

Major Trends in the Rice-Wheat System in Pakistan's Punjab



The introduction of Green Revolution technologies in Pakistan's rice-wheat systems during the mid-1960s produced impressive results in reversing the food crisis as well as stimulating the economic growth in agriculture, particularly in the Punjab Province. Land under cultivation increased by a mere 0.7% annually from 1966 and the increased production was primarily triggered by changes in technologies like fertilizers, mechanization, seed of high-yielding varieties, and superior livestock breeds. Changes in cultivation technology also had its impact on the livestock, both quantitatively and qualitatively. The sustainability of the various practices, however, needs to be considered.



Two-way Changes

Intensification strategies and high doses of external inputs in the agricultural sector heralded a bright new dawn through the Green Revolution. Food shortages decreased while agricultural growth received a boost in the mid-1960s and 1970s. Could this be sustained? The very same factors that contributed to the success, *vis a vis* intensification and external inputs, show indications that they have led to degradation of the resource base and now there is growing evidence of a slowdown in productivity growth.

Changes in the Crop Sub-sector

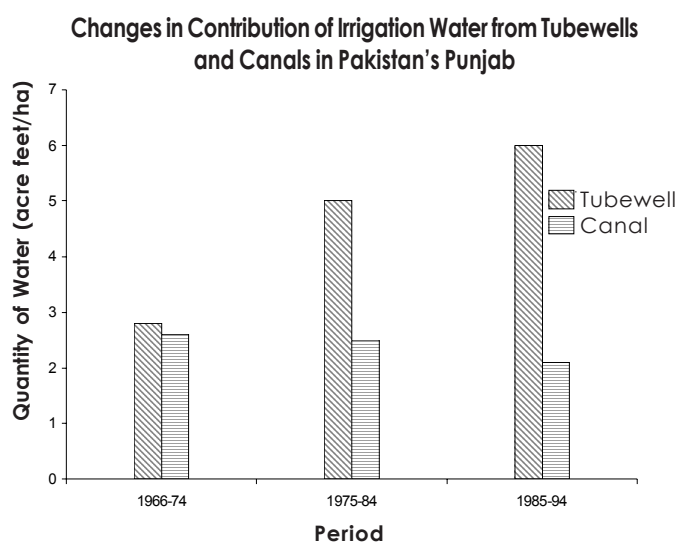
Pakistan's Punjab Province, with a farming population of over 60 million, has assured irrigation for over 80% of its cropped area through a network of canals and tubewells. It is known as Pakistan's bread basket as it is the center of production of wheat and rice, which form the staple diet of its populace.

Technology

Technological change was triggered by the introduction of new varieties of wheat in 1966. By 1983, almost all the wheat-growing area was covered with these modern varieties. The technological innovations in the high-valued, aromatic Basmati rice, mainly for the export purpose, initiated with the release of Basmati 385 in 1985, which was rapidly adopted (Sharif *et al.*, 1992). New high-yielding cotton varieties gained acceptance only in the post-Green Revolution period (1985-1994). Fertilizer use jumped more than sixty fold in less than 30 years from 1.5 kg of nutrient per hectare in 1966 to 94 kg per hectare in 1994.

Irrigation

Irrigation water from tubewells is the lifeblood of the rice-wheat system in the Punjab. Timely availability of irrigation water in adequate quantities has been possible through investment in privately-owned tubewells. Per hectare quantities of water from canals available for crop irrigation has decreased both in absolute terms and in relation to groundwater use.



