COMBATING POVERTY THROUGH FARM LEVEL WATER MANAGEMENT

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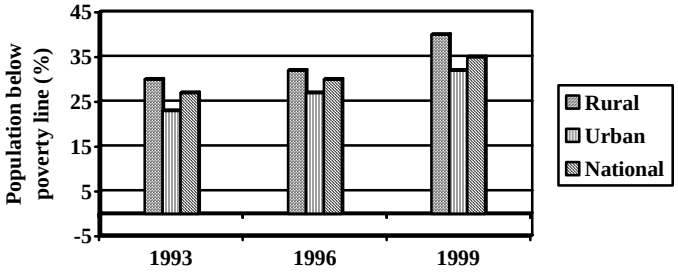
Poverty Situation

There is general consensus that rapidly declining poverty trends during the 1980s reversed in the beginning of the 1990s and continued to scale up in Pakistan. It is being argued that this destitution is likely to persist due to the current trends of Pakistan economic performance and may become a permanent gesture of the nation. Poverty has emerged as a major challenge constraining the economic development of the country. Poverty has mainly concentrated in rural areas of the country, which are diverse in terms of climate, land fertility, availability of irrigation water, level of integration with urban sector, population growth and skill levels. The Government of Pakistan is preparing National Poverty Alleviation Strategy.

In spite of the government efforts to revamp the agriculture sector through land reforms, providing subsidies to encourage the use of fertilizers and plant protection services, encouraging farm mechanization, introduction of Green Revolution, and improving irrigation water availability, the poverty has increased in rural areas. The reason for this trend could be the terms of trade favorable for industrial sector, greater income inequality, and poor incentives for small farmers. It is documented that poverty has increased from 27 percent in 1993 to 35 percent in 1999. As rural population is dependent upon agriculture for their livelihood, the performance of agriculture sector directly relates to poverty trend in rural areas. The development in agriculture sector with aim to improve farm productivity may help in poverty alleviation in rural community.

Povety Trend in Pakistan



Agriculture is the mainstay of Pakistan's economy that contributes 25 percent of GDP. Besides, it provides employment to over half of the country's labor force and supports directly or indirectly about 70 percent of the population. Agriculture and agro-based

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products account for 80 percent of the nation's total export earnings other than being a source of raw materials for domestic, industrial and household requirements.

The 'Green Revolution Technologies' introduced in Pakistan during mid 60s and 70s led to dramatic increase in the yields and production of wheat and rice, the two most important staple food grains. These crops occupy 54 percent of the total world's area planted to cereals and provide 41 percent of the calories consumed by over six billion people around the globe. In the first decade of Green Revolution, grain production grew rapidly mainly due to high yielding varieties (HYV) and increased cropped area. Afterwards, the land devoted to rice and wheat was stabilized and since then there has been almost no scope for further expansion in area for these crops.

Challenges to Agriculture

Evidence is accumulating that growth in rice and wheat yields has begin to slow down in the high potential agricultural areas of Pakistan. This may have resulted from degradation of the resource base devoted to rice-wheat systems. The factors which stalled the Green Revolution are mining of soil nutrients, declining organic matter, increasing salinity, fluctuating watertable, and buildup of weed infestation and pest population. Another important element in stagnation of productivity could be traditional way of cultivation leading to heavy tillage. Contrarily, population of Pakistan is increasing at an annual rate of over two percent. These conflicting realities, i.e. declining rate of production and increasing population growth, are serious concerns for all of us.

Water Resource Constraints

As population grows, dependence on irrigation increases for meeting food requirements. This places extraordinary stress on freshwater systems, particularly in arid and semi-arid regions. In addition, freshwater ecosystems are being intensely modified and degraded by human activities. So much water is consumed for domestic, industrial and agricultural uses that the natural flow of major rivers, such as Colorado, Yellow, Indus, and Amu Darya, no longer reach the sea during dry season.

