Increasing crop production in *barani* areas

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The total area of Pakistan is 79.61 million hectares (mha), out of which 23 mha is cultivated and 8.9 mha is culturable waste. About 25 per cent of the cultivated land is rainfed, and depends on rainfall for water requirements of crops and plants. The culturable wastes also exist due to water deficit.

The productivity of rainfed crops is quite low. This is mainly attributed to soil moisture stress at critical crop growth stages and low soil fertility. This is why it is said that the dry lands are not only thirsty, they are also hungry.

The unpredictable and erratic rainfall induces on element of risk, uncertainty and instability in crop production. The farmers are conservative in use of high cost inputs including fertilisers. The available water is not properly utilised. The Water Use Efficiency (WUE) and Fertiliser Use Efficiency (FUE) in rainfed agriculture are also low.

However, it is believed and experimentally proved, that FUE can be enhanced through proper water management and WUE can be improved by judicious use of fertilisers. Moreover, the production of wheat can be increased by adopting the following technologies. These technologies have been developed and tested at pilot scale by various components of Pakistan Agricultural Research Council (PARC), Islamabad.

Water harvesting

Pakistan is predominantly an arid country, and thus the production of crops and plants is mainly dependent either on irrigation or on rainfall runoff. In the rainfed areas, low and erratic rainfalls cause drought, which hampers successful crops/plants production. Water harvesting and runoff farming is a technique developed for growing crops and plants in the arid areas where precipitation is inadequate and unpredictable.

There are two general approaches of rain water harvesting:

(i) In situ water harvesting, which consists of conserving as much rain as possible where it falls through land and soil management. The practices mainly consist of contour furrowing, contour benches, bed-furrow system and other cultural operations. The guiding principle is to maximise infiltration and retention of the incidental rain and minimise runoff/deep percolation losses. This approach is workable in semi-arid areas, where sufficient amount of rainfall is received to mature the crop. If the runoff losses are avoided, then it may fulfill the crop/plant water requirements.

(ii) Catchment based water harvesting - wherein rainwater is allowed to runoff from the upper reaches of catchments and collected at the lower reaches, for sustained crop/plant production. The underlying principle is to minimise infiltration and maximise runoff on catchment, slopes for greater water harvest on adjacent areas. The runoff from the catchment may be enhanced through its physical, chemical and biological treatments, or by modifying ground surface configurations.

This approach is mainly practised where the precipitation is not sufficient to meet the crop/plant water requirements and demands. The choice of the technique to be adopted is based on various criteria such as topography, soil type, land use and rainfall pattern and intensity. The gentle slopes, with moderately deep medium textured soils, are suitable for crop production, whereas undulating topography and steep slopes with shallow to moderately deep soils are more feasible for fruit/forest plant production.

Supplemental Irrigation (SI)

It is defined as the application of limited amount of water to the crop/plant when rainfall fails to provide sufficient water for plant growth to increase and stabilise yields. The additional amount of water alone is inadequate for crop production. Hence, the essential characteristics of SI is the supplemental nature of rainfall and irrigation. It is well documented by PARC that the water productivity (i.e. the ratio of economic yield of crop and the total amount of water consumed) of rain and S.I. exceeds the water productivity of either component if applied alone.

The source of water for S.I. may be either from the harvested/stored water, dugwells or streams/perennial nullahs. The amount and timing of S.I. are not meant to provide water stress-free conditions over the growing season, but to provide enough water during the critical stages of crop growth to ensure optional yield in terms of yield per unit of water. Potentially, S.I. may have three major effects: (a) yield improvement, (b) stabilisation of production from year to year (increasing rehability) and (c) providing the conditions suitable for economic use of higher technology inputs, such as high yielding varieties, fertilisers and herbicides, irrespective of seasonal rainfall.

