AJES
ASIAN JOURNAL OF ENVIRONMENTAL SCIENCE
DOI: 10.15740/HAS/AJES/11.2/171-177
A REVIEW
VOLUME 11 | ISSUE 2 | DECEMBER, 2016 | 171-177 e ISSN-0976-8947 Visit us : *www.researchjournal.co.in*

Dryland agriculture in India – problems and solutions

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Article Chronicle :
Received **:**
16.06.2016;
Accepted **:**
30.11.2016

ABSTRACT : Dry land agriculture is the agriculture which limits the crop growth to a part of the year due to lack of sufficient moisture (Peterson *et al.,* 2006). 68 per cent of the cultivated area in Indian agriculture comes under dryland, which contributes about 44 per cent of the total food production and plays a critical role in India's food security. A vast majority of the small scale farmers depend on the dry regions for their livelihood. According to the Fourth five year plan of India, dry lands are defined as areas which receive rainfall ranging from 375 mm to 1125 mm and with very limited irrigation facilities. Dry regions are economically fragile regions which are highly vulnerable to environmental stress and shocks. Degraded soils with low water holding capacities along with multiple nutrient deficiencies and depleting ground water table contributes to low crop yields and further leading to land degradation. In order to ensure long term sustainability for dry land agriculture in India, various components are to be taken into consideration like socio-economic resources, integrated water shed development, improvement of rain water use efficiency, diversification of agriculture through livestock farming alternative land uses and integrated soil–nutrient-water-crop management. Dry land farming areas needs much closer attention.

HOW TO CITE THIS ARTICLE : Vijayan, Roshni (2016).Dryland agriculture in India – problems and solutions. *Asian J. Environ. Sci.,* **11**(2): 171-177, **DOI: 10.15740/HAS/AJES/11.2/171-177.**

Key Words :
Dryland Agriculture, Economy, Drought, Abiotic stress, Green revolution

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The earth's land surface is covered by drylands forming about 41 per cent which is inhabited by 2 billion people (about one third of world population). Drylands are areas with low soil moisture, high evapotranspiration which results in water deficit prevailing throughout the year. Thedrylands are not equally distributed between the rich and the poor nations. About 72 per cent of the global dryland are in the developing nations and rest 28 per cent falls in industrialized nations (Fig. 1) (*www. millenniumassessment.org*). In a country like India, where 44 per cent of the total food production being supported by drylands and thereby playing a critical role in nation's food security. With the increasing population food production has to be increased. A real need to second green revolution has been envisioned, which can be achieved by improving the dryland agriculture. Geographically dryland agriculture area in India includes the north western desert regions of Rajasthan, the plateau region of central India, the alluvial plains of Ganga Yamuna river basin, the central highlands of Gujarat, Maharashtra and Madhya Pradesh, the rain shadow regions of Deccan in Maharashtra, the Deccan Plateau of Andhra Pradesh and the Tamil Nadu highlands (Rao and Ryan, 2004 and Singh *et al.*, 2004).

Importance of dry land farming :

Characteristics of dryland agriculture in India :

