Agronomic Measures in Dryland Agriculture

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Introduction
India is still a predominantly agrarian economy with total geographical area of 328.7 million ha (Mha) out of which 141 Mha is the net cultivated area devoted to agriculture, of which only 63Mha or 44% is the net irrigated area producing more than 56% of the total food grains (FAO, 2011). While generating only 44% of the total food, rainfed agriculture is critical as it contributes significantly to the production of coarse cereals (90%), pulses (87%), and oil seeds (74%). These commodities, produced under rainfed agro-ecosystems, are vital for ensuring food and nutrition security for the ever-growing population because of the large diversity in rainfall patterns, temperature regimes, parent materials, vegetation and relief or topography. Soil and water conservation which includes both agronomical as well as mechanical measures place a key role in resource conservation of dry land agriculture. The agronomical methods are supported with mechanical measures, where the land slope exceeds the permissible limits. However in certain of the cases, these agronomical measures will be supported by mechanical measures, where the land slope exceeds the permissible limit. Basically, agronomic methods are used in inter-bunded areas, and mechanical measures compliment to help boost the crop yields in the rainfed drylands. Agronomical measures will be mainly adopted in the inter-bunded areas, mainly in the croplands. In the croplands, these mechanical measures compliment the agronomical measures in boosting the crop yield from the drylands.

Contour tillage:
All the agricultural operations are to be done in the contour, or across the direction of slope, where the holdings are very small. Contour tillage is the tillage
wherein, all the activities, all the agricultural operations. They have to be carried out along the contour bunds. Even though the operation is very simple, it plays a major role in the process of soil erosion through the run off. It tends to arrest the soil erosion and it also stores the run off water and also soil moisture. It also conserves the soil and due to increased time of concentration, more rainwater seeps through the soil profile to recharge the water. The moisture gets more time of concentration to seep into the soil and also after seepage into the soil, it is going to recharge the water. The tillage will be done across this.

**Dead furrows**

When all the tillage operations are complete, it is advisable to leave a dead furrow at every 10 meter interval. This should remain in the position until the crop is harvested. This is also even the operation is very simple, it plays a major role in retarding the process of soil erosion through runoff. Dead furrows aid in reducing the runoff velocity and they also conserve the water. By opening the dead furrows, the velocity of the water can be reduced and it is made to seep into the soil, thus conserving the water.

**Organic matter**

Adding organic manures, like farm yard manure and compost every year as basal application to soil, improves the soil physical conditions. The organic matter improves the activities of soil micro-organisms and also provides the much-needed micro plant nutrients of all kinds, besides nitrogen, phosphorous and potash. The organic matter can be added in terms of green manures and they can be incorporated into the soil and you can apply the formal manure also. Application of these organic matter into the soil will increase the activity of the micro-organisms and decomposition of the crop residues and besides supplying the primary nutrients; nitrogen, phosphorous and potassium along with the plant micro nutrients.

**Choice of the varieties**

There are two types 1. Drought resistant varieties 2. early maturing varieties.

1. Drought resistant varieties. These Varieties with proven genetic character to withstand longer periods of drought. These varieties perform well in situations where the interval between the rainy days are long. These varieties, when they are planted in the soil and when the long dry spells occur during a cropping period. They are able to withstand this moisture stress, because of their genetic character of drought resistance. Hence in drylands drought resistant characters, the varieties with drought resistance have to be used.

2. Early maturing varieties are the Varieties with shorter duration life cycle, should be chosen so as to cut down the water requirements of the crop. The success rate of short duration crops is greater than the long duration crops. In case of drylands, the short duration varieties of the crops should be used, so as to lower the water requirements. So these short duration varieties, they complete their life cycle in a very short period. And coupled with this, they have a less water requirements. So that whatever the available little moisture is available, these can be utilized by the short duration varieties. In case of drylands, the success rate, where the short duration varieties or the short duration crops are being used, the success rate is very high, when compared to using longer duration varieties.

