Raised-bed technology for agri-production

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Pakistan is an agricultural country with world's largest contiguous irrigation system called Indus-basin irrigation system (IBIS). It comprises gross command area of 40 million acres (m. ac). The water allocation of 3-5 cfs/1000 acres is just sufficient to achieve a cropping intensity of 70-80 per cent, which is too low to meet the ever increasing demands of growing population for food and other needs. The farmers in the process of increasing the cropping intensity developed groundwater to an extent that around 40 per cent of total water use in agriculture is from groundwater. The average cropping intensity of the IBIS is around 120 per cent. In the IBIS, the ground-water aquifers in about 60 per cent areas provide water of marginal to hazardous quality. The use of it has resulted into secondary salinisation and sodification.

The agricultural production in IBIS is constrained with many factors such as shortage of fresh water, low irrigation efficiencies, poor quality under groundwater, soil salinity/sodicity, increasing cost of energy and seasonal/permanent waterlogging. All these factors consequently cause low crop production. In IBIS field crops are irrigated using basin irrigation method. Application losses in fields are nearly 25-40 per cent under flood and basin irrigation. Low application efficiencies in IBIS are result of over irrigation, improper irrigation methods and timings, unscientific irrigation scheduling and unleveled fields. Poor irrigation efficiency not only results in wastage of precious irrigation water but also causes nutrient leaching, waterlogging, salinity and groundwater degradation. The fertilizer use efficiencies (FUE) and water use efficiencies (WUE) are quite low. Because of poor irrigation efficiencies, within 100 years of the development of IBIS, the water table has risen from 40 m to within 3 m on about 42 per cent of Indus basin the area.

The situation is worst in Sindh province where water table is within 3 m on about 57 per cent irrigated area of the province. Waterlogging is particularly acute during the monsoon, which makes the situation adverse for growing crops. Because of increasing population and its standard of living (use of water in baths, kitchen and lawns, etc) there is increasing demand for freshwater. However, supplies can not keep up with such demand, and increasing scarcities are inevitable regardless of whether climate change might alter rainfall patterns. Furthermore there is ever-increasing competition for water availability among agriculture, industry and domestic users. It is estimated that domestic and industrial water uses will increase 15 per cent of the available water resources in 2025 as against the present use of 3 per cent. The worsening scarcity of water threatens agricultural growth and is likely to increase water related health problems and degrade the environment. Despite enormous shortage of water for irrigation and domestic consumption, its use is more extravagant. Land and water productivities can be increased through adopting appropriate irrigation methods. In the face of increasing shortages of water in the future and aggravating problem of waterlogging and salinity/sodicity, improvements in the irrigation efficiency is a vital necessity. There is a proverb that "prevention is better than cure" so an efficient irrigation supplements drainage. Even 10 per cent reduction in water losses at all the three levels (canal, water course, field) will save over 1.0 million hectare meter (mhm) of irrigation water which can be used to increase cropped area, cropping intensity and crop yields.

Surface irrigation is the most ancient and widely practiced method of irrigation in the world. Many improvements have been made to this method over the years, yet its average performance is still below the achievable levels. Recently, bed planting has been introduced in the IBIS, where temporary beds of around 60-75 cm width are made and crops like wheat, maize and cotton have been planted. Some early work conducted in Pakistan have shown that non-permanent bed/ridge and furrow irrigation produced appreciably increased yields along- with water saving. Considering the ever increasing cost of energy (for land preparation, bed forming etc) and soil degradation (physico-chemical conditions) permanent raised bed technology is emerging. Realising the problems and production potential of the irrigated area, a collaborative project entitled "Permanent Raised Beds to Improve Productivity of Water Use and Control Salinity in Pakistan" was initiated jointly by Pakistan Agricultural Research Council (PARC), Islamabad and Australian Centre for International Agricultural Research (ACIAR) at Mardan. Field experiments and demonstration trials were conducted at farmers' fields with their active participation for five croppings seasons.

As a result of two years' field experimentation and demonstration it was observed that: (i) Furrow bed irrigation system compared to basin saved 29 per cent, 23 per cent and 26 per cent irrigation water for kharif maize, rice and wheat, respectively; (ii) Furrow-bed outyielded than basin for all the seasons under maize with the average increased value of 46 per cent. For rice and wheat on non saline/sodic soil, furrow bed gave comparable yield to basin; (iii) For maize, furrow bed gave 33 per cent greater net return as compared to basin. Whereas, for wheat net return was 6 per cent higher. These returns will further increase over the period; (iv) On cumulative basis weed burden under furrow bed was 31 per cent and 36 per cent less as compared to basin in maize and wheat, respectively. Low weed burden not only increase crop yields but will also decrease cost for weed control and drudgeries involved during crop harvesting; (v) The data further indicated that furrow irrigation of permanent raised-beds are considerably less susceptible to deep drainage losses. By comparison the basin irrigation method lost on average 18 per cent more of the water applied to it than was applied to the raised-bed, (vi) The soil physico-chemical health was better under permanent beds than basin. It will further improve with the life of permanent beds. A well structured, stable raised-bed soil into which water moves in an unsaturated phase, will ensure waterlogging and anaerobic conditions never occur.

So in water scarce areas, furrow-bed irrigation provides option for increased water productivity. There was 25 per cent reduction in irrigation water applied to furrow-bed system as compared to basin irrigation system. Considering 120 per cent cropping intensity in irrigated areas, with the same amount of available irrigation water 25 per cent more area can be irrigated during both the seasons. By adopting furrow-bed irrigation system on large areas along with precision land leveling and improvement of water conveyance system, the waterlogging problems can be controlled. The water saved through improved irrigation application methods can be used to further increase cropped area and reclamation of salt affected areas. The saving in irrigation depth especially in water scarce areas where it has to be supplemented with poor quality groundwater will reduce salt load through irrigation.

The adoption of permanent raised-beds, along with plant residue management, can control soil salinity. This technology fulfills good promise for the control of water erosion and increased crop yields especially in high rainfall zone. Crop productions per unit of water under furrow-bed system would be even greater on waterlogged (temporary/permanent) soils and in wet physical environment which encourage plant roots and consequently increased yields. The profitability and promise for raised-beds depends on rainfall amounts, distribution and watertable depths. Areas with high rainfall, high watertable on one hand and water scarce on the other hand have the potential for adoption of permanent raised bed technology. Furthermore, widely spaced crops/vegetables and crops sensitive to water ponding are more appropriate for adoption.

During implementation of project some researchable issues were identified which will be addressed in second phase of project under research and adaptation. However, initial research and demonstration indicate that permanent raised beds through saving irrigation water and improving physico-chemical health of soil provide an opportunity for sustained agriculture production in water scarce/waterlogged areas. To increase the water and land productivities irrigation units should be properly levelled to improve irrigation application efficiencies. The water use efficiency and marketable products can further be increased through optimum use of fertilizers, cultural practices and improved crop varieties.

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