– Rainfall: The most important

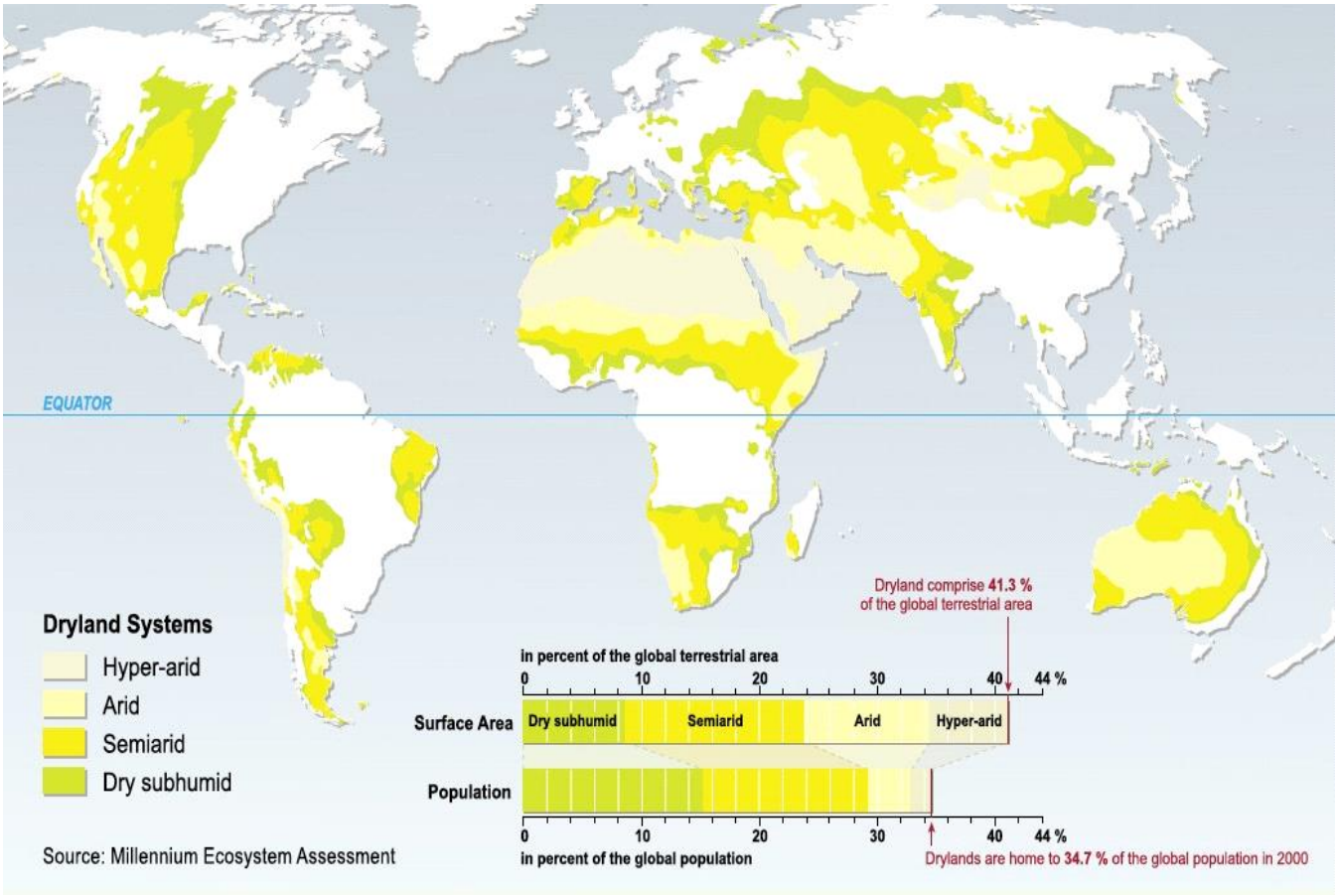

Fig. 1 : Dryland areas of the world
Source : ***http://oceanworld.tamu.edu/resources/environment-book/aridlanddegradation.html***

contributing character in the drylands is low rainfall, within a range of from 375 mm to 1125 mm which are unevenly distributed, highly erratic and uncertain. The crop production in drylands is mainly dependent on the frequency and intensity of rainfall making it a less productive.

– Soil: The major causes for land degradation include the chemical degradation of soil, loss of soil structure and texture, loss of natural vegetation leading to soil erosion. Sequestration of carbon also turns out to be a major problem, which further degrades the soil making it less productive (*ftp://ftp.fao.org*).

– Occurrence of drought: The extensive climatic hazards are seen in drylands as the soils are weak and can be subjected to environmental stress to a higher level, leading to further land degradation. Drought is a common scenario in drylands as water availability is less further leading to low productivity.