**Seed rates**

Seed rates, every crop will have a recommended seed rates, if it is a normal season, sowing is done with a normal seed rate selective thinning is recommended, if the occurrence of drought is expected to reduce the plant population. Use of scarce soil moisture among the fewer plants. During the crop growth, if the occurrence of the drought is expected the thinning is recommended. Thinning means removal of unwanted plants, thinning of more plants, thinning of extra plants, that is removal of extra plants is recommended. Plant population will be cut down by the thinning operation, so that whatever the few plants left over, they can use the limited water moisture available. Hence this is the idea behind carrying out the thinning. If there is a late season, where the monsoon is moderately delayed. Normal cropping with reduced seed rate is advised. If there is late season. If the sowing is carried out beyond the recommended season; beyond the recommended time, that is during the late season, wherein normal cropping practices can be followed, but with a reduced seed rate. Reduced seed rate is recommended to have smaller populations of plant, so as to utilize the left-over moisture by the fewer plants. With respect to seed rates.

**Line sowing**

This line sowing on contours is essential. It arrests the run off and conserves the soil being eroded. It helps in the labour efficient implements in weeding. In the line sowing because of the definite planting geometry, wherein the plants are planted at equi-distances at pre-described distances, it arrests the run off and it will store the soil moisture. And also it is recommended because if the line sowing is taken, the weeding can easily be taken between the spaces of the plant rows. In this way line sowing is advantageous in drylands.

**Wider spacing**

Wider spacing between the rows and between the plants within the row. This reduces the plant population. Competition between the plants for scarce soil moisture. The fewer plants have greater access to limited available moisture. In case of drylands wider spacing should be followed. That is wider spacing between the rows.
and between the plants. Wider spacing should be followed.

**weeding**

The frequent weeding is an important part of the dryland agriculture. Line sowing and mechanical weeding with appropriate size of blade harrows/cycle weeders remove the unwanted vegetation, which competes with the main crop. Absolutely weeding will be carried out. The purpose of carrying out weeding in the drylands is that whatever the extra plants, unwanted plants are there, they compete with the main crop for resources. When these unwanted plants are removed through cycle weeders or blade hoe whatever the moisture available, they can be utilized by the crop plant successfully. Removal of weeds helps the main crop obtain greater accessibility to soil moisture and plant nutrients for its own growth.

**Mixed or Inter-Cropping System**

Mixed or inter-cropping systems, they are the forms of multiple cropping, wherein these cropping system acts as the insurance against the crop failure. Whenever the main crops fails the component crops will give some sort of income to the farmer. In a way it acts as an insurance against the crop failure. So different root systems of mixed crop feed at different depths of the soil. So the soil moisture will not be taken away from the same depth, because in the mixed cropping systems or in the inter-cropping systems the crops will be selected in such a way that both the crops will have a different rooting pattern. When they have different rooting pattern, they extract the moisture from the different layers. So there not be competition for nutrients. And also in mixed cropping and inter-cropping will fetch fewer grains, very little quantity of grains for the farmer.

**Strip Cropping**

Strip cropping is a practice wherein raising erosion permitting crops along with the erosion resistant crops having abundant adventitious root system and providing high percentage of canopy in strips. Here a few rows of erosion permitting crops and followed by a few rows of erosion resisting crops will be planted. These two types of crop plants will have adventitious root system and also they have higher percentage of canopy, which can arrest the loss of moisture. The close growing erosion resisting strips are generally legumes which fix nitrogen in the soil. In this strip cropping generally legumes will be selected, because of the fact that they have nitrogen fixing plants. The increased resistance to the run off in the erosion resisting crops results in higher volume of water percolating through the soil profile, due to increased time of concentration, and the canopy also protects the soil from the beating action of the soil. In case of strip cropping, wherein erosion resisting crops resist the soil because of higher concentration of time will be available for the water to seep into the soil.

**Agri-Horticulture**

Agri-horticulture, it is an important alternate land use system, wherein the marginal lands do not produce good annual crop returns, even in the normal season, these kinds of soils are best used for raising trees of economic value and creating permanent assets. In such a situation tree based components should be adopted. This is one of principles adopted in the alternate land use systems. Agri-Horticulture provides a viable enterprise, wherein agriculture component
is grown along with the horticulture component, these lands are also good for raising dryland horticulture crops, such as mango, cashew and tamarind. A part of the land could be earmarked specially for planting mixed tree species known in the area for providing fuel, fodder and timber. In case of agri-horticulture system, the farmer can reserve a part of the land for this agri-horticulture activities, so that he will be getting along with the crop component a fruit plant and nutritious security. Crops suitable for dryland horticulture are fruits; mango, sapota, guava, ber, tamarind and custard apple can be selected for the dryland horticulture, in the drylands. Agronomic measures contribute a vital role for enhancing production in drylands. However, the timeliness of the operation and preciseness with which these operations perform will yield a better results in case of drylands.