Crop System	Fertilizer Nutrient kg/ha			Water (Acre feet/ha)					
				Tubewell			Canal		
	1	2	3	1	2	3	1	2	3
Wheat-Mungbean	6.1	26.0	49.1	0.6	1.4	2.0	3.5	3.2	2.9
Wheat-Mixed	14.1	46.0	76.0	1.1	1.9	2.5	4.9	4.6	4.2
Wheat-Rice	12.3	44.8	64.7	2.8	5.0	6.0	2.6	2.5	2.1
Wheat-Cotton	18.5	62.3	120.3	1.5	2.4	2.6	5.9	5.4	4.8
Punjab Average	14.1	48.3	86.1	1.4	2.5	3.0	4.7	4.3	3.9

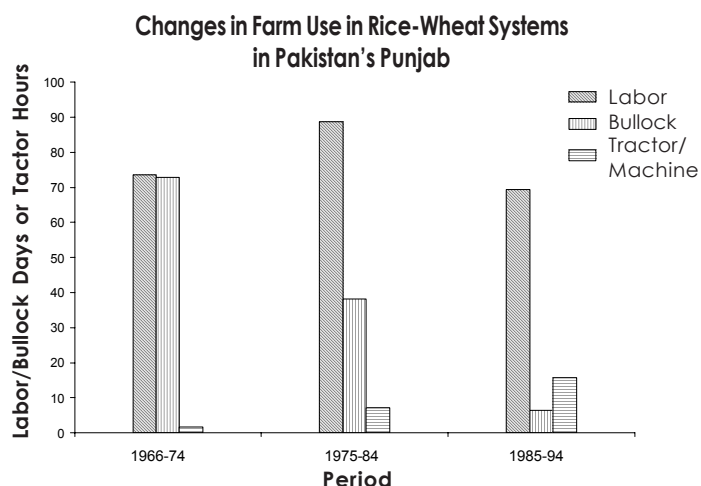
1 = Green Revolution Period (GRP) 1966-1974
 2 = Input Intensity Period (IIP) 1975-1984
 3 = Post Green Revolution Period (PGR) 1985-1994

Labor

Labor use and labor wages saw major changes due to the Green Revolution. Intensification increased the demand for labor from 71 labor days per hectare in 1966 to 108 labor days in 1977, representing an increase of 40% in just 12 years. The increased demand, coupled with alternative employment opportunities in the affluent Middle East, pushed the wages high enough for the farmers to consider other options.

Mechanical Power

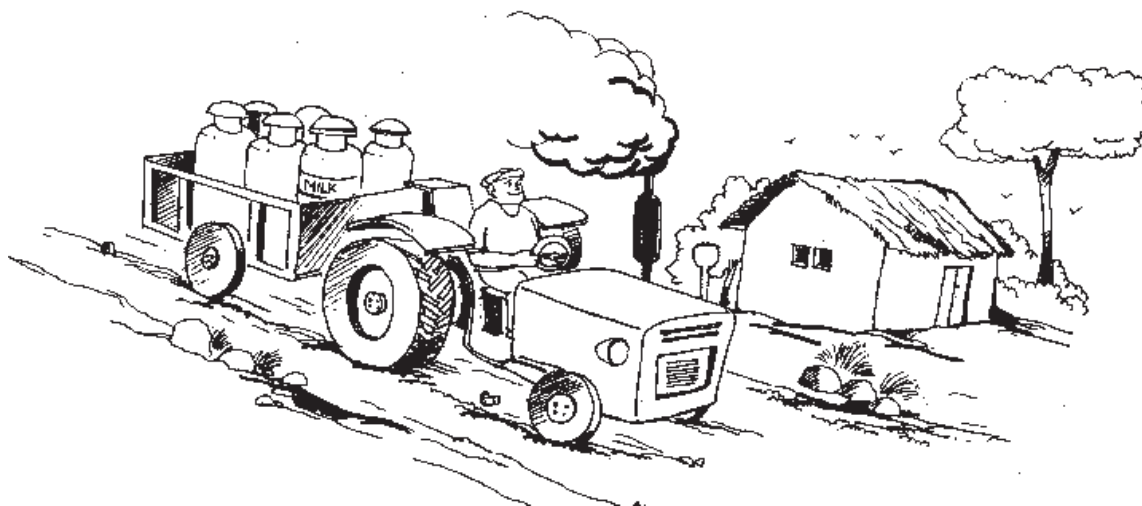
Mechanization of agricultural operations reversed the trend of labor use. From a peak of 108 labor days in 1977, the requirement dropped to just 63 labor days per hectare in 1994 i.e., almost 10% below the 1966 level. Mechanization also decreased the use of bullocks from 82 days per hectare in 1966 to just six days in 1994. During this period, the use of mechanical power (tractor, harvester, thresher) increased from less than one hour per hectare to 17 hours.



