*Mycopath* (2011) 9(2)**:** 79-85 **Review Article**

# Resource conservation strategy for enhancing wheat productivity in Pakistan

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## Abstract

Wheat (*Triticum aestivum* L.) is the staple food of Pakistan and its share in country's gross domestic product (GDP) is 2.6%. It is grown in different cropping systems, such as cotton-wheat, rice-wheat, sugarcane-wheat, maize-wheat, and fallow-wheat. Currently, only 20% of wheat is being planted at optimum planting time (15$^{th}$ October to 15$^{th}$ November). Improved tillage and crop establishment methods present real potential for improving the sustainability and productivity. Shifting towards new interventions of resource conservation and exploitation of available resources is therefore, necessary for enhancing wheat productivity. Delayed harvesting of summer crops with the consequent late planting of wheat; less or no access of the farming community to improved inputs like seed, non-judicious use of fertilizers, less or no control of weeds, inappropriate use of irrigation water, drought stress in rainfed areas, no care of the soil degradation and inefficient and ineffective extension services are some of the major reasons for low and instable productivity of wheat. Use of modern technologies like laser land levelling, zero tillage through happy/combo seeder, bed planting of wheat, crop residue management and wheat straw chopper may be helpful in the time lost between the harvesting of kharif crops and sowing of wheat. By reducing this interval wheat can be sown earlier and yield reduction can be avoided. In addition to these modern technologies, use of early maturing varieties of kharif crops may also be beneficial to achieve in time sowing of wheat crop.

**Keywords:** Conservation, Pakistan, technology, wheat, yield.

## Introduction

In Pakistan, wheat is the most important crop and cultivated on an area of 8.8 million hectares. It contributes 12.5% to the value added in agriculture and 2.6% to GDP (Anonymous, 2012). Over the past three decades, increased agricultural productivity occurred largely due to the deployment of high-yielding cultivars and increased fertilizer use. Wheat is grown in different cropping systems, such as cotton-wheat, rice -wheat, sugarcane-wheat, maize-wheat, fallow - wheat. Of these, cotton-wheat and rice-wheat systems together account about 60% of the total wheat area whereas rain-fed wheat covers more than 2.2 m ha area (Farooq *et al.,* 2007). Wheat is indispensable source of carbohydrates for the poor. Sowing of wheat after mid-November causes reduction in grain yield by one percent per day (Hobbs and Morris, 1996). Farmers generally plant wheat late in rice - wheat, sugarcane - wheat, and cotton - wheat areas of Pakistan due to late harvesting of these kharif crops which results in drastic low yields (Hobbs and Gupta, 2001; Khan *et al.,* 2010). Late-planted crop has lower germination, fewer tillers, smaller heads, shrivelled grain and lower biomass than the timely planted crop (Ugarte *et al.,* 2007). Therefore, shifting of two weeks earlier than that of presently used sowing time may result in an increase of 2.0 million tones in national wheat production. Currently, only 20% of wheat is being planted at optimum planting time (15$^{th}$ October to 15$^{th}$ November). Improved tillage and crop establishment methods possess real potential for improved and sustainable production of wheat. It is, therefore, imperative to look for new interventions of resource conservation technologies and to exploit the all possible available resources to enhance the crop productivity for the enhancement of farmer's income and livelihood. The present study was focused on increasing productivity of wheat crop by looking for the strategies for reducing the gap between the harvesting of summer crops and sowing of wheat under the agro climatic conditions of Pakistan.

## Factors contributing towards yield gap

Wheat production in the country has been well below the potential and variable during different growing years. The major reasons for low productivity and instability include delayed harvesting of kharif crops like cotton, sugarcane and rice, and consequent late planting of wheat, non-availability of improved inputs like seed, inefficient fertilizer use, weed infestation, shortage of irrigation water, drought in rainfed and terminal heat stress, soil degradation, inefficient extension services. Moreover, farmers are not aware of modern technologies because of weak extension services system. A comparison of the national average yield of wheat with that of progressive farmers can be seen in Fig. 1.