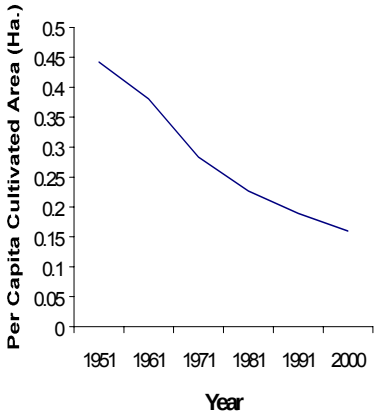
New estimates of water scarcity calculated by the World Resources Institute in collaboration with the University of New Hampshire show that 2.3 billion people live in river basins under water stress with annual per capita water availability below 1,700 m^3. Of these, 1.7 billion people reside in highly stressed river basins where water availability falls below 1,000 m^3 per capita annually and chronic water shortages threaten food production and hinder economic development. Assuming that current consumption patterns will continue, at least 3.5 billion people or 48 percent of the world's projected population will live in water-stressed river basins by the year 2025. Water is, therefore, certain to remain major topic of discussion and will be a perennial agenda at global gatherings of resource conservation and environmental policy makers during coming years. As such, it is highly important to develop better understanding for water scarcity and its trend in future. It is also necessary to consider possible strategies based on increasing water productivity (crop per drop) leading to efficient management of the scarce water resources.

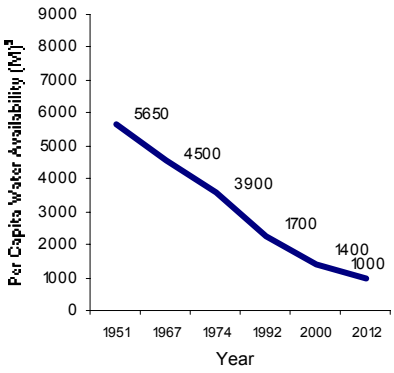
Canal Water Availability

Pakistan has the largest single contiguous gravity flow irrigation system in the world. The country is, however, facing serious water crises due to persistent drought condition in the last three years. This has resulted from highly lesser rainfall from the normal triggered mainly due to disturbance in main weather system responsible for generating water resources of the area. Water shortage registered during the last 3-4 years was as high as 40-50 percent. The total inflow of western rivers during Kharif season fell to 75.78 million acre feet (MAF) in 2001 from 116.05 MAF in 1998, while in Rabi season it dropped to 15.45 MAF in 2001-02 from 22.55 MAF in 1998-99. The total inflow of western rivers fell to 91.23 MAF in 2001-02 from 159.10 MAF in 1992-93. Resultantly, canal withdrawals in the Punjab during Rabi season fell to 9.78 MAF in 2001-02, which were more than 20 MAF from 1992-93 to 1995-96. The canal water deficit in the province usually remained around 1.99-5.74 MAF before the beginning of water crises. On the basis of current water shortages and rapidly increasing future demands, the experts have foreseen that this situation would simply be unsustainable for the agriculture and national economy.

Need to Conserve Agricultural Resources

The population of Pakistan was only 50 million in 1960 but it has increased to 156 million during the last four decades i.e. almost three times. Resultantly, per capita land availability has been declined from 1.59 to 0.50 hectares during this period. Similarly, per capita agricultural land availability has been reduced from 0.44 to 0.17 hectares during the last 40 years. Likewise, per capita water availability has also reduced from 5,650 m^3 to 1,400 m^3 during this period.





Agriculture in Pakistan has generally performed well and it grew by more than three percent a year for the past 40 years. Sources of growth, however, remained changing over the years from introduction of improved seeds, use of chemical fertilizers, and development of irrigation facilities during 1960s, to intensification of water and fertilizer use in the 1970s, and improvements in crop management and incentives in the

1980s. Although progress made in the past has been quite impressive but a careful look suggests that the momentum is running out. Stagnation in productivity is mainly due to factors such as resource degradation, failure to adapt technological changes and poor incentives. There is no chance of a significant increase in total cultivable land and irrigation infrastructure. At best, a 10 percent expansion in water resources can be expected, that too at exorbitantly huge costs.

