INSITU MOISTURE CONSERVATION TECHNIQUES IN DRYFARMING - A REVIEW

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ABSTRACT

To increase the moisture availability to the agricultural crops, it is necessary to adopt in-situ moisture conservation techniques in addition to the large scale soil and moisture conservation and water harvesting structures in the watershed. The principle behind the recommendation of different practices is to increase the infiltration by reducing the rate of runoff, temporarily impounding the water on the surface of the soil to increase the opportunity time for infiltration and modifying the land configuration for inter plot water harvesting. Earlier efforts for moisture conservation were concentrated upon construction of various types of bunds across the land slope to control erosion and conserve soil. All the erosion control measures however, led to accumulation of water against the structures rather than its proper and uniform distribution in the interterraced area and at times led to reduction in crop yields. To overcome these problems the insitu moisture conservation techniques are recommended. Generally, the subsoiling and deep digging decreases the soil penetration resistance and increases profile water use when compared with conventional tillage. In a study, subsoiling, mould board ploughing and deep digging resulted in 80-100 per cent more stover yield and 70-350 per cent more grain yield of maize than the control. Application of maize stalk as mulch increases the yield of rainfed wheat variety C-306 by 19.97 per cent. A study reveals that jalshakti (hydrophilic polymer) in furrows at sowing + mulch combination is the best one in terms of maximum yield, soil moisture content and water use efficiency in the rainfed mustard crop. Basin listing increases surface depression storage of precipitation, thereby potentially reducing storm runoff and increasing soil water storage availability to crops. In a study, the basin lister resulted in an increased crop yield of 11.0 per cent as compared to conventional method of summer ploughing. The broad bed and furrows result in larger moisture storage than the other tillage methods. In a study, there was 13.45 per cent increase in yield in broad bed and furrow system over the flat bed method of sowing. It is reported in another study that there was 11.67 per cent increase in yield of ragi in the ridge and furrow system over the flat method of sowing. In a field investigation on the effect of different methods of sowing on yields of ground nut, it is reported that there is 40.80 per cent higher yield of pod in the ridge-furrow method than the flat bed sowing systems. In general, it could be possible to reduce soil and water losses by adopting in-situ conservation practices like dead furrows at 3.6 m interval across the slope (25 to 30 days after sowing) with the arrival of rains, coupled with compartmental bunding with 20 m length and 10 m width before germination of crop. In an investigation, it is reported that compartmental bunding increases the grain and fodder production of rabi sorghum by 38 and 50 per cent respectively.

Out of the total geographical area of 328.73 m ha in India, only 143 m ha is under cultivation. Even after realising the complete irrigation potential of the country, 50 per cent of the cultivated area will continue to depend on the rainfall. In the past three decades, the rate of growth of food production has more or less kept pace with the population growth mainly due to the productivity gains from irrigated areas following the green revolution. Currently, irrigated areas produce an average of 2 tonnes of food grains per hectare. The average productivity in rainfed areas is only 0.7 to 0.8 t/ha according to Singh and Venkateswarlu (1999). About 70 per cent of the cultivated land is rainfed which depends on natural precipitation for crop production (Mahipal et al., 1996) and rainfed agriculture accounts for 45 per cent of cereals and 75 per cent each of pulses and oil seeds (Hazra,
The objectives for developing technology under these conditions should, therefore, be for improvement in yield and stabilization of crop production but these areas are marked by erratic and unpredictable rainfall, creating an atmosphere of high risk, insecurity and very low yields. The main crux of the problems for increasing agricultural production in any area is to increase the output per unit of input. The farm returns depend not only in the crops grown, but also how efficiently the available resources are utilised. All these are pointers to indicate that the land resources should be utilised to the optimum extent possible. Since the available land area is limited and finite, the necessity to improve the productivity of the land and to increase the income of the farmers have become important. It is therefore necessary to introduce technologies in dryland farming to increase production.

Problems in dry farming

While considerable importance has been given to increase the productivity of the irrigated lands under green revolution, much attention has not been given to increase the productivity of the rainfed areas. As the moisture is the limiting factor in the rainfed farming and the rainfall is the only source of water for these lands, it is necessary to conserve rain water and to maximise the retention of moisture. Further the following are the problems in these lands.

i. Inadequate soil moisture is the chief constraint in drylands where the annual rainfall is 500 mm to 1000 mm. It is not evenly distributed and highly variable and erratic.

ii. The soils are light/medium textured. Their water holding capacity are low.

iii. The lands are often having rolling topography. The rainfall runs off quickly, removes soil and fertilizers.

iv. Subsoil hard pan is formed due to continuous use of implements upto certain depths constantly, which intam precipitate the clay in the subsoil horizon.

To overcome these above problems, the current cultural practices should be improved and certain engineering measures are necessary.