Crop System	Labor (days)			Bullock (days)			Machine (hours)		
	1	2	3	1	2	3	1	2	3
	Wheat-Mungbean	82.4	86.4	62.6	83.8	45.8	8.0	0.8	2.6
Wheat-Mixed	89.5	108.4	84.6	74.4	45.6	10.8	1.4	6.0	14.7
Wheat-Rice	73.6	88.7	69.4	72.9	38.1	6.5	1.6	7.1	15.7
Wheat-Cotton	87.2	100.7	65.8	85.4	49.6	7.7	1.7	6.4	17.3
Punjab Average	85.0	98.7	71.1	79.6	45.8	8.5	1.5	5.7	14.8
1 = 1966-1974 2 = 1975-1984 3 = 1985-1994									

Intensification

The introduction of short-duration modern varieties of major crops, supported by increased water availability, triggered double crop cultivation on the same land. This, coupled with increased use of fertilizers, contributed to the highest yield gain during the Green Revolution period. The yields of all crops in the province increased at an average rate of 1.8% per annum, led by wheat and cotton. The production increased at a rate of 3.8% per annum during the Green Revolution period (1966-1974) and then slowed down to 2.8%. The average rate of increase in production during 1966-1994 was 3.3% for all crops. After the release of new, early-maturing mungbean and high-yielding cotton varieties in the post-Green Revolution period (1985-1994), the growth in wheat-cotton and wheat-mungbean systems was double that of wheat-rice system.



Soil Deterioration

Soil organic matter content which was already low in the 1970s got worse and showed a decline at the rate of 2.4% per annum. Available phosphorus has decreased in all the four systems. The total soluble salts increased significantly during this period in all of the four cropping systems and soil reaction or pH increased in two of these systems indicating an increase in salinity and alkalinity of the soil.

Water Quality

Electro-conductivity of tubewell water shows drastic increases at a rate of 1.3% per annum in all the production systems. Residual carbonate (RSC) doubled during the study period reflecting the common observation that the tubewells are increasingly yielding low quality ground water. Steady decline in the contribution of canal water to crop irrigation is a disturbing trend.

Effects on Livestock

Mechanization of farm operations dramatically reduced the need for bullocks from 82 days per hectare in 1966 to just six days per hectare in 1994. This led to the increase in meat production due to the slaughter of bullocks and male calves. Bullock population was increasingly substituted by milch cows and buffaloes leading to a spurt in milk production. With increased availability of fodder, the number of animal units increased at a rate of 1.5% per annum.

Conclusions

Green Revolution has ushered in a better life for the millions of people living in Pakistan's Punjab. It has not only increased production of food grain and cotton but also triggered increases in livestock, meat and milk. The Green Revolution, however, also resulted in high irrigation water and fertilizers being used at higher levels having deleterious effects on soil and groundwater quality and thereby raising disturbing questions about the future.

There are several reasons to believe that the resource degradation is not internalized to producer decision making and that policy intervention is necessary. Distorted policies have led private and social costs to diverge, e.g., fixed annual energy charges have led to overuse of low quality tubewell water, a major contributor to soil salinity. Public-sector research has been biased towards developing technologies based on packages of modern inputs neglecting sustainable practices like integrated crop management. Removal of price distortions and a focus on diversification and sustainability are opportunities that must seriously be considered.

Adapted from:

Ali, M. and M. Byerlee. 1999. Technological Change and Productivity in Pakistan Punjab: Economic Evidence. pages 78-95. *In*: Pingali, P.L. (ed). 1999. Sustaining Rice-Wheat Production Systems: Socioeconomic and Policy Issues. Rice-Wheat Consortium Paper Series 5. Rice-Wheat Consortium for the Indo-Gangetic Plains, New Delhi, India.

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