The growth in the future will have to be achieved through increased productivity by making more efficient use of limited resources. There is a pressing need to ensure efficiency and sustainability in utilization and management of the two most important natural resources i.e. irrigation water and arable land. There are good prospects for enhancing productivity of all major crops, particularly that of wheat and rice by about 30-50 percent.

Majority of researches propose that developing countries should favor an agro-ecological model such as Conservation Agriculture which emphasizes biodiversity; recycling of nutrients; synergy among crops, animals, soils, and other biological components; and regeneration and preservation of natural resources. For example, 'more you till, more you harvest' phenomenon will remain no more sustainable. The priorities and options will, therefore, have to be re-fixed.

The trade policies in the past were conducive for developing countries allowing liberal marketing of their agricultural products in the world market. It will, however, become difficult for these countries to remain competitive in export markets after implementation of WTO policies because of their lower productivity levels viz-a-viz developed nations. Ways and means will, therefore, have to be adopted to lower the cost of production and enhance productivity simultaneously. The immediate available option is that of adoption of new resource conservation technologies, which offer both of these opportunities.

The above facts reveal that an abrupt change is needed for adoption of new technologies for crop production by making efficient use of available natural resources. Otherwise, it will become extremely difficult to fulfill food demand of the population of this region. The best option for effective utilization of resources and increasing productivity is adoption of resource conservation technologies.

Conservation Agriculture - An Option for Poverty Alleviation

Conservation Agriculture is an approach for the design and management of sustainable and resource-conserving agricultural system. It seeks to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water, crop and other biological resources in combination with selected external inputs. It represents a resource saving and efficient/effective agriculture, which contributes to environmental conservation, and at the same time, enhances production on sustainable basis. Elements of Conservation Agriculture, inter alia, include organic soil cover, improved on farm water management, minimum tillage, direct seeding through the crop residue, and appropriate crop rotations to avoid disease and pest problems. Adoption of resource conservation technologies helps in improving input use efficiency and productivity leading to better farm returns for uplifting living standards of rural community.

Resource Conservation Technologies

The best option for effective utilization of resources and increasing productivity is adoption of resource conservation technologies, which do not pose threat to natural resources. Effective linkages, however, should be established for transfer of these innovations to the user community.

A resource conservation technology package has been developed for efficient utilization of available resources as described hereunder.

Watercourse Improvement

Tertiary irrigation conveyance network in Pakistan is called watercourses. These are community channels off-taking from government controlled irrigation system. The watercourses are operated and maintained by the shareholders receiving water through these channels. A watercourse commands an area of about 150-250 hectares and is shared by 40 to 50 farm families. Studies have indicated that about 40 percent of irrigation water is lost during its conveyance through country's about 135,000 watercourses because of their aging and deteriorated conditions.

Improvement of the watercourse consists of complete demolishing of community channel and it is rebuilding/re-aligning according to the engineering design with clean compacted soil. Parts of reconstructed channel are lined and necessary water control structures are installed to improve conveyance of irrigation water. All these works are carried out through active participation of the beneficiary farmers who contribute entire skilled and unskilled labor in addition to sharing 20-30 percent of the material costs. Starting with improvement of 1,330 watercourses under the Pilot Project, over five year's period, almost 40 percent of total watercourses of Pakistan have so far been improved.

Various studies and previous experience of watercourse improvement has shown that on an average, annual water saving in an improved watercourse is about 240 acre feet besides other socio-economic benefits. Some of the same are given in Table 1.

Statistics reveal that farmers with small and medium holdings have benefited more from watercourse improvement so far (Table 2), which has contributed in poverty alleviation in rural areas.

Table 1: Major benefits of watercourse improvement.