In-situ moisture conservation methods

To increase the moisture availability to the agricultural crops in the individual farmer’s field and to increase the infiltration and percolation of rain water into the root profile, the in-situ moisture conservation techniques are recommended.

i) Deep tillage: Sriram et al. (1982) reported that deep tillage was superior in producing higher crop yield over shallow tillage on alluvial soils. Chaudhary et al. (1985) investigated different deep tillage operations viz., subsoiling, mould board ploughing and deep digging to 45 cm and concluded that subsoiling and deep digging decreased the soil penetration resistance and increased profile water use when compared with conventional tillage. Subsoiling, mould board ploughing and deep digging resulted in 80-100 per cent more stover yield and 70-350 per cent more grain yield of maize than the control. Hutchinson et al. (1985) suggested that subsoiling could increase percolation of water and increase soil aeration with a consequent improvement in moisture utilization.

Khan (1989) studied the effect of deep tillage (subsoiling and deep ploughing) on the yield of bengal gram and wheat and concluded that in bengal gram, subsoiling + gypsum and subsoiling + saw dust treatments significantly increased the soil moisture content. Heilman et al. (1991) reported that the soil profile water content was consistently greater in the wing-chisel tillage plots than in the conventional tillage plots. Velayutham et al. (1994)
evaluated contour bunding, contour ploughing and broad based ridging practices with cowpea, castor and thinai and reported that the grain yields with the contour bunding, contour ploughing and broad based ridging averaged 0.87, 0.97 and 0.93 t/ha respectively.

Mohamed (1996) compared tillage practices namely post harvest offset disking (8-10 cm deep), post harvest chisel ploughing (with 5 cm spikes at 10-15 cm deep), pre-seeding chisel ploughing (with 40 cm shovels at 15-20 cm deep) and reported that an effective soil moisture penetration resulted from the pre- seeding shovelled chisel ploughing improved the soil moisture content available for plant use. Anker et al. (1997) investigated the effect of tillage (chiseling, mould board ploughing) on soil moisture conservation and found that the soil moisture storage efficiency was higher in mould board ploughing than chiseling.

ii) Mulching: Wilhoit et al. (1990) assembled a simple strip tillage implement to conduct a field experiment with summer cabbage and reported that the strip-tillage cabbage yield from a heavy mulch treatment was 56 per cent higher than that from a stubble mulch treatment, under very dry conditions. Sharma et al. (1992) evaluated different mulch covers (pine needles, saw dust, hay, black polythene and control i.e., no mulch) for in situ moisture conservation on yield of grapes under rainfed condition and concluded that the pine needles mulch was the most effective one for maximum conservation of moisture and high yield.

Munishkumar and Surajbhan (1993) investigated different combinations of mulches and reported that the highest cotton seed yield (1159 kg/ha) was observed with organic mulch + jalshakti (hydrophilic polymer) + mixtalol followed by organic mulch + jalshakti (1051.5 kg/ha). Uttam and Das (1993) reported that application of maize stalk as mulch increased the yield of rainfed wheat variety C-306 by 19.97 per cent.

Sandal and Acharya (1997) investigated different tillage practices in a maize-wheat cropping sequence and reported that maize sown on conventionally tilled plots mulched with lantana and sowing wheat with minimum tillage + mulching with lantana’ conserved sufficient moisture and resulted in timely sowing of rainfed wheat with higher grain yield. Suraj Bhan et al. (1997) assessed different water conservation practices and concluded that jalshakti (hydrophilic polymer) in furrows at sowing + mulch combination was the best one in terms of maximum yield, soil moisture content and water use efficiency in the rainfed mustard crop. Gichuru et al. (1998) reported that mulching with crop residue resulted in increased moisture conservation and higher grain yield than with other tillage practices, maize and bean grain/seed yields were 833, 1083 and 850 kg/ha and 936, 922 kg/ha for tied ridges, crop residue mulching and conventional tillage respectively.

iii) Basin listing: Anonymous (1987) developed a tractor drawn basin lister attachment to cultivator and reported that the moisture level at different depths were more (2-5 cm deep) in plots treated with basin lister. Elmaeni and Elsahookie (1987) established the maize crop by sowing (a) on ridges with basin listing (b) in the furrows and (c) on the ridges and concluded that sowing on ridges with basin listing out yielded other treatments producing grain yields of 7.37 and 11.9 t/ha from spring and autumn sowings respectively. Nagarajan et al. (1988) evaluated basin lister, broad bed former and chisel plough in comparison with the conventional method for moisture conservation in dry farming and reported that the basin lister resulted in an increased crop yield of 11.0 per cent as compared to conventional method of summer ploughing.
Jones and Stewart (1990) reported that basin listing increases surface depression storage of precipitation, thereby potentially reducing storm runoff and increasing soil water storage availability to crops. Durairaj et al. (1992) reported that 2-4 per cent more moisture was retained in the soil following basin listing compared to conventional ploughing. Kathirvel et al. (1992) evaluated the basin lister with broad bed system, compartmental bunding system and conventional method for cotton crop in rainfed condition and concluded that the basin lister treatment resulted in 10 per cent increased soil moisture storage and 30 per cent increase in crop yield.

