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Important of rainfed agriculture

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Abstract
Indian economy is mainly dependent on agriculture, which contributes 21 per cent of the country's GDP and 60 per cent of the employment. Rainfed agriculture occupies 67 percent net sown area, contributing 44 percent of food grains and supporting 40 percent of the population. In view of the growing demand for food grains in the country, there is a need to increase the productivity of rainfed areas from the current 1 t ha-1 to 2 t ha-1 in the next two decades. The quality of natural resources in the rainfed ecosystem is gradually declining due to over exploitation. Rainfed areas suffer from bio-physical and socio economic constraints affecting the productivity of crops and livestock. In this context a number of economically viable rainfed technologies have been discussed. These include soil and rainwater conservation measures, efficient crops and cropping systems matching to the growing season. The farming systems approach in rainfed agriculture not only helps in addressing income and employment problems but also ensures food security.

Keywords: rainfed agriculture, climate change and crops

Introduction
Rainfed agriculture is largely practiced in arid, semi-arid and sub-humid regions in the country. With about 68 per cent of rural population (Kumar *et al.*, 2009) [8], these regions are also home to 81 per cent of rural poor (Rao *et al*., 2005) [10]. In rainfed regions, the annual precipitation is lower than the evapo-transpiration demand particularly in arid and dry semi-arid zones. Coarse cereals (85%), pulses (83%), oilseeds (70%), and cotton (65%) are the predominant rainfed crops grown in India (CRIDA, 2007) [5].
The demand for food grains in India is projected to be 308.5 m t by 2030 taking base year as 2004-05 while the supply of food grains is projected as 265 m t based on projected population growth (0.95 per cent per annum), thus leaving a gap of 43.5 m t (Ramesh Chand, 2007) [12]. The National Commission on Farmers has also highlighted on the large yield gap between the yields at research stations and in farmers' fields and insisted that bridging of the yield gap remains a challenge. The current productivity of rainfed crops is about 1.0 t ha_1 and this can be enhanced to 1.5 t ha_1 by bridging the yield gap by popularizing the bet-bet practices.
Rainfed agriculture is a gamble with monsoon while rainfed soils in these regions are not only thirsty but are also hungry. The main natural resources are rainfall and soils which support the rainfed production systems and livestock are discussed below

Rainfall: India is blessed with a monsoon regime that is more or less regular in its cycle of onset, spread and withdrawal over the country. The southwest monsoon experienced by India is a part of the larger Asian monsoon circulation and provides a major portion of the annual rainfall of the country. India on an annual basis receives about 4 x 103 km3 (400 M ha m) of precipitation (FAI, 1994) [6] out of the 5 x 105 km3 precipitation received globally (Lal, 1994) [9]. India's share, thus, is about one percent of the global precipitation. The rainwater availability in different monsoon periods that indicates a major contribution is from the southwest monsoon (74%) as compared to northeast monsoon (10%). Of late, there is an evidence of erratic behavior of rainfall like increased frequency of high intensity rains, reduced number of rainy days and shift in rainfall. Most future scenarios indicate that there may not be a significant change in the total rainfall in the country in the years to come but the distribution could become more erratic with high intensity storms followed by long dry spells. The challenge is to harvest the monsoon during excess rainy events and re-use efficiently during dry spells for improving the yield and income per drop of rainwater

Soils: Alfisols and Vertisols of peninsular India and Aridisols of extremely dry climates are the principal soil orders in dry areas, although Entisols and Inceptisols also occur, especially in topo-sequences. Vertisols, Alfisols, Entisols and associated soils are the major soil orders extensively are under rainfed crops.

About 30% of dry land area is covered by Alfisols and associated soils while 35% by Vertisols and associated soils having vertic properties and 10% by Entisols of the alluvial soil regions (Virmani *et al*., 1991) [14]. For example, rainfall varies from less than 500 mm in the Vertisols area of Gujarat and alluvial soil region of Rajasthan and Haryana to >2000 mm in Alfisol and associated soil areas in eastern India. In the dry land areas of significant agricultural importance, the annual rainfall ranges between 500 and 1000 mm

Rainfed soils are extremely prone to rainwater induced erosion. As per the harmonized dataset, 73.3 m ha of arable land is affected by water erosion resulting in soil loss of more than 10t/ha/annum (*Anonymous* 2008) [4]. Apart from soil and nutrient losses, poor nutrient management is leading to multi nutrient deficiency of essential nutrients, which is posing a threat to rainfed agriculture.

