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THE ECONOMICS OF RAINFED VERSUS IRRIGATED WHEAT PRODUCTION IN PAKISTAN

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Abstract

Wheat is the main food crop of Pakistan. Over 80% is grown under irrigation, the remainder being rainfed. A wide range of growing environments is found for irrigated wheat, but wheat-cotton, rice-wheat and wheat-maize rotations are common. Increasing cropping intensity imposes a number of constraints on irrigated wheat production. Rainfed wheat is grown in less intensive and more uncertain environments, often interacting closely with livestock in the farming system. Irrigated wheat is in a post-Green Revolution era, while rainfed wheat is experiencing its own slower Green Revolution now. Reductions in the labor intensity of wheat production are occurring as off-farm demand for labor increases. Despite this, wheat technology is more labor intensive than for wheat in many sub-Saharan countries. Expansion of irrigation for future wheat development will be costly and severely constrained by water availability. Considerably less expensive options are to develop rainfed wheat production and to use land and water of the current irrigation schemes more efficiently. Changes in pricing policy would also assist considerably in promoting local wheat production.

Introduction

Wheat is the number one food crop of Pakistan. It is the major crop grown during the winter for most areas. As well, the staple food of Pakistanis includes heavy helpings of chapati or nan, the main foods derived from wheat. Normally, 90-95% of total wheat use in Pakistan is derived from domestic production. Only twice in the past 25 years has self-sufficiency been achieved. Wheat ranks high among the priorities of policy makers in Pakistan, because of its importance to farmers and consumers, especially low income ones.

There are some interesting contrasts and parallels between wheat production in Pakistan and in sub-Saharan Africa. First, wheat is a smallholder's crop in Pakistan (as well as a large landholder's crop), grown with an interesting blend of labor-intensive and mechanical technologies. Second, wheat is grown in a variety of different farming systems, with greater intensity of land use than seen generally in sub-Saharan Africa. Third, Pakistan experienced the Green Revolution with irrigated wheat in the late 1960s and early 1970s. This has given rise to some interesting challenges in the post-Green Revolution era for irrigated wheat. In contrast, rainfed wheat is now experiencing its own slower technological revolution. Pakistan has to weigh its alternatives for future wheat development, especially as expansion of irrigation will be costly and severely constrained by water availability. As in sub-Saharan Africa, the costs of irrigation schemes have to be weighed against other development strategies, such as boosting rainfed production or more efficiently utilizing water from current schemes. Finally, there are some interesting parallels in wheat pricing policy in Pakistan with food pricing policies in sub-Saharan Africa.

Wheat Production in Pakistan

Wheat production in Pakistan spans a range of environments (6). Most of the wheat produced is from the irrigated plains, where the world's largest contiguous irrigation system allows farming in the hot semi-arid to arid environment. As well, small-scale irrigation of wheat can be found in mountainous areas of northern Pakistan, where the winters are much colder. Rainfed wheat production is only feasible in the northern plateaus of the Indus Valley, and in higher areas of Pakistan to the north and west. Overall, about 80% of the area planted to wheat is irrigated, but 85% of total production is from irrigation.

This year's wheat crop in Pakistan was a record, exceeding 14 mt. Growth in wheat production over the past 20 years has just exceeded 4% p.a. Irrigated output grew at 4.1% p.a. with area and yield contributing about half of the growth each. In contrast, rainfed wheat production grew at 3.6% p.a. due to strong growth of yield (at 4.2% p.a.) However, these growth rates hide some worrying trends in wheat productivity in the irrigated areas. For example, in the irrigated Punjab, yields of high yielding semi-dwarf wheats have stagnated since the mid-1970's, despite a doubling of fertilizer use, increased mechanization and other technological improvements (4).

A major difference between irrigated and rainfed wheat in Pakistan is in the intensity of cropping. Irrigated wheat is commonly grown in rotation with other crops, especially rice, cotton, maize and sugarcane. Average rates of cropping intensity range from 130% to about 180% in irrigated areas (2). Average cropping intensity in rainfed areas ranges from just over 100% to around 170% under the most favorable conditions (13). Rainfed wheat is more likely to be grown after fallow, and then followed by a summer crop. Maize, sorghum/millet, and pulses and legumes are commonly grown in rotation with rainfed wheat.

