of landless households in rainfed areas were relatively constant through 1971, but

Table 5.4. Real income of rural households, Punjab, Pakistan, 1965–1987.[a]

	Rainfed areas			Irrigated areas		
Year	landless	small farms	large farms	landless	small farms	large farms
1965	4914	3835	7928	2502	21751	34312
1966	7961	9201	38212	5811	20664	37208
1967	6744	8891	21785	6594	22237	30985
1968	7053	8333	17520	7117	21828	32022
1969	6333	8318	18531	6812	24171	33105
1970	6102	13356	23540	7010	24291	35474
1971	6541	14475	23587	6958	33213	43272
1976	12837	6128	7000	12134	21190	25517
1977	17033	6691	15648	11345	27822	54591
1978	20556	8541	16090	14245	26076	49264
1979	14662	8074	16452	13466	26169	50180
1980	6812	5842	10092	12930	13646	32454
1981	n/a	6073	10250	n/a	29825	95365
1982	17168	16183	17505	11835	18124	37291
1984	16996	20452	24323	8428	20137	45001
1985	n/a	20999	20371	n/a	13805	48850
1986	23856	27805	34248	11189	14938	41993
1987	26913	24342	32175	11663	14645	42940
Average	12655	12086	19737	9377	21918	42768
Trend growth of income (% per year)[b]						
1965–1987	6.6***	4.4***	0.8	4.6***	−1.7**	1.7*
1976–1987	5.1	14.9***	10.4***	−1.7	−5.3**	1.0

[a]All values expressed in 1980 rupees; 1972 through 1975 and 1983 not available.
[b]Based on semi-log regressions; *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.
Source: PERI, *Farm Accounts and Family Budgets.*

have risen dramatically since 1976.[4]

A likely explanation for these interregional differences in the post-Green Revolution period is that participation in non-agricultural labour

[4]Up to 1980, the PERI publications contain data that disaggregate these households by primary income source (i.e. shopkeepers, menial labourers, artisans, and agricultural labourers). Considerable within-group differences in annual income are evident. In both rainfed and irrigated areas, agricultural labour households have been consistently the poorest of these various classes of households, while in all cases shopkeepers had the highest incomes. None the less, all landless households have enjoyed significant real income growth between 1965 and 1980. For example, the annual growth rates of households whose primary source of income was agricultural labour were 4.5% and 5.7% in rainfed and irrigated areas, respectively.

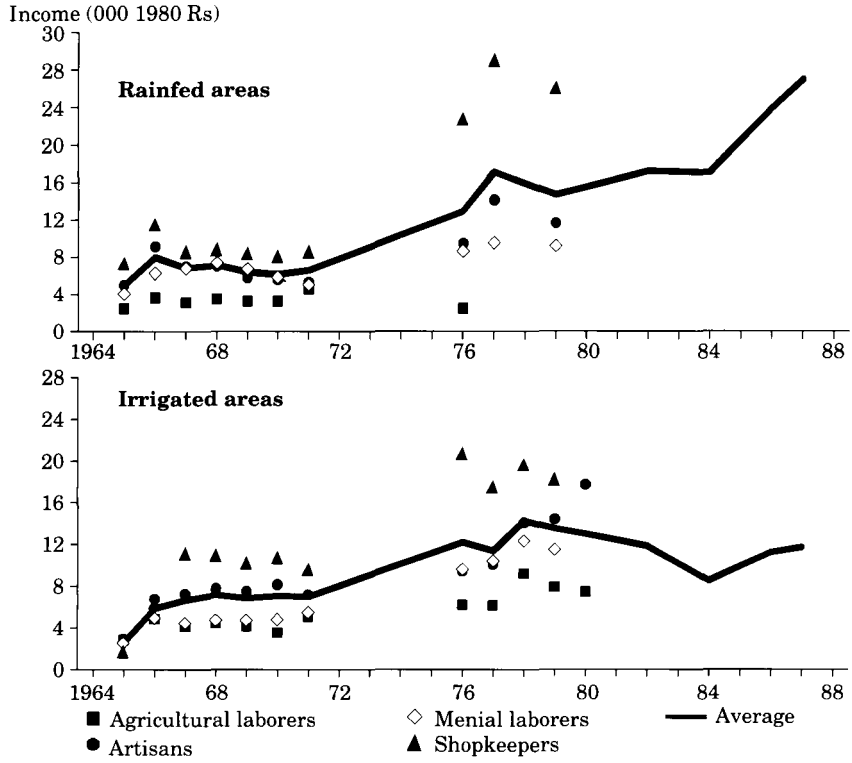

Fig. 5.3. Real incomes of landless rural households, the Punjab, Pakistan, 1965 to 1987.