Due to increased rainfall intensities, land degradation is likely to increase in future. The gap between nutrient supply and demand is likely to widen further by 2030 at 50 m tons of NPK. With phosphate and potash raw materials reserves depleting worldwide, the availability of chemical fertilizers may become increasingly difficult. Biomass recycling and legumes in the crop rotation are to be encouraged in order to sustain soil fertility in rainfed areas.

Production systems: Historically rainfed farmers practice high diversity in cropping systems with livestock integration which is an in-built risk management strategy. The cropping patterns have evolved based on the rainfall, length of the growing season and soil types. However, due to changed consumer preferences and market demand, farmers are substituting the crops which are more remunerative like cotton in place of castor. There is a sharp increase in area under maize and cotton in the past few years at the cost of coarse cereals like sorghum, pearl millet mainly due to higher returns. Such changes have implications on fodder availability to livestock. This trend is likely to further increase by 2030.

The change in cropping pattern will have implications on the resource use. Continuous mono cropping increases vulnerability of farmers to weather risks, depletes soil fertility, ground water and leads to build up of pests and diseases. This issue has to be dealt both through technology and policy. For example, we have to evolve management practices for farmers' choice of remunerative crops without degradation of the natural resource base and also define agro-ecological zones where such cropping systems can be adopted sustainably. Simultaneously, need based policy incentives are required to encourage farmers adopt agro-ecology-compatible cropping systems so that the farmers' income is maintained and the natural base of the country is not degraded.

Livestock: Livestock is an integral part of rainfed farming systems in India. India has world's largest livestock population accounting for about 55 and 16 percent of the world's buffalo and cattle populations, respectively. Rainfed areas account for two-thirds of total livestock population. India ranks second in goats (124.5 m out of world's 764.5 m) while third in sheep (59 m out of world's 1028.6 m) but of late there is a significant change in the livestock composition.

There is a steep fall in bullock's population with the share of farm animals in power supply declining from 71% in 1961 to 8% in 2006 and rise in number of cross-bed cows. India is globally the largest producer of milk with an annual production of 108.5 m t during 2008-09. Most of this production is coming from the rainfed regions where livestock population is large and is a major component of the livelihood systems. Currently the deficit in demand and supply of dry and green fodder stands at 12% and 63%, respectively and the gap is likely to be further widened with increase in demand for milk and meat products and change in cropping pattern like cotton at the cost of coarse cereals. There is a need to devote at least 10% of the net sown area for fodder production which is presently around 5% (*GoI,* 2006) [7].

Major agro-climatic zones of rainfed farming

Rainfed farming mainly consists of three major agro-climatic zones namely, arid, semi-arid and dry sub-humid having varied rainfall. The rainfall of different climatic zones is set out in

Table 1: Classification of climatic zones based on rainfall

Climatic zone	Rainfall (mm)
Arid	<500
Dry semi-arid	500-750
Moist semi-arid	750-1000
Dry sub-humid	1000-1600
Humid	>1600

Source: Virmani *et al*. (1991) [14]

Arid and semi-arid areas

These areas experience high variability in total amount, onset and recession of rainfall, high potential evapo transpiration (PET) and are prone to soil erosion. The soils are poor in fertility and water holding capacity. The dry land technology focuses on soil and water conservation, crop management, efficient cropping systems and integrated farming systems.

Dry sub-humid areas

Dry sub-humid areas constitute 7.64% of the total geographical area of the country. Over 25% of rainfed area receives an annual rainfall of 1000-1600 mm. The high rainfall in these regions is favourable to water harvesting. The soils are red loams, lateritic, alluvial and deep black in nature.

Crop Planning in Rainfed Areas

The rainfall and soil type play a major role in crop planning besides market demand. Of late, some commercial crops are grown in areas where rainfall and soils are not suitable. The sustainability of crops and cropping system depends upon efficient matching of crop with respect to requirement of soil type and rainfall. In dry lands, the depth of soil has got large implication on holding of rainwater which otherwise goes as runoff.

