NEW ERA AGRICULTURE MAGAZINE

Moisture conservation and its efficient utilization

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Introduction

Water is the most important single factor determining crop production. Even after the maximum exploitation of the irrigation potential, two thirds of India's cultivated area have to depend on rainfall for success crop production. Out of the 260 million acres of rainfed crop land, about 77 million acres receive less than 30 inches of rainfall in spite of the large number of rainy days. Besides, the uncertainty of the quantity of rainfall, long breaks in the monsoon and desiccating factors like high winds, low humidity, bright sun and high temperature also contribute to the failure of crops. Another 63 million acres of rainfed crop land receiving annual rainfall between 30 and 50 inches is also subject to drought, though not so frequently as the area receiving less than 30 inches of rainfall.

Problem regions: Two distinct problem regions receiving less than 30 inches of annual rainfall are demarcated, one in the North and the other in the South. The other region comprises certain parts of Punjab, Rajasthan and Cutch in the Great Indo-Gangetic plain.

The second region comprises parts of Gujarat, Maharashtra, Mysore and Andhra Pradesh in Peninsular India. Parts of Madhya Pradesh, Uttar Pradesh and Chennai in the moderate rainfall zone (between 30 and 50 inches of annual rainfall) also suffer from droughts. Scarcity of moisture is the main problem of the northern region. The problem of the southern region is twofold. It is both a soil moisture problem and a soil problem.

Nature of soils: The alluvial plains of the northern region are sandy loams and clay loams. The soils are very deep. Physical characteristics of the soil permit easy penetration of rain water to lower depths and allow the utilization of most of the water held by the soil. The soils are rich in plant nutrients. Erosion by water is not a serious problem, though wind erosion is seen in certain places. The soils of the Peninsular Plateau are either derived from the Deccan traps as in Maharashtra and parts of Mysore or from granites and gneisses as in Andhra Pradesh and parts of Mysore. Bases on depth, the soils of the trap are grouped into three classes: deep, medium and shallow soils.

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The topography is undulating. Serious water erosion is evident. The high clay content and other physical characteristics of the soil impede penetration of rain water into lower layers and restrict the movement of moisture into the plant. The soils derived from granites and gneisses are red soils and black soils. Red soils are comparatively shallow and have poor water holding capacity. Black soils are deep and have a high clay content. Due to physical characteristics, they impede the infiltration of rain water and movement of soil moisture to the plant. The topography is undulating. Water erosion is serious. Soils formed under low moisture and high temperature are poor in organic matter and nitrogen. Soils derived from granites are extremely deficient in phosphates whereas those derived from trap seem to be rich enough.

Agricultural Practices: Millet is the chief crop of the problem area. It is the staple food grain of the people and cattle. Bajra, jowar and Italian Millet are important crops. The important commercial crops are groundnut, cotton and castor. Red gram and horse gram are popular legumes. Bajra is grown extensively in the northern region as a Kharif crop. In the trap region, bajra is grown during kharif and sorghum during rabi season. In the granite trigon, Kharif crops are grown in red soils and rabi crops in black soils. Jowar is the most important millet. Millets are row crops that grow erect and do not cover the soil fully. They generally allow erosion. Cultivation up and down the slope is common. At the time of erosive rains, the kharif and rabi crops are either not on the ground or too young to protect the soil. Cattle manure is the only manure for the dry land. This is available in limited quantity and is usually applied once in four or five years and mostly to the commercial crops.

Disposal of rain water: The losses of rain water by evaporation vary from 60 to 75 per cent. Ten to 20 per cent of the rain water is lost as surface run off. Only 10 to 20 per cent of rain water is absorbed by the soil. Of this, 10 per cent is lost as underground drainage depending on the nature of soil. Five per cent of the rain water is retained as water not available to crops. Five to 15 per cent of rain water alone is available for plant growth. Out of the 25 inches of rainfall received during crop period, only one to four inches of water is available for plant growth. About three to five inches of rainfall has to be made available for the sorghum crop to give one-thirds ton of grain and two thirds ton of straw. Inadequacy of moisture in years of low rainfall or erratically distributed rainfall accounts for frequent failure of crops.

Conservation of Moisture: The amount of water available for crop production can be increased by reducing evaporation,

transpiration, run off and increasing the ability of the soil to absorb and retain rain water.

Reducing evaporation: The use of mulches is suggested for reducing evaporation. Dust mulch has not been found to be effective to reduce evaporation losses. Stubble mulch is effective in reducing evaporation losses only in years when rains are frequent. Use of paper and plastic mulches to reduce evaporation losses in rainfed crops is not practiced.