## Production strategy

- Laser land levelling
- Zero tillage through happy/combo seeder
- Bed planting of wheat
- Crop residue management
- Wheat straw chopper

## Laser land levelling

Conventional methods of land levelling are time consuming, laborious, inefficient and expensive. Therefore, farmers are turning to level the land with laser levelling. Laser land levelling is a process of smoothing the land surface (± 2 cm) from its average elevation using laser-equipped drag buckets. This practice uses large horsepower tractors and soil movers that are equipped with global positioning systems and/or laser-guided instrumentation so that the soil can be moved either by cutting or filling to create the desired slope/level (Fig. 2). This technique is well known for achieving higher levels of accuracy in land levelling and offers great potential for water saving and higher grain yield. Major benefits of laser land levelling include; uniform moisture environment for crops, more level and smooth soil surface, uniform distribution of water, uniform germination and growth of crops and reduction in time and water required to the field.

## Zero tillage technology for wheat in rice-wheat cropping system

Rice-wheat cropping system occupying 70% of the total cultivated land meets the food security of the people of Pakistan. The improved package of resource conservation technologies indicates the rapid potential for improving the sustainability and productivity of the system.

Zero tillage is a method of sowing a crop without prior cultivation and with very little soil disturbance at seeding. In rice-wheat systems use of a tractor-drawn seed drill with 6 to 11 inverted-T tines to seed wheat directly into unplowed fields with a single pass of the tractor (Fig 3). This increases the amount of water and organic matter (nutrients) in the soil and decreases erosion. In the late 80s, 34 zero-tillage trials were conducted on farmers' field over three years in the rice-growing belt of the Punjab (Aslam *et al.*, 1993).

Coupled with the problems of late planting of wheat is the problem of poor germination and plant stand. Most of the farmers sow wheat by broadcasting the seed into plowed land and incorporating it by another plowing. The loose straw and stubbles are raked and clog the seed drills. Broadcast seed results in seed placement at many different depths,. Interestingly, significantly fewer weeds were found under zero-tillage than conventional tillage (Mishra and Singh, 2012; Franke *et al.*, 2007; Malik *et al.*, 2004), contrary to the experience in developed countries (Baker *et al.*, 2006) this observation has been confirmed at many other locations. In 336 on-farm trials in Haryana State, India, significantly lower weed counts were found in fields with zero-tillage either before or after herbicide applications. This difference can be explained by the fact that, in the rice-wheat cropping system, most weeds in the wheat crop germinate only in wheat season. Because the soil is disturbed less under zero-tillage, fewer weeds are exposed and germinate. Crop cuts have shown that zero-tillage produces 400-500 kg $ha^{-1}$ more grain than traditional systems. This is attributed to earlier, timely planting, fewer weeds, better plant stand and improved fertilizer efficiency because of placement with the seed drill. Some farmers are now in their fourth year of using zero-tillage and find no deleterious effects that would make them revert back to the traditional system.

## Bed planting for non rice-wheat cropping system

In bed planting systems, wheat or other crops are planted on raised beds. This practice in the last decade or so has resulted in dramatic yield increase. Causes of low application efficiencies include over-irrigation, improper irrigation methods and timing, non-specific irrigation scheduling and non levelled fields (Gill, 1994). The Bed-and-Furrow system of irrigation for wheat and other row crops have many benefits over the conventional basin irrigation methods (Fig. 6). Heavy monsoon rains cause temporary water logging, especially on sodic soils with low permeability, and about 35% of the Indus basin is affected by either waterlogging or salinity or both (Anonymous, 1997). The early rains are very damaging for crop. The farmers who have not shifted to this technology had to broadcast or drill the seed for even three to four times. Contrarily, cotton grown along Bed and Furrows save the farmer from major damages under many such catastrophes.

Major Benefits of the technology include:

- Water saving of about 50%
- The crop growing operations are quicker and require less labor.
- Less incidence of disease occurrence and better survival against the virus attack.
- Early maturity.
- Improved efficiency of cultural operations
- In hand harvested rice fields, wheat crop can be planted in just one pass.
- The bed planter reshapes the beds and furrows, plants the crop and places fertilizer at appropriate depth into the soils along seed or between seed rows in the center of the bed at 5-10 cm depth.