– Extensive agriculture: Prevalence of monocropping extensively makes farm lands lack of nutrients and result in reduction of yield.

– Crops grown: The crops grown in a particular region will be similar and are not much remunerative compared to the major crops like rice and wheat. When similar crops are grown, all mature at the same time and a large quantity of produce will reach the market leading to glut in the markets. This situation is severely exploited by the traders and the middlemen in the markets. The issue of marketing turns out to be a big problem in dryland agriculture.

– Poor economy of farmers: Economic status and of living of farmers is low in drylands, due to the less choice of the crops that are grown in these areas.

Contribution of drylands to Indian Agriculture :

Dryland agriculture has been in practice from time immemorial. The area under drylands has shown varied changes in the past decades. Contribution of dryland

agriculture is of utmost importance, as 44 per cent of the nation's total food production coming from the drylands. The increase in the irrigated area had an impact on dryland agriculture. The major crops of cotton and oilseeds had shown an increase in the area grown in drylands, where as pulses remain unchanged. These changes are mainly due to the factors of improved irrigation, socio-economic factors etc. and more importantly the impact of green revolution. The area under drylands in India is in a declining rate and is expected to be stabilized by 2050 at 75 million ha (Rao and Ryan, 2004 and Singh *et al.*, 2004).

Since 1950 a lot of changes have happened in the dry lands in terms of area and yield. The area which was initially under pearl millet and sorghum was replaced by more remunerative crops. This was seen with changes in cropping systems and food habits of the people in these areas. Pulses growing areas remained unchanged even though there was a shift of pulse growing area from one agro climatic zone to another. The area under cotton and corn was found to have a drastic increase mainly due to more irrigation facilities provided for these crops. In general, there has been an increase in productivity of dryland crops during a period of 50 years mainly due to the adoption of improved crop husbandry and farming technologies (Subba Rao, 2002).

Problems of dryland farming :

Soil and moisture problems :

Soils are highly diverse in the drylands of India. In semiarid regions, the alfisols and vertisols predominate, whereas in river basins inceptisols and entisols(alluvial soils) are seen and in desert regions, aridisols (Peterson *et al.*, 2006).

Crops grown in alfisols are subjected to severe drought stress, whereas those grown in vertisols have less severity to drought, due to its better water holding

Table 1 : Soil related constraints to advancing agricultural production in dryland agriculture of South Asia (Rao and Ryan, 2004)

Constraint	Aridisols	Alfisols	Inceptisols	Vertisols
Erosion by water	2	3	2	3
Erosion by wind	3	1	3	0
Compaction	3	3	3	3
Crusting	2	3	3	1
Trafficability	0	0	0	3
Salinization	2	1	3	3
Nutrient depletion	1	2	1	2
High soil temperatures	3	2	3	2
Drought stress	3	3	1	2
Soil organic matter depletion	3	3	3	3

0= none, 1= low, 2= moderate, 3= severe

Table 2 : Saline and waterlogged areas in canal command areas of India

Project	Waterlogged area(000` ha)	Potential irrigated area (%)	Saline/alkali areas(000` ha)	Potential irrigated area (%)
Ram Ganga (UP)	195.0	(9.7)	352.4	(17.6)
ShardaSahayak (UP)	260.0	(7.0)	253.3	(6.7)
Gandak (Bihar)	562.0	(52.9)	400.0	(38.1)
Sri Ram Sagar (AP)	60.0	(47.6)	1.0	(0.8)
NagarjunaSagar (AP)	33.1	(9.4)	26.4	(8.0)
NagarjunaSagar (AP)	114.0	(24.0)	69.2	(14.5)
Tungabhadra (AP)	30.0	(10.0)	14.8	(5.0)
Tungabhadra (Karnataka)	37.7	(7.4)	20.0	(4.0)
Kadana (Gujarat)	89.0	(38.7)	60.7	(28.7)
Chambal (MP/ Rajasthan)	98.7	(20.3)	40.0	(8.2)
IG Canal (Rajasthan)	43.1	(8.0)	29.1	(5.4)
Krishna (Maharashtra)	3.3	(30.9)	-	-
All Commands (Gujarat)	13.8	(6.1)	540.0	(23.9)

Source : Down to Earth *http://www.indiaenvironmentportal.org.in/content/soil-salinity-threatens-command-areas*

capacity. Vertisols are poor in infiltration leading to salinity . . . . . *et al.*, 2006). Alluvial soils of arid regions have low soil fertility, but respond well to inputs and are highly productive under irrigated conditions. Wind erosion predominates in aridisols.