S. No.	Description	% age
1	Time saving in irrigation time	28%
2	Labor saving	50%
3	Increase in cropping intensity	23%
4	Increase in cropped area	17%
5	Increase in yield	16-37%
6	Increase in net farm income	20%

Table 2: Composition of beneficiaries from watercourse improvement.

Landholding (Ha.)	Total Area (Ha.)	No. of Beneficiaries	% of Beneficiaries
0 - 2	65,735.63	50,180	50.88
2 - 5	96,097.16	29,026	29.43
5 - 10	90,785.42	13,537	13.73
> 10	100,867.61	5,882	5.96
Total	353,485.82	98,625	100.00

Laser Land Leveling

Precision Land Leveling, another resource conservation technology, was introduced on an area of about 28,000 acres under the Pilot Project during 1976-80. About 500,000 acres have been precisely leveled in the country so far. Initially, bucket type soil scrappers were used for precision land leveling, which have now been replaced by laser beam guided automatic Scrappers for more precision in land leveling work. Impact assessment studies conducted (Abdul Sattar et al., 2001) reveal following benefits of precision land leveling.

- Curtailment in irrigation application losses upto the extent of 25 percent.
- Reduction in labor requirements for irrigation by about 35 percent.
- Enhancement in the irrigated area by about two percent by brining the number as well as length of field ditches and dikes to a minimum.
- Increase in the crop yields by about 20 percent.

To assess the adoption rate of precision land leveling among various farmer categories, an analysis was carried out for 7,565 beneficiaries of the technology. The data revealed that 80 percent of the farmers benefiting from this technology were having small landholdings (Table 3) and adoption of the technology helped in improving input use efficiency and crop yields and uplifting living standards of farming community.

Table 3: Composition of beneficiaries of precision land leveling technology.

Landholding (Ha)	Total Area (Ha)	No. of Beneficiaries	% of Beneficiaries
1 – 5	29,365.2	6,052	80
5 – 10	5,138.9	1,060	14
> 10	2,202.0	453	6
Total: -	36,706.1	7,565	100

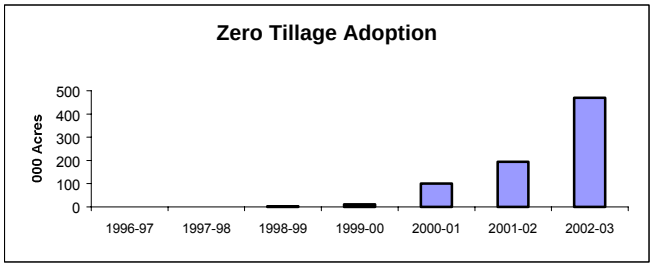
Zero Tillage Technology

Main reasons for low yields of wheat include late maturing of long-grain 'Basmati' rice variety sown in the region resulting in delayed wheat planting besides high cost of land preparation and other inputs. After rice harvest, sufficient residual moisture is generally available to establish new crop. Conventional tillage accelerates soil moisture evaporation and requires extra irrigation water for Rauni (pre-planting land soaking) to bring the field back to semblance of a seedbed. This causes major delays in wheat sowing, which ultimately affects final crop yields. Decreases in wheat yield at a rate of

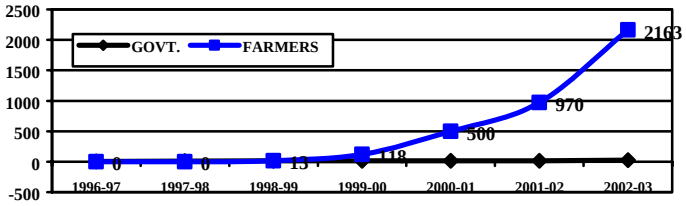
one percent every day due to delay in sowing after mid of November is well documented.

Minimum/Zero Tillage is an innovation that not only offers conservation of water and energy resources but also results in better crop yields. This technology was being practiced since long in many parts of the world and it was introduced in Pakistan during 1980s. Initial trials were confined to progressive and large farmers. Although, yields results were impressive but uptake of the technology remained limited. This was partly because of high cost of zero tillage seed drills and their limited availability, besides general apprehension of the farmers about the new technology. It could, therefore, not be popularized among the farming community in spite of a lot of its benefits.