The increased intensity of cropping imposes major constraints to raising irrigated wheat productivity (although it implies increased overall farm productivity). For example, a strong decline in wheat yields occurs for wheat planted beyond mid-November in the main wheat areas of the Punjab. Wheat yields decline by approximately 1% per day that planting is delayed (9). Thus wheat sown up to 6 weeks beyond the optimal planting date could suffer a yield loss of 30-40%. A large area of wheat is planted after the "optimal" planting date, because of competition from other crops in the farming system, especially cotton, rice and sugarcane (2, 12).

Zero-tillage is one technology showing very promising results as a means of shortening the turnaround time from rice to wheat (1). It offers considerable savings in cultivation and planting costs (about 85%), as well as much better timeliness of wheat planting after rice. Coupled with other changes such as use of herbicides, mechanical harvesting, and shorter duration rice varieties, considerable potential exists for gains in wheat productivity in the intensive cropping systems of Pakistan.

Moisture is the principal limiting factor in the rainfed wheat areas. Trials show that deep plowing offers considerable scope to increase productivity of wheat, especially when combined with improved varieties and fertilizer (11). A major challenge for the rainfed wheat areas is to extend the use of deep tillage, improved varieties and fertilizer to farmers.

Labor-Intensive versus Mechanical Technologies

The long history of growing wheat in Pakistan and an abundance of labor led to traditional wheat technologies that were labor intensive. However, with economic growth, the opportunity cost of labor in agriculture has increased. As well, farmers face very tight time constraints for land preparation and planting between the two main crop cycles of the year. Consequently, there has been widespread adoption of tractors and related tillage equipment in Pakistan. Private hiring of tractors is common and most farmers use tractors, at least for their heavy tillage needs. Mechanical

threshing of wheat has also been widely adopted. The main operations in wheat production involving labor are broadcasting of the seed and fertilizer (in irrigated areas only) and cutting and stacking of the crop at harvest. Since broadcasting does not demand much time and drills are available from machinery manufacturers, the choice between drilling and broadcasting depends largely on the crop response to different treatments. Generally, research has established that gains from drilling of seed and fertilizer placement are modest in irrigated areas, while the gains are sizeable for rainfed wheat (1, 11).

With regard to cutting wheat, tractor-mounted reapers are under manufacture in Pakistan. The reapers have potential for rice and wheat cutting, and so offer considerable potential to substitute for labor at harvest, especially on larger farms. Similarly, some 400-500 combine harvesters have been imported in the country. The experience with combines has been mixed. Many contractors have had financial difficulties, although demand for combines for wheat harvesting on large farms is strong (14).

The costs of different mechanized technologies are presented in Table 1, which shows the purchase price of the machinery, size, work rate and the costs per operation for Pakistan. There is obviously variation in costs of each of these items depending upon location, soil conditions, and so on. Nevertheless, they indicate the main costs faced by farmers employing mechanized technologies. It is of particular interest that the cost of combine harvesting is about the same as that of reaping and threshing mechanically. However, a central feature of mechanical threshing is the gathering and processing of the wheat straw into a more digestible feed, while with combines the straw is left in the field. With the high value placed on wheat straw as a feed, especially on small farms, it is likely that mechanical threshing will remain popular amongst farmers for many years.

Profitability of Rainfed and Irrigated Wheat

Some typical budgets for rainfed and irrigated wheat are presented in Tables 2 and 3. For rainfed wheat, tillage operations usually span the fallow period from June to October, whereas for irrigated wheat, the tillage operations span a few weeks. Wheat is broadcast in irrigated areas, while it is generally line-planted with drills in rainfed areas. Much of the rainfed wheat is interplanted with mustard, which is grown as a winter fodder and harvested manually. Note that the average yields in rainfed areas are lower than those in irrigated areas, although the variability is considerably higher. Costs of growing are slightly higher in irrigated areas, but higher average yields with irrigated wheat lead to higher net returns per hectare. It is important to note the comparatively high value of returns coming from wheat straw, a very valuable livestock feed in Pakistan. This is especially the case in the rainfed areas, where livestock are an important component of the farming system. Without returns from straw, wheat would be unprofitable in both areas.