Source: PERI.

markets by members of rainfed landless households was greater than participation by their counterparts in irrigated areas. Poorer households in rainfed areas are generally considered to have supplied the greatest share of the labourers who emigrated during the foreign employment boom of the late 1970s and 1980s (Ifran *et al.*, 1982). Consequently, remittances from abroad may explain a significant portion of the observed real income growth of landless households in rainfed areas. Additionally, rainfed areas have traditionally been more important than irrigated areas as a source of labour supply for non-agricultural sectors of Pakistan's economy (Rahman, 1981). Thus, these households probably benefited from the general expansion of the economy to a greater extent than their counterparts in irrigated areas.

In all but one year between 1965 and 1982, the income levels of irrigated small farms exceeded incomes of rainfed farms (Fig. 5.4). Beginning in 1982, this situation was reversed. In conjunction with the fact

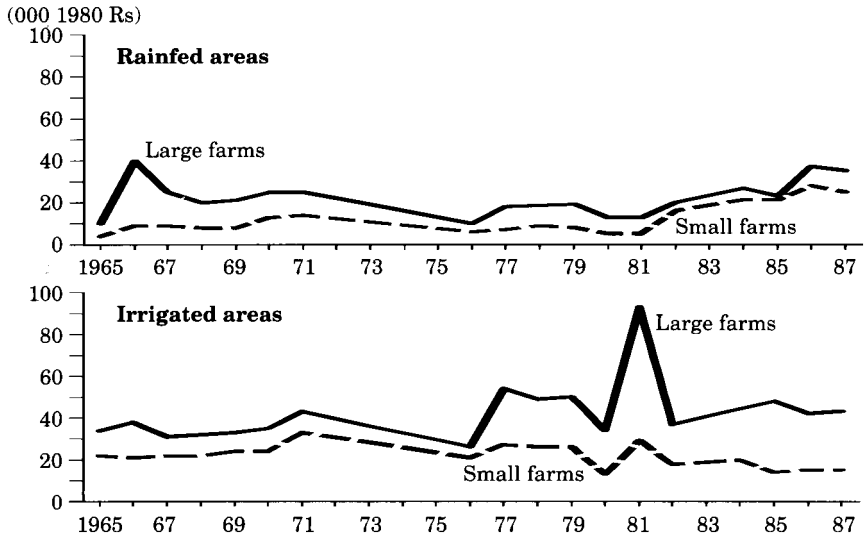

Fig. 5.4. Real income of farm households, the Punjab, Pakistan, 1965 to 1987.

Source: PERI.

that farm profits have been falling in the post-Green Revolution period, this indicates that non-agricultural sources of income have been more important for farm households in rainfed areas than for irrigated farm households.

This is confirmed in Fig. 5.5, which shows the components of household income for farm households in four different time periods between 1965 and 1987. In irrigated areas, profits from cropping activities have been the dominant source of total household income in all periods, accounting for 50% to 61% of small farm household income and 50% to 66% of large farm household income. In rainfed areas, the share of total household income from crop production has steadily fallen since 1971 for both small and large farm households. Whereas crop production activities accounted for about 50% of large farm household income in the 1968–1971 period, this had fallen to 21% in the 1984–1987 period. This trend is even more dramatic for rainfed small farms; for these households the share of total income from crop production fell from 58% in 1968–1971 to only 5% in 1984–1987.