Soil degradation has many related factors,with soil compaction and degraded levels of organic matter are found to be most important cause for south Asia as a

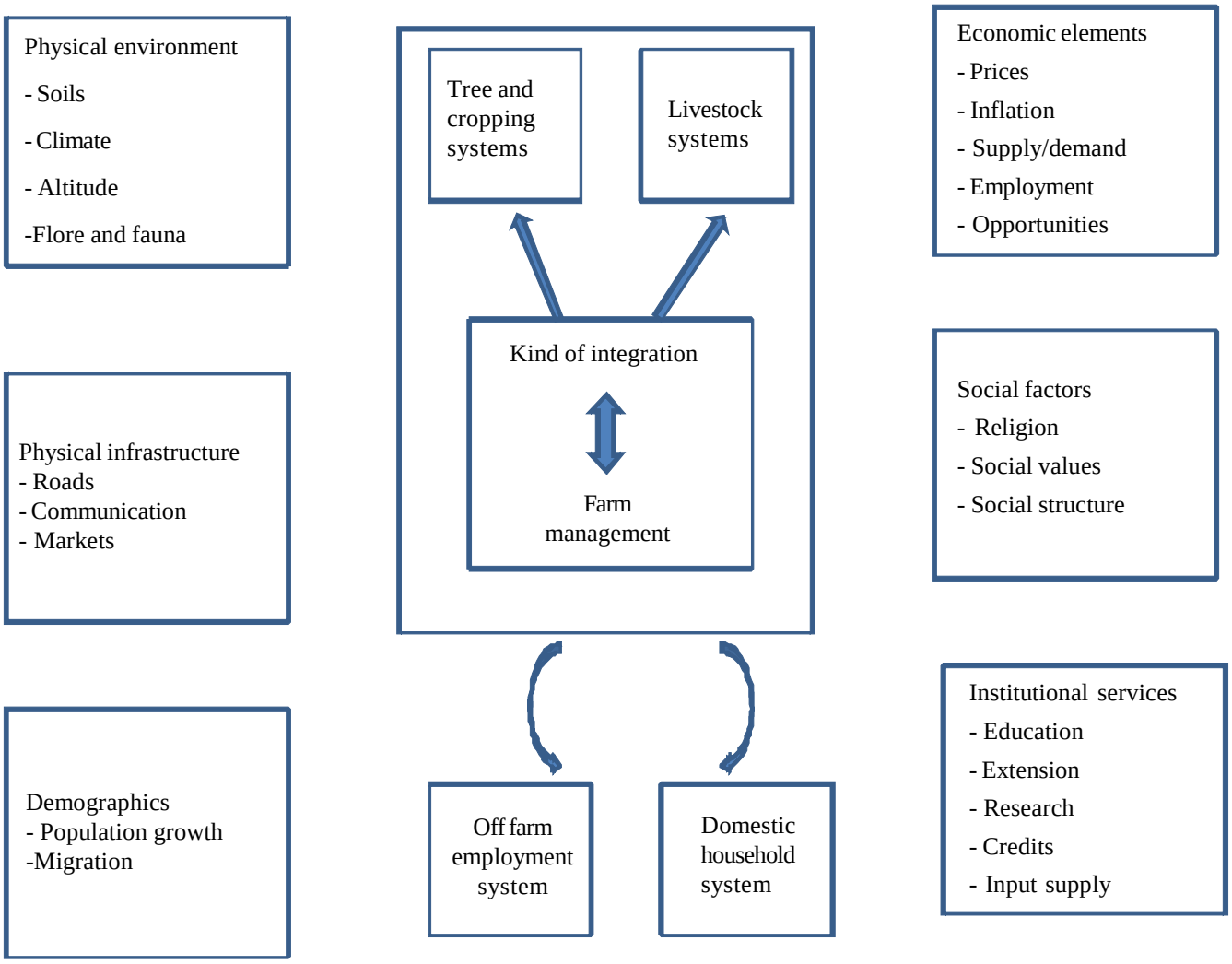

Fig. 2 : Integration of all the aspects inorder to achieve a proper management in drylands. Source (Rao and Ryan, 2004 and Singh *et al.*, 2004).

Table 3 : Crop substitution

Place	Year	Traditional crop	(yield q/ha)'	Alternate crop	(yield q/ha)
Bellary	1973	Cotton	2.0	Sorghum	26.7
Varanasi	1971	Wheat	8.6	Chickpea	28.6
Ranchi	1973	Upland rice	28.8	Maize	33.6
				Sorghum	44.5
Indore	1971	Green gram	11.8	Soybean	33.3
		Wheat	11.2	Safflower	24.2
	1972	Wheat	5.0	Safflower	32.7
Agra	1972	Wheat	10.3	Mustard	20.4
Hiasar	1973	Wheat	3.2	*Eruca sativa*	16.1
Bijapur	1972	Wheat	9.4	Safflower	18.5

whole (Table 1). Soil erosion by water is found to be the major cause in mountainous areas and in undulating terrains in Central India. With the improvement of irrigation facilities, Salinization has turned out to be a major cause for degradation of soils (Peterson *et al*., 2006).

Better utilization of the available moisture based on the soil type, crop grown are to be taken care of. Utilization of the available preserved moisture is an art that crops adapted to drylands possess. Water obtained during the sparse and irregular rainfall days are to be conserved inorder to make it available during moisture stress period. Water conservation measures are to be given more emphasis. Watershed based approach are found to be more productive in terms of water and soil conservation.

Environmental changes of water logging and salinity:

Soil degradation has a close link with water logging and salinity problems. Irrigation salinity has major impact on dryland crops. Over irrigation, poor drainage, improper irrigation for damaged soils etc. are the major causes for water logging and salinity. All these factors causes an increase in groundwater recharge and rise in water table, resulting in the accumulation on salts on the soil surface (*www.informaction.org*).These environmental changes results in reduction of yields and abandonment of lands which has facilities for irrigation. Estimates from Central Arid Zone Research Institute, Jodhpur predicts that 60 per cent of the command areas in India will develop water logging and salinity problems in a decade span (Table 2).

Dietary habits and nutritional characteristics of crops grown :

The choices of the crops that are to be grown in drylands are very limited. Oilseeds pulses and coarse grains like bajra are grown in drylands. Farmers have to purchase food grains and other needy items from the revenue they obtain from the sale of the crops grown. Since the dryland crops are not much remunerative leading to an economic imbalance. Crop substitution is another alternative. Farmers possess socio-economic reasons for growing traditional crops which are not high yielding. But when markets are developed, it can bring about changes in the food habits. Introduction of long staple varieties of cotton to irrigated areas made less demand to dryland cotton, making the land available for alternative crop of sorghum in bellary area (Table 3) (Spartt and Chowdhury, 1978).

