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Agronomic Management for Sustainable Crop Production in Arid Environment

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In the arid regions of India, over-exploited fragile natural resources are predominantly under mixed farming; (pastoral as well as arable). Total cultivated area is 59.2% and the farming is almost entirely rainfed in this zone with low and unstable yields. The climate is a major determinant of crop yields in this zone. Erratic behaviour of the meager rainfall (100-450 mm; ~90% during July-September), extreme temperatures (often >45°C in the peak of summer and sub-zero in winter) and high summer winds (>30 km h^{-1} during sandstorms in summer) are the perpetual climatic problems to reckon with, especially for agriculture. Drought is and will remain a major determinant of agriculture in the region. In western Rajasthan, which carries the onus of 62% of the arid zone, has a distinct rainfall gradient from east to west that is best reflected in the arid western plain where the mean annual rainfall varies from 100 mm in the western most part of Jaisalmer district to 370 mm in the east of Jodhpur, most of it is received during July-September.

The terrain is dominantly sandy, with sand dunes of 10-30 m average height, interspersed with interdune plains of different sizes covering more than 60% area. The soils are dominantly sandy, with 60-90% fine sand and 2-10% of silt-clay in the topsoil. These are generally low in organic carbon, low to medium in available phosphorus and medium to high in available potassium. Most of the micronutrients are adequate, but deficiency of Zn, Mn and Fe are reported from some of the intensively cropped irrigated fields, especially in the eastern half of the region.

Due to prevailing socio-economic situations, cropping in the Indian arid zone has been considered to be, by and large, a subsistence rather than commercial activity. The typical characteristics of subsistent farming is that most of the farmers resort to growing a number of rainfed crops on their farm holdings primarily to fulfill their household needs, and follow the practice of rotating a particular crop combination over a period of 3-4 years. It results in a multiplicity of cropping systems, which remain dynamic in time and space, making it difficult to precisely determine the spread of different cropping systems using conventional methods, over a larger territory. The productivity in recent past has improved due to adoption of new cultivars and technologies. Results of research efforts on various aspects of crop production in arid zone are reviewed in this chapter.

Tillage and Residue Management

Soil tilth is the physical conditions of a soil described by its bulk density, porosity, structure, roughness and aggregate characteristics as related to water, nutrient, heat and air transport, stimulation of microbial and micro fauna population and processes and impediment to seedling emergence and root penetration. Tillage is necessary to control weeds and to bring out optimum tilth and soil physical environment conducive to proper germination and crop stand establishment.

Soil type is the main factor to determine the kind and the level of tillage operations for field preparation. The light soils require less tillage than heavier soils (Venkatesswarlu, 1981). Excessive tillage on light sandy soil may be detrimental for sustainable agriculture in the arid regions due to wind erosion hazards (Gupta and Gupta, 1981). Therefore, optimum tillage practice for light soil may be different from what may be the best for heavy soil. Conservation tillage is more appropriate strategy for rainfed production system. Conservation tillage is generic term encompassing many different soil management practices. It is generally defined as tillage system that reduces loss of soil or water relative to conventional tillage, mostly a form of non-inversion tillage, allow protective amount of residue mulch on the surface. However, experiments on reduced or zero tillage in arid regions did not give encouraging results so far. Farmers generally adopt a system of plough planting which can be considered as minimum tillage.

A combination of tillage and mulches can benefit soil organic matter content, bulk density and erodibility properties besides improved soil and moisture conservation (Bhatnagar and Sur, 1984). Thus the results obtained in different locations clearly indicated that crops gave better response when