Implications for Income Distribution

Rural income distribution in Pakistan is generally considered to be highly

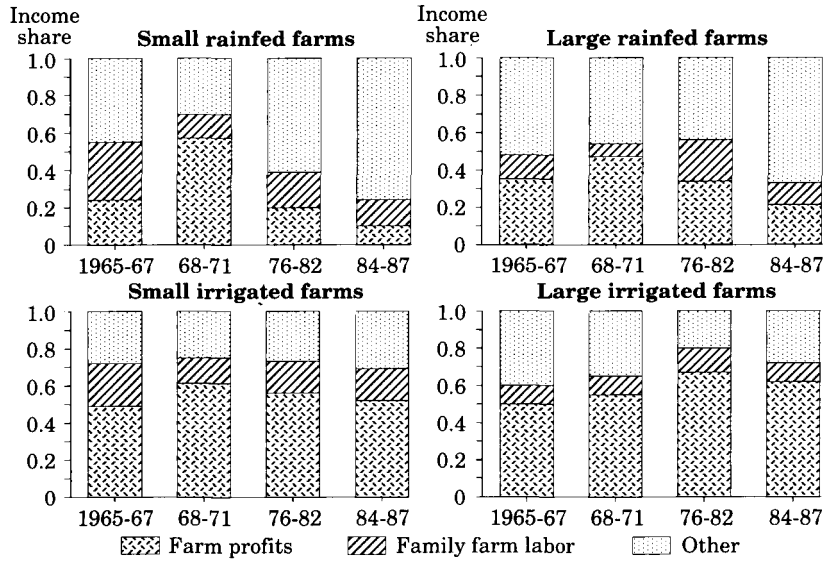

Fig. 5.5. Components of rural household income, the Punjab, Pakistan, 1965 to 1987.

Source: PERI.

unequal (Guisinger and Hicks, 1978). Data presented on the dynamic behaviour of real incomes indicate a generally progressive trend in rural income distribution over the past 25 years, both intraregionally and interregionally. Between 1965 and 1987, real income growth has been greater for households that were initially poorer.

In an attempt to quantify these changes. Table 5.5 presents two measures of relative income distribution across household types. These include the mean absolute difference between average income levels and Gini coefficients. Both measures indicate that significant improvements in relative rural income distribution have occurred over time. These measures mask differences within groups, and thus understate the overall disparities in relative income distribution across the entire rural population. Such intragroup differences are likely quite large, as evidenced by the differences between average incomes of various types of landless households (Fig. 5.3).

Interestingly, increased agricultural productivity due to technological change appears to have had little if any effect on this improvement in income distribution; rather, the ability of poorer households to take advantage of opportunities outside the agricultural sector is evidently more responsible. While income growth during the Green Revolution period was significant for all households, relative income levels across groups were not markedly altered. In the post-Green Revolution period, real profits from

Table 5.5. Measures of relative income distribution between rural household groups, the Punjab, Pakistan, 1965 to 1987.

	Gini coefficient[a]	Mean absolute difference[b]
1965–1971	0.310	0.133
1976–1980	0.298	0.127
1982–1987	0.202	0.091

[a]Gini coefficients computed assuming a constant population share for each rural household type.
[b]Mean of the absolute differences in group shares of total rural income over all cross-household comparisons.

crop production activities either fell or remained relatively constant for all groups. Households in rainfed areas, who have participated more extensively in domestic and foreign labour markets outside the agricultural sector than households in irrigated areas, enjoyed significant real income growth, while real incomes in irrigated areas fell or, in the case of large farm households, grew slightly.

Two related conclusions emerge from these observations. First, continuing increases in agricultural *productivity* do not always translate into increases in agricultural *profitability*. Government intervention in Pakistan's agricultural economy has effectively subsidized consumers at the expense of producers. This is not to say that enhanced productivity has not benefited farm households in Pakistan; on the contrary, without the impressive productivity gains achieved through technological progress farm profits would no doubt have been much lower than they were. Nonetheless, the cumulative effect of the matrix of government agricultural policies has been to impede the ability of farm households to improve their well-being relative to the non-agricultural sector.

Second, real income growth in rural Pakistan appears to have depended on the ability of rural households to diversify out of agriculture. There is certainly nothing intrinsically wrong with this, insofar as non-agricultural opportunities continue to expand – although there may be significant social costs associated with labour migration that are not captured in household income data. As a cautionary note, however, reliance on foreign labour markets as a major source of employment may pose significant risks to an economy like Pakistan's if those labour markets are sensitive to geopolitical upheavals. In this regard, recent events in the middle East serve as an ominous reminder that employment opportunities in foreign labour markets may disappear as quickly as they open up.

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