Reducing transpiration: Different species and even varieties & strains within a species vary in the amount of water they require to produce pound of dry matter. The strains of crops that use less water have to be grown. They withstand rigorous conditions and yield normally due to the capacity of the plant tissues to survive desiccation. Early maturing varieties are preferrable as they complete their life cycle before drought conditions set in. Another possible means of reducing transpiration is by the control of plant population to avoid undue competition for moisture. Widely spaced rows and widely spaced plants within rows reduce plant population to the optimum and decrease the number of plants that transpire. The yield per plant is increased and the final yield per acre is not decreased. In fact, the widely spaced crops may be the only ones that will yield in very dry seasons. Weeds are undesirable plants. They compete with crop plants for moisture and plant nutrients & reduce the yield of crops. The water requirement of weeds is as high as those of dryland crops. While the water requirements expressed as transpiration ratio (pounds of water transpired to produce a pound of plant tissue) was 424 for rabi jowar. Deep ploughing, harrowing and interculture serve mainly to control weeds.

Decreasing run off: The velocity of runoff has to be reduced to retain water for a longer time on the field to facilitate absorption by the soil. The ability of the soil to absorb rain water has to be increased. Run-off losses can be reduced only if these two conditions are satisfied. The velocity of run off can be reduced by various methods. The most important of them are contour cultivation, bund-former bunding and contour bunding. Strip cropping also serves the purpose wherever it is feasible.

Contour cultivation: By ploughing across the slope and sowing across the slope, each ridge of a plough furrow and each row of crop acts as an obstruction to runoff. Each furrow serves as a detention structure. This is a very effective practice.

Bund former bunding: Temporary bunds of seven inches height are put up after the [re-monsoon showers in May with a bund-former dividing the files into compartments of 5 to 10 cents. These compartments hold the rain water and allow it to soak the soil if the

soil has good infiltration. This costs only a rupee or two per acre and should form a regular cultivation practice wherever possible.

Contour bunding: A series of bunds across the slope intercept the run off at various places and the rain water is held on the field for a longer time. Bunding is a universally recognized supplementary practice for conservation of soil and water. Increasing the ability of the soil to absorb and retain moisture is another way. The soil must have good water holding capacity to hold the water that has infiltered into it and make it available for plant growth. The texture, structure and organic matter content influence infiltration and water holding capacity. This can be achieved by the application of farmyard manure and compost. Application of tank silt to sandy soil increases the water holding capacity.

Farmyard manure is not available in adequate quantity for manuring the dryland. Fuel plantations have to be grown extensively and cattle dung be saved from being used as fuel. Green leaf producing plants as Pongamia, Gliricidia and Ipomoea can be grown on field bunds and compost prepared with plant wastes. It is possible to produce two tons of plant material on an acre every year from the third year onwards from vegetation grown on field bunds. Unless compost and farmyard manure is applied to dryland every year in optimum quantities, it will not be possible to increase infiltration and retention of rain water in the soil for crop use.

Efficient utilization of conserved moisture: Efficiency of water use by crops is correlated with soil fertility. To some extent, high fertility provides insurance against drought. Much less water is required to mature a jowar crop on a field manured with farm yard manure than on a field not so manured. A well fertilized crop uses water much more efficiently than a crop grown at low fertility level. Well fertilized crops have more extensive and deeper root systems and can use water from greater depths and extensive areas. It is therefore, necessary to build up the fertility of the soil by the application of farm yard manure or compost every year. On an unfertilized soil about 95 per cent of the nitrogen and over 50 per cent of phosphorus comes from organic matter and they have to be released by bacterial action. Bacteria hibernate or at least remain inactive at low moisture levels and the plant is starved of the nutrients. But if nitrogen and phosphate is ploughed under, they are absorbed by roots even at a low moisture level. The idea that crops on fertilized soil fail during a year of drought is not correct. The question of efficient utilization of of fertilizer is closely linked up with placement. Starter fertilizer high in phosphate and with 10 pounds of nitrogen can be drilled in bunds 1.5 to 2 inches to the side

of the seed and two inches below the seed. Germination is not affected and root development is increased to tap moisture effectively from a larger volume of soil. Farmers leave a certain portion of their holding fallow for one season. The chief object of fallowing is to conserve and carry forward sufficient soil moisture from one season to the next to secure a crop even in years of drought. Fallowing is not effective on light and shallow soils as they do not have capacity to store the moisture. The land under fallow has to be kept in rough and cloddy condition to reduce run off and absorb rain water. The weed growth has to be effectively controlled during the fallow period. Unless the above measures are adopted, fallowing does not serve any purpose. Fallowing is not recommended on soils with less than 18 inches depth as the moisture of one year cannot be carried over to the next in such soils.

Dry Farming: Dry farming is an improved system of cultivation in which the maximum amount of moisture is conserved in the soil from low and ill distributed rainfall for the production of optimum quantities of crops on an economic and sustained basis. It is a package of all practices that conserve moisture and utilize efficiently the conserved moisture. Essentially, it consists of the following practices. Deep ploughing only to eradicate perennial weeds or to break plough pan or hard pan. Bund former bunding and contour bunding to prevent run off and conserve moisture. Contour cultivation to facilitate absorption of rain water and reduce erosion. Use of strains of crops that withstand drought. Wider spacings of plants between rows and within rows to ensure optimum plant population. Strip cropping wherever feasible to reduce evaporation and conserve moisture & soil. Continuous adoption of dry farming practices has gradually increased the levels of productivity.