Overall, wheat returns per hectare in these representative budgets are not high. However, returns per unit of labor and per unit of water are quite high when compared with competing crops (10). A key factor influencing profitability of wheat has been the comparatively low level of the farm support price of wheat.

Support Price of Wheat

For many years, Pakistan has maintained a support price for wheat based on cost of production and market conditions. Studies suggest that the price of wheat has been slightly below import parity in most years. However, a very serious gap now exists between the farm support price and import prices (Fig. 1) This has occurred because import prices have risen quite sharply in dollar and, in particular, in rupee terms. Political pressures to keep the price of basic staple foods down and to minimize budget outlays are strong. Consequently, the support price of wheat for Pakistani farmers was well below international levels in 1988-89. Strong disincentives to grow wheat have emerged

as a result of the comparatively low farm price. As well, smuggling of wheat to the high-priced neighboring markets of India, Afghanistan and Iran has been reported.

A recent study has shown that there are also strong indirect disincentives on Pakistan agriculture (7). These arise from trade and exchange rate policies which indirectly tax agriculture through increasing the prices of inputs or maintaining a stronger rate of exchange of the rupee against foreign currencies than would be the case in their absence. The combined effects of wheat prices below world parity and trade and exchange rate policies has suppressed wheat production in Pakistan by over 20% (7). Policy adjustments thus offer considerable potential for Pakistan to develop domestic wheat production.

Irrigated versus Rainfed Wheat Development

An important question that arises for wheat development in Pakistan is where the future priorities should lie. In the past, irrigation has been the major source of production increase, especially associated with the expansion of irrigation capacity and the related Green Revolution. Now the opportunities to expand irrigation area are diminishing, as the costs of major dams are higher and tubewells appear to be near the limit of expansion.

Several opportunities exist for further wheat industry development, however. First, considerable potential exists for improved productivity of wheat on current area through crop management research and well-targeted extension programs. With the yield gap between top-performing farmers and average farmers exceeding more than 50% in most wheat areas, productivity can be raised with simple changes in crop management. New technologies, such as zero-tillage and improved weed control offer potential for gains as well. Second, the efficiency of water delivery and water use on farms can be improved considerably by lining channels and by allocating water more efficiently to wheat (5). Third, wheat production in rainfed areas can be expanded sizably. The key to this will be better tillage practices and moisture conservation. Each of these options appears to be considerably less expensive than further development of new lands for irrigation. However, each will require high inputs of crop management research and related extension, both of which need to be strengthened in Pakistan if these strategies to improve wheat productivity are to succeed.

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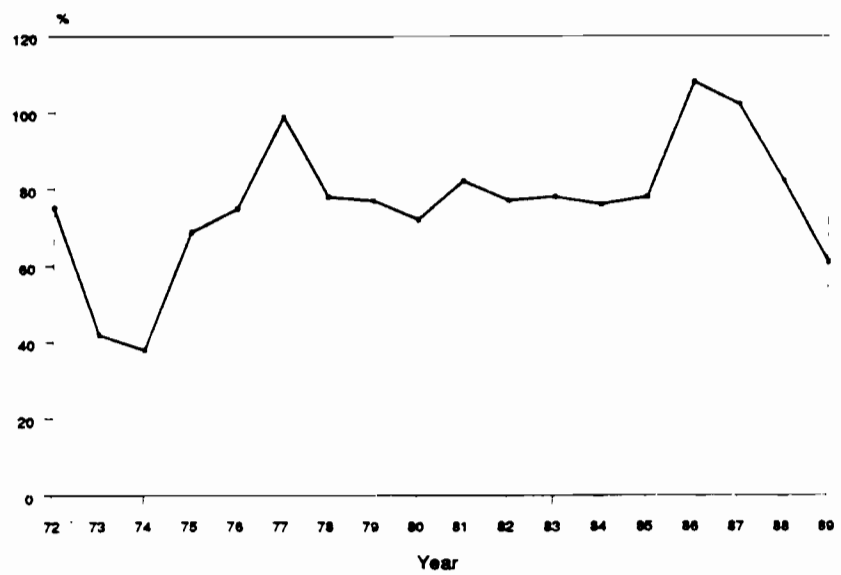