Channappa (1994) attempted to increase the crop yield through increasing opportunity time in the interterraced area and reported that the jowar grain yield was higher in listing system by 6.22 per cent over control. Asokan et al. (1995) reported that 5-6 per cent more moisture could be saved by using a tractor drawn basin lister in the clay loam soil in comparison with tilling the soil with cultivator. The effective field capacity of the basin lister was recorded as 0.48 ha/h.

iv) Broad based bed and furrows:
Maurya and Devadattam (1987) reported that the moisture availability, crop yield and cost-benefit ratio were higher for the broad bed and furrow system than the flat bed system. Devi et al. (1991) investigated the effect of different tillage practices viz., deep tillage, broad bed and furrows, dead furrows, ridges and furrows and flat bed (control). The authors reported that the broad bed and furrows resulted in larger moisture storage than the other tillage treatments. Channappa and Ashoka (1992) evaluated the effect of broad bed and furrow system for ragi among other moisture conservation systems (ridges and furrows and flat bed method of sowing) and observed that there was 13.45 per cent increase in yield in broad bed and furrow system over the flat bed method of sowing.

Ratif et al. (1994) reported that the increase in sorghum yield compared with growing in flat beds was the highest in broad bed and furrows and the water use efficiency of sorghum was also the highest in broad bed and furrows (6.18 kg/ha per mm). Broad bed and furrows had significantly higher total soil moisture content upto 60 cm deep. Jayapaul et al. (1996) conducted an investigation on land management methods and observed a progressive increase in seed yield of soya bean due to broad bed and furrows land management. By using this method, the highest economic returns in terms of net returns and cost-benefit ratios were obtained.

v) Ridges and furrows:
Surajbhan and Singh (1979) investigated the feasibility of moisture conservation practices under dryland conditions and concluded that ridging and furrowed increased the yield of maize and mustard and brought about an additional profit of Rs. 285.60 per hectare over the conventional method. Channappa and Ashoka (1992) reported that there was 11.67 per cent increase in yield of ragi in the ridge and furrow system over the flat method of sowing. Hadvani et al. (1993) studied the effect of different methods of sowing on yields of ground nut and reported that there was 40.80 per cent higher yield of pod in the ridge-furrow method than the flat bed sowing systems. Tripathi and Suraj Bhan (1993) concluded that among the moisture conservation practices, furrowing + mulching was the most efficient in conserving soil moisture and increasing crop yield of rainfed sorghum. Itnal et al. (1994) studied the interterrace land management practices and reported that the ridger and furrows (60 cm apart) showed higher yield of rabi sorghum by 50.65 per cent over control.

Surajbhan et al. (1995) reported that furrowing is the most efficient among the moisture conservation practices in reducing
water use, increasing water use efficiency and yield of rainfed sorghum. Gupta et al. (1997) investigated the effect of in-situ moisture conservation on yield of maize-mustard cropping system and reported that significant improvement in yield resulted from ridging and furrowing. Maximum net returns was obtained by ridging and furrowing with the minimum through contour sowing (control). Vaidyanathan et al. (1998) conducted a study on the effect of moisture conservation practices on the yield of rainfed castor and the results revealed that sowing of castor in ridges and furrows has recorded higher yields by 17.69 per cent than the flat bed system field.

vi) Compartmental bunding: Katyal et al. (1992) stated that compartmental bunds converting the interbund area into square parcels of 10 x 10m or 15 x 15m were useful for temporary impounding of water for improving the moisture status of the soil. Katama Reddi and Padmalatha (1993) reported that it could be possible to reduce soil and water losses by adopting in-situ conservation practices like dead furrows at 3.6m interval across the slope (25 to 30 days after sowing) with the arrival of rains, coupled with compartmental bunding with 20 m length and 10 m width before germination of crop.

Itnal et al. (1994) reported that compartmental bunding was an in-situ moisture conservation practice suited for medium deep to black soils where rabi cropping is predominantly taken. More et al. (1994) reported that compartmental bunding increased the grain and fodder production of rabi sorghum by 38 and 50 per cent respectively. More et al. (1996) assessed the use of compartmental bunding (6 x 6 m spacing) as a moisture conservation measure and concluded that compartmental bunding increased mean sorghum grain yield from 0.69 to 0.96 t/ha and mean fodder yield from 1.20 to 1.79 t/ha.

CONCLUSION

The problem under dryland agriculture is that of low yield and unstable production. Despite the realization that it is much difficult to increase the production from drylands, it cannot be neglected, as a large number of farmers with more than two-thirds of the cultivated area of the country is involved. Unless the vast areas of drylands are developed, increase in production cannot be achieved. Thus the improvement of rainfed farming is the key to the development of agriculture. For this, India needs a new direction and potential agricultural strategies to increase the agricultural production.

REFERENCES