Water holding capacity of the soils

The water holding capacity of the soil depends upon the soil type and depth of the soil. For the sake of clear understanding, a simple approximation for the water holding capacity of the soil for one meter deep soil profile is shown in Table 3. Soils with high water holding capacity support double cropping while with low, only mono cropping that is single crop in rainy season only.

Soil Water Status and Crop Response

Water, one of the prime natural resources plays a crucial role in agriculture sector in general and rainfed farming in particular. Its use must be rationalized in time and space. In addition, water quality also plays an important role in the management of irrigation, which determines the salt buildup as well as soil health. Hence, the study of soil water status is of utmost importance in determining the behavior of crop response. It means that soil water status highly influences crop response. This refers to crop yield obtained per unit of land after using the various inputs like water, seed, fertilizer, pesticides, human labour, bullock labour/tractor power, etc. It means that crop response depends on various inputs and soil water to a greater extent in rainfed areas. However, some crops extract water from deeper layers and have deeper root system. The response of crop varies with stage of crop growth and some stages are very critical like flowering and seed set. Critical stages of few crops, which are sensitive to moisture stress, are set out in (Table 2). Any reduction in soil moisture at these stages results in poor crop yield. At these stages, t here is a need of supplemental irrigation which is possible only through rainwater harvesting in different structures like farm ponds, check dams, small tanks, percolation ponds, etc.

Table 2: Critical growth stages and moisture sensitive periods of important crops

S. No.	Crop	Moisture sensitive period
1	Rice	Primordial development, heading and flowering
2	Sorghum	Booting, blooming and milky stages
3	Wheat	Crown root initiation, flowering, milking and grain filling
4	Groundnut	Flowering, peg penetration and seed development
5	Sunflower	Two weeks before and after flowering
6	Cotton	Flowering to boll development
7	Sugarcane	Formative phase
8	Chilli	Flowering
9	Tomato	From commencement of fruit set

Water Requirement of Major Crops

Water requirement of crop is determined based on the calculated values of evapo transpiration (ET). These are computed using climatologically and soil parameters. Other quantities such as, deep percolation losses and water required for land preparations are added to the ET values. Water requirement for different crops grown under *kharif* and *Rabi* is set out in Table 3.

Table 3: Water requirement of different crops

Crop	Growing season	Water requirement (mm)
Rice	Kharif	1000-1500
Rice	Rabi	1200-1800
Sorghum	Kharif	450-600
Maize	Kharif	450-600
Wheat	Rabi	450-550
Finger millet	Kharif	400-450
Pearl millet	Kharif	400-550
Green gram and black gram	Kharif	250-400
Bengal gram	Kharif	350-450
Pigeon pea	Kharif	350-450
Groundnut	Kharif	350-500
Sunflower	Kharif	350-500
Sesamum	Kharif	300-350
Soyabean	Kharif	400-450
Castor	Kharif	500
Sugarcane	Perennial	1950-2750 (per year)
Banana	Perennial	1600-2200 (per year)
Lime	Perennial	900-1200 (per year)
Grape	Perennial	900-1200 (per year)

Crop planning for improving resource use efficiency

Crop planning implies an effort to put each piece of land to its optional use. The experience of the recent years has shown that economic factors and advanced technology have brought numerous changes in cropping patterns and the progressive farming community is fully conscious of it. We can only suggest in broad terms the crop zones, which are most efficient. The cropping pattern should be built around them. A farmer can select according to his resources what is most suitable for him. In fact the objective of crop planning would be to work out and popularize such crop rotations built around the most efficient crops of each region selected on the basis of their relative suitability for that region and raise the income of the farmers that would help in increasing the total production of different crops in the country.

It hardly needs to be emphasized that a silent revolution in agriculture is taking place and the changes in cropping pattern depend upon the advances in agricultural technology, chemical industry and economic factors. This is an age of specialization and if farmers in different soil - climatic regions can specialize in growing the most efficient crops of the region concomitant with the most efficient use of land, water, fertilizer and power, it will usher in an era of greatest prosperity for the country, through dry land agriculture.

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