Figure 1. Farm price in Pakistan as percentage of world wheat price.

Table 1. Price, size, work rate, and costs of alternative machinery in Pakistan, 1989.

Type	Purchase price US$	Size	Work rate	Cost of operation US$/ha
Tractor				
- MF 240	7,500	40 HP	-	-
- MF 375	10,500	75 HP	-	-
Moldboard				
- Plow	320	3 furrow 0.8 m	-	17.90
Cultivator	320	11 tyne 2.3 m	1.0 hr/ha	4.80
Drill	480	11 tyne 2.3 m	1.25 hr/ha	6.00
Zero Tillage Drill	1700	2.3 m	1.5 hr/ha	9.50
Hand Sprayer	30	1.0 m	3.0 hr/ha	1.00
Tractor Mounted Reaper	930	2.3 m	1.0 hr/ha	12.00
Tractor Driven Thresher	1250	1.3 m	1.0 t/hr	25.30[a]
Combine Harvester Self-propelled	80,000	4.2 m	0.8 hr/ha	40.00

[a] Cost varies with yield.

Table 2. Enterprise budget for wheat in low rainfall zone of northern Punjab.

Activity	Rate	Cost quantity	(US $/ha)
Yield average		1.2 t/ha	
Cultivation cost	$4.80/ha	8	38.40
Seed cost:			
Wheat seed	$11.90/100 kg	100 kg	11.90
Drilling	$6.00/ha	-	6.00
Fertilizer cost:			
Urea	$6.70/bag	2.0 bags[a]	13.40
DAP	$9.00/bag	1.0 bag	9.00
Spreading	$1.00/ha	-	1.00
Input cost	79.70		
Capital cost	5.60		
Miscellaneous costs	4.00		
Total cost, excluding land rent		89.30	
Land rent	@ $40/ha/yr	-	20.00
Total cost, including land rent		109.30	
Gross returns			
Grain	$63/t[b]	1.2 t	75.60
Straw	$24/t[b]	2.4 t	57.60
Total gross income			133.20
		Net returns	$23.90
	Residual return to capital	27%	

[a] One bag contains 50 kg of fertilizer.
[b] Field price (i.e. harvest and marketing costs deducted).

Table 3. Enterprise budget for wheat in rice-wheat cropping system of northern Punjab.

Activity	Rate	Cost quantity	(US $/ha)
Yield average			2.0 t/ha
Cultivation cost:			
Ploughing	$4.30/ha	4	17.20
Planking	$2.15/ha	2	4.30
Seed cost:			
Wheat seed	$11.90/100 kg	100 kg	11.90
Drilling	$6.00/ha	-	6.00
Fertilizer cost:			
Urea	$6.70/bag	2.5 bags[a]	16.80
DAP	$9.00/bag	2.5 bags	22.50
Application	$1.20/ha	-	1.00
Irrigation canal	$5.40/ha	-	5.40
Input cost, excluding land rent		85.10	
Capital cost			6.00
Miscellaneous costs	4.30		
Total cost, including land rent		95.40	
Land rent	@ $ 120/ha/yr	-	60.00
Total cost, including land rent		155.40	
Gross returns			
Grain	$63.00/t[b]	2.0 t	126.00
Straw	$14.00/t	4.0 t	56.00
Total Gross Income	182.00		
		Net returns	26.60
	Residual returns to capital	21%	

a One bag contains 50 kg of fertilizer.
b Field price (i.e. harvest and marketing costs deducted).