## Crop residue management through Turbo seeder

Presently crop residues in combine-harvested rice fields are being burnt for cleaning fields before planting of wheat, causing a serious atmospheric pollution and also results in loss of nitrogen up to 80%. Rice straw / chaff left after harvest help keep the soil healthy and productive. Organic matter from these residues binds soil particles and improves the soil structure. Leaving the straw as surface mulch has not received much thought in Asian agriculture. However, results from rainfed systems and some preliminary results in Asia suggest that practice may benefit crop establishment and vigor under zero-tillage (Sayre, 2000).Well-structured soils possess potential to drain faster, make better seedbeds, and improve soil ability to deliver water and nutrients to crops. Burning crop residues lower the soil ability to produce high yields as over 60 percent of the nutrients stored in crop residue are lost through burning. Besides, burnt soils require increasing amounts of fertilizer to be productive. Chopped Rice straw is also a valuable commodity as it can be sold to the local companies/industries making products like straw board and paper. Supplementary income through selling of rice chaff in the market in addition to improving soil structure is its additional importance. The continuous developments have resulted in the "Combo Happy seeder/Turbo seeder", a compact, lightweight, tractor mounted machine with the capability of managing the total loose straw and anchored rice residue in strips just in front of each furrow opener. It consists of two separate units a straw management unit and a sowing unit. The Turbo Seeder cuts, lifts and throws the standing stubble and loose straw and sows in one operational pass of the field while retaining the rice residue as surface mulch. To reduce the straw load over the seed row, the straw managing rotor was modified to cut standing stubbles for 7.5 cm width (just in front of the furrow openers) and leaving the standing stubbles in other 12.5 cm strip between the two furrow openers. It was observed that with the above modification nearly 30 % of the total straw load was reduced. This PTO driven machine can be operated with 40-60 HP tractors and can cover one acre in 1-2 hours (Fig. 7).

**Benefits**

- Timely planting of wheat without land preparation in rice stubbles / residues Uniform drilling of seed
- Saving of irrigation water.
- Chopped residue as mulch helps in moisture and temperature conservation
- Less weed infestation
- Decreased pollution
- Enhanced soil microbial activity.
- Helps in protecting the fertile surface soil against wind and water erosion.
- increased soil $NO_3^-$ concentration by 46%

## Wheat straw chopper

Wheat harvesting through combine harvester is gaining popularity in Pakistan. The conventional combines are, however, mainly concerned with the grains, which generally leave the straw un-cut and un-chopped in the field for subsequent burning. To manage the straw from combine harvested wheat fields, a tractor operated wheat straw chopper-cum-blower, having the capability to harvest uncut straw and to pick up the combine ejected straw from the combine-harvested fields for subsequent chopping was identified from the region (Fig. 8).

One unit of the machine was acquired through the Rice-Wheat Consortium. The chopper was initially tested and demonstrated at National Agricultural Research Centre (NARC), Islamabad and subsequently at farmer's fields to assess its suitability for adoption in the local conditions. In view of field performance of the chopper, the farmers showed their keen interest in its use. The machine is capable of converting wheat stubbles on one acre into straws in one hour by consuming just 6 liters of diesel. The chopper not only converts stubbles in to straw but also collects wheat spikelets/grains from the field left from being harvested through combine harvester in a specified chamber in the machine after separating it from the stubbles. The straw so collected in the sac or in the trolley fitted behind the chopper also reduces labour requirement to load straw over the trolley. In Pakistan, the technology has gained the popularity and almost 2000 wheat straw choppers are being used by the farmers and more than 30 manufacturers are making units.

## Conclusion

It is concluded that wheat productivity in Pakistan can be increased and sustained by using resource conservation technologies like zero tillage, laser land levelling, furrow cultivation, crop residue management etc. Use of these technologies will reduce the gap between harvest of the kharif crops and wheat sowing on one hand and on the other will help in the efficient use of valuable resources like water, fuel and soil.