Balanced use of fertilisers

The soils of rainfed areas are suffering with tremendous physical and chemical (organic matter and nutrients) losses. Soil erosion with nutrient mining, due to centuries old cropping and inadequate nutrient replenishment (almost no organic matter recycling and inadequate and imbalanced fertiliser use) has resulted in multiple nutrient deficiencies of acute magnitude.

Fertiliser use efficiency is very low because of alkaline calcareous soils and uncertain rainfall patterns. Extensive experimentation done by PARC has indicated that with proper fertilisation, yield of crops can be increased 6-7 times, compared to unfertilised crop. Phosphorous and potassium application also improves plant resistance to moisture stress and water use efficiency of crops.

Substantial crop productivity increase have been recorded extensively with fertiliser application in degraded soils. For example, wheat yield increased by 100-400 per cent with M, 100-350 per cent with P, 15 per cent with Zn and 10 per cent with B application. It has been demonstrated that band placed 20 Kg P per hectare, results in the same wheat yield increase obtained with soil surface broadcast 40 kg P per hectare.

Cultural operations, such as mulching, fertilising and proper initial spacing have beneficial effects on crop production in semi arid and arid areas. There is a positive interaction between water and fertilisers under certain limits. Water increases FUE and fertilisers improve WUE, and there is synergistic effect of both inputs. Favourable water regimes make possible fertiliser applications at levels which would be entirely ineffective under conditions of moisture stress.

For the expansion of fertiliser use, good rainwater management practices are crucial and un-managed rainfall is a precious resource wastage. Highest responses from nutrients are achieved by integrated nutrient management (INM) approach. Balanced application of appropriate fertilisers is a major component of INM. Fertilisers need to be applied at the level required for optional crop growth is based on crop requirements and agro-climatic conditions.

Tillage for moisture conservation

Tillage practices influence moisture and root penetration depth in soil, which consequently effect fertiliser requirements as well as crop yield. Deep tillage, alongwith improvement of field bunds and land forming, is very effective in enhancing moisture conservation. Through adopting these practices, it is possible to achieve 200 per cent cropping intensity, with significant increase in crop yields under medium rainfall zones on deep soils.

It has been reported that primed seeds emerge faster and grew more vigorously. This lone reason is enough to adopt seed priming. In many cases, however, crops also matured earlier and gave higher yield. Approximately 12 hours of soaking and surface drying before sowing traditionally has been shown to be effective in all crops like wheat, barley, sorghum etc.

Weed control

Weeds in rainfed agriculture are serious competitors of crops for moisture, nutrients, and space. It has been observed that nitrogen and phosphorous uptake by weeds was greater under zero tilled mungbean, compared with conventional and deep tillage. Therefore, effective weed control is essential for efficient utilisation of nutrients and water.

Seed priming

It may be defined as soaking treatment of seed with water before sowing into soil. Seeds in semi arid tropics are sown into hot, drying soils, where potential metabolic rates are high, but lack of water is the main constraint. In such a situation, the prehydration of seed is the main purpose for seed priming, although bio-chemical advantages may also be important.

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The seed priming can also be done with water injection machine attached to seed drill. This is a simple water barrel placed on the back of tractor and water connections placed in the hopers of seed drill. Seed priming through this technique has improved seed soil contact, which enabled them to germinate earlier. Yield increase of wheat by 15-20 per cent was observed due to seed priming.

Drought resistant varieties

Plants possess great genetic variability towards different stresses like drought, soil salinity/sodicity, waterlogging and nutrient deficiencies. To exploit this potential, there is a need to screen the planting materials for different stresses. Under rainfed conditions, inspite of adopting all the soil and water conservation practices, there might be drought/soil moisture stresse(s) during different crop growth stages.

To avoid/overcome such stresses drought tolerant/resistant cultivars may be helpful. Furthermore, cultural practices like optimum plant population, time of sowing and method of sowing are also helpful for crop stand establishment and harvesting good yields. Sowing of drought resistant varieties with improved agronomic practices leads to the use of available moisture more efficiently and reduces surface runoff and soil loss.

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