On Farm Water Management (OFWM) took responsibility of its introduction amongst the farmers during 1996-97. This time, small farmers were targeted by making simple and locally manufactured relatively cheap drills commercially available. Wheat was grown on only 50 acres at 12 sites with five government-owned zero tillage drills during 1996-97. The technology was readily accepted by the farmers due to its contribution in reducing cost of production, conservation of resources, and improving yields. The area under zero tillage increased exponentially over a five-year (1997-2002) period. Wheat was grown with this technique on an area of about 470,000 acres (190,000 ha) in Pakistan during 2002-03, and presently, there are more than 2100 zero tillage drills owned by farmers.



Number of Zero tillage Drills



Years

Research studies carried out during past five years indicate the following benefits of zero tillage technology:

- saves cost of cultivation to the tune of Rs. 750 to 950 per acre
- saves irrigation water by 20 percent
- reduces use of diesel by 22 liters per acre

- allows early sowing of wheat by at least 5-15 days
- increases plant population upto 22 percent
- decreases weed infestation by 40 percent
- enhances microbial activities in the soil
- accelerates decay process of stubble
- improves soil fertility
- enhances fertilizer use efficiency
- increases grain yield upto 33 percent

Bed Planting Technology

Bed and Furrow planting technology permits growing of crops on beds with less water. This technique has been tested for various crops on limited scale and has proved quite successful. Wheat was grown on 137 acres during 1999-2000 with only four bed planters that expanded to 411 acres during 2000-2001. There are now 20 such machines with farmers. The technique is also being evaluated for rice production in farmers' fields this year. It has potential to be the technology of the future as its adoption can make it possible to grow more rice with less water.

Some of the advantages associated with furrow-bed technology of crop production are as follows:

- savings of about 30 percent irrigation water
- reduced chances of plant submergence due to excessive rain or over-irrigation
- lesser crusting of soil around plants and, therefore, suitable for saline and sodic soils
- adaptable for various crops without changing basic design/layout of farm
- enhanced fertilizer use efficiency due to local application
- minimizes the chances of crop lodging

Higher Efficiency Irrigation Technology

In barani and desert areas, water being the most scarce resource demands that it must be used most judiciously without wasting a single drop of it. In most of the barani areas, the land is undulating and gravity flow irrigation from tubewells and other sources is not possible, while at other locations like deserts, where soil is sandy, gravity irrigation results in significant water wastage due to seepage. These areas, having rich and fertile land, if provided efficient irrigation system, have a potential of increasing crop production by two to three folds. At such locations, higher efficiency irrigation systems like drip/trickle, portable rain gun units or multi-sprinklers, hand moved systems can be used for raising high value crops. The department of On Farm Water Management (OFWM) has completed 65 micro irrigation schemes in barani areas. Some of the major benefits of the same are given below:

- better application and distribution efficiencies
- adoptable under undulated areas
- allow judicious and efficient utilization of scarce water resources

Recommendations

- Resource Conservation Technologies like watercourse improvement, precision land leveling, higher efficiency irrigation techniques, zero tillage, bed and furrow planting, etc., may be promoted at an accelerated pace to combat drought crisis.
- Research, education, extension and water resource management institutions may be further strengthened and linked for knowledge/information sharing for efficient conservation, management and development of resources.
- Capacity building of staff involved in development and promotion of resource conservation technologies may be carried out through exchange visits among the provinces for sharing their experiences.
- More emphasis may be provided on mass awareness and participatory approach in planning and decision making for sustainable agriculture.
- Cost effective applications of conservation agriculture techniques may be developed for various ecological regions, marginal lands, and deteriorating groundwater resources.
- Socio-economic and environmental issues may be studied and mitigating methods and technologies should be developed to promote conservation agriculture in the region.