**Table 1**: Total area under conservation Agriculture in Pakistan.

| Technologies | Machinery | Total adoption (ha) |
|---|---|---|
| Laser Land Leveling | 8124 | 898944 |
| Zero Tillage | 6047 | 507050 |
| Bed Planting | 2509 | 276450 |

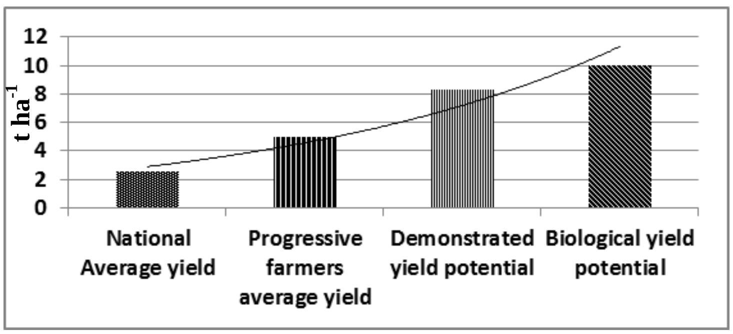


**Fig. 1:** A comparison of national average yield with that of progressive farmers and domesticated and biological yield potential.

**Fig. 2:** Laser land leveller in operation and the filed levelled afterwards.


**Fig. 3:** Paddy stubbles and tractor drawn seed drill sowing wheat in paddy stubbles with zero tillage.

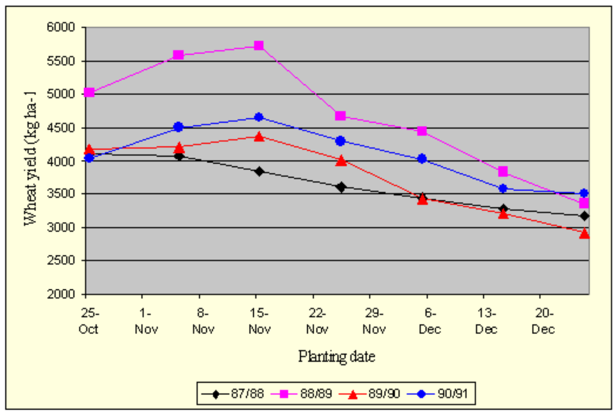


**Fig. 4:** The effect of planting date on wheat yield.

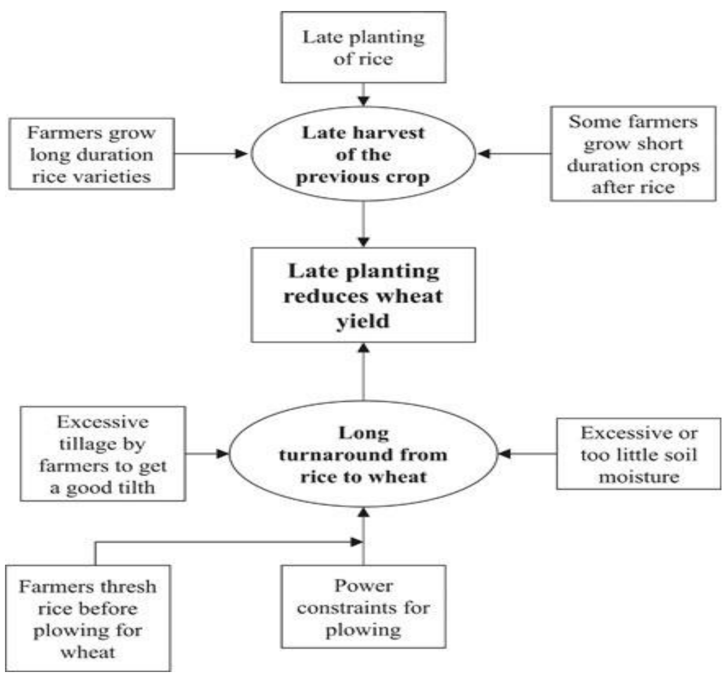


**Fig. 5:** The most common causes of late wheat planting following rice harvest.

**Fig. 6:** Bed Planter making beds for wheat sowing and wheat beds afterwards.

**Fig. 7:** Combo happy seeder/turbo seeder sowing wheat in crop residues.

**Fig. 8:** Wheat straw chopper cutting the wheat stubble in the field.

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