Probable solutions :

Agronomic approaches :

The primary objective to dryland farming is to preserve the soil and water, inorder to achieve maximum productivity. Agronomic approaches are developed based on the land terrain concerned. In the undulating terrain, soil erosion being the major constrain. Gullies can be seen in areas with severe erosion. Management of such areas can be achieved by stabilizing the soils by forestry and pasture, with regulated grazing. The land can be further developed by contour bunding and terracing. In marginal lands with poor fertility proper application of fertilizer are beneficial. But these lands possessing reduced moisture, deep placement of fertilizers are needed. Drylands near the river beds are to be given management based on the onset of monsoon. Since these drylands are prone to floods in certain part of the year. Crops grown should be able to manage drought stress, as these areas lack irrigation and should be harvested before the floods. Agronomic measures that has to be followed in plain dry lands tracts to increase the soil productivity can be achieved by proper tillage, proper management of the time of sowing, fertilizer management, selection of proper cropping systems suitable to the area like double cropping, alley cropping, use of better cropping pattern for specific locations, proper weed control and plant protection measures (*www.world-agriculture.com*).

Engineering approaches :

Various engineering approaches are utilized for conservation of soil and water by the collection of excess rainwater, regulation of runoff, managing evaporation and seepage losses. Lands with 3-5 per cent slopes are subjected to contouring, which preserves moisture and prevents soil erosion. The opening of ridges and slopes across the slopes reduces the flow of water and makes it to percolate into the soil. Compartmental bunding to areas with less than 1 per cent slope provides even spreading of water to the entire area. Water harvesting measures are utilized for improving the moisture status of the soil. Construction of check dams, farm ponds are other measures being utilized (*www.world-agriculture.com* and Gunnell, 2003).

Breeding aspects :

Even though the crop husbandry is being taken up in drylands with farmers depending on the unreliable rains, it has many limitations to make it productivity by just utilizing agronomic and engineering measures alone. With the development of suitable varieties and utilization of proper technologies will give a wholesome solution for increasing the productivity in the drylands. The new plant types are to be developed which posses all the necessary characters for the drylands. The particular ideotype should have short duration of growth, extensive root growth, basic modifications necessary for growing in drylands and drought tolerance.

An ideal plant suitable for growing in drylands should possess seedling vigor and short duration, deeper roots with good branching, dwarf plants with less but erect leaves to capture more sunlight, moderate tillering to reduce competition, resistance to pests and diseases, efficient photosynthetic machinery to convert more inputs into yields (*www.world-agriculture.com*).

Innovation in technology transfer :

Inorder to achieve stability in dryland production, an integration of long, medium and short term technologies are needed. The technologies developed must be in a watershed basis with people's participation. Methodologies should be developed to initiate and encourage farmers' participation in dryland agriculture. Participatory rural appraisal, group interaction of farmers to know more about farmer perception are to be utilized for the better understanding of a programme to make it beneficial for the dryland farmers (Rao and Ryan, 2004 and Singh *et al*., 2004).

Grass root level extension is to be the prime criteria. Even though there is tremendous growth in agricultural research and education, a vast number of farmers are not been exposed to the improved technologies which are been developed. This results in reduction in the final output of the whole improvement of the drylands. Nongovernmental organization having linkages with farmers has been working well in many parts of Indian drylands. The self-help group approach is also gaining momentum in many states of India. All the approaches put together will help to develop the land for a sustainable production (Rao and Ryan, 2004 and Singh *et al.*, 2004).

The indigenous technical knowledge (ITKs) which are present in the farming communities on the various aspects of farming could be refined with the modern research facilities. The refined ITKs are more readily accepted by the farmers (Rao and Ryan, 2004 and Singh *et al*., 2004).

Other technical knowledge of remote sensing can also be utilized in mapping the drylands based on various criteria and further utilization into development of area based projects.

Conclusion :

There is no one solution for the dryland farming to make it more productive. Dryland farming must be an integrated approach of all the system (Fig.2). Mainly the ignorance of the land users makes it more and more vulnerable to further degradation. Each dry environment is distinct in its own; solutions developed should be based on the basic needs of the local conditions prevailing in that region.Soil, water and all the natural resources are never taken for granted, these resources when utilized in a judicious manner gives maximum output. Green revolution of the 1960s was oriented on growing improved varieties and the present day emphasis should be a sustained development of agriculture especially in dryland areas.

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