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Dry land integrated farming system - A Review

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ABSTRACT

In India, nearly 100 million ha of land is under rainfed cultivation and therefore, rainfed agriculture will continue to play an important role in the Indian economy. The disappointing results of conventional cropping systems in advancing the productivity of small farms were the driving force in the development of farming systems research. It views the whole farm as a system with the integration of crops, animals, soils, workers, other inputs and environmental influences wherein the farm family attempts to produce outputs within the limitations of its capability and resources and the socio-cultural setting. Development and adoption of **i**ntegrated farming system will help in productivity enhancement, employment, income generation and nutritional security both for human and livestock. The different components of the system have complementarities with waste products of one component becoming source of food and energy for other components. Considerable research efforts are being made in evolving situation specific integrated farming system. Literature on dry land integrated farming system is reviewed and presented below.

Key words: Rainfed farming.

Characteristics of dry farming: In India, weather plays an important role in crop production under dry land situation. Dry land constitutes nearly 62 per cent of the total cropped area of 142 m. ha. in the country contributing about 42 per cent of total food production (Reddy, 2000).

Dry land is characterized by highly fragile resource base and mainly depends upon the prevailing weather conditions. Among them, rainfall is the major deciding factor. Erratic and ill-distribution of rainfall coupled with high rates of evaporation in dry climate often lead to periods of water deficit and has serious implications for stability of crop production (Aggarwal and Kumar, 1993).

Singh (1995) opined that the length of growing period varied from 60 to 300 days due to variations in total rainfall, its distribution, potential evapotranspiration and soil water storage. The important soil groups are vertisols and alfisols and their associated orders, which are characterized by low organic matter and poor nutrient status particularly with nitrogen, phosphorus, sulphur and calcium. The main constraints that limit crop production in dry land are moisture stress and deficiency of nutrients. Poor soil fertility and low water holding capacity also lead to poor crop yields in dry farming regions (Sheshshayee *et al.*, 2003).

Present farming system in dry land area is characterized by low and unpredictable yield due to an inefficient use of rain and soil, rare use of fertilizers, high yielding varieties and improved soil conservation measures (Pathak and Laryea, 1995). Efficient resource management, improved crop production technologies and alternate land use systems are the key issues to increase the productivity of dry land areas (Singh, 1995). Important crops cultivated in dry land were sorghum, cotton, soybean, groundnut, sunflower and pulses (Singh *et al.*, 2000). Approximately 30 to 60 per cent reduction in potential crop yield was due to abiotic stresses and majority of it is attributed to drought (Sheshshayee *et al.*, 2003).

The low and highly erratic distribution of rainfall is a major cause of instability in production and low yields in many of the dry land crops. Cultivation of crops adopting traditional farming systems without use of fertilizer inputs has also contributed to low productivity. Most of the rainfed ecosystems possess marginal soils with poor soil fertility (Velu, 2011).

Tamil Nadu comes under the ecozone of bimodal rainfall in which the mean annual rainfall is around 700 mm received during two seasons. Scarcity of water and drought is fairly common in dry land (Virmani, 1995). Red loamy

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soil predominates in dry land of Tamil Nadu, with some sandy alluvium and red sandy soil. The red loam soil type contains bunker gravel and this type is the best land for rearing livestock. The soil is rich in calcium and phosphorus. Crops grown in dry land of Tamil Nadu are cotton, finger millet and sorghum. During the monsoon season, millet and sorghum are grown (Policy note, 2010).

Integrated farming system in dry land: The selection of enterprises must be based on the cardinal principle of minimizing the competition and maximizing the complementarity between the enterprises.

In Uttar Pradesh, it was observed that crop + dairy + goat farming followed by crop + goat farming had the maximum potential (Singh and Sharma, 1987). Similarly, Singh *et al.* (1988) suggested the integrated farming system with goat and sheep rearing under dry land of Punjab region of India.

Integration of dairy + biogas + silviculture for garden land condition and cropping + goat under rainfed situation were the best model for the Western Zone of Tamil Nadu (Rangasamy *et al.*, 1990). Possibility of raising small breeds of livestock and poultry in rainfed uplands of Eastern India when a cereal and grain legume crop formed an integral part of the farming system (Singh *et al.,* 1993a). Kale (1999) and Das (2001) have also reported similar findings. Phengvichith (1998) stated that to realize the potential contribution of livestock in a crop-livestock system, appropriate system oriented technology must be generated on farm to ensure social acceptability and economic viability.

Predominance of milch cows, goats and buffaloes along with cropping in dry land was observed by Radhamani (2001) for Western Zone of Tamil Nadu. For one hectare area of dry land, integration of sorghum + cowpea (grain), sorghum + cowpea (fodder) and *Cenchrus glaucus* each in 0.33 ha intercropped in *Emblica officinalis* with tellicherry goat (5+1) in 0.01 ha could be recommended against raising sole sorghum crop alone.

Integration of goat (11+1), rabbit (7+1) and pigeon (10 pairs) with crop component cumbu (G) + soybean (G), maize (F) + cowpea (F), *Cenchrus ciliaris* -+ *Stylontanthes scabra* was identified as the best model for one hectare dry land area of Western Zone of Tamil Nadu (Thirukumaram, 2002).

In an integrated farming system along with crop components, goat, pigeon, buffalo, agroforestry system and farm pond were integrated by Esther Shekinah *et al*. (2005). Tellicherry breeds were maintained for meat purpose. Buffaloes were maintained solely for milk. The farm pond was dug for collecting the runoff to be used in times of moisture stress and silt collection. Through the quantification of physical indicators, the study led to the conclusion that farming systems with enterprise combination of cropping (fertilized with composted buffalo manure), pigeon (10 pairs), goat (5+1), buffaloes (two milking buffaloes + one calf), agroforestry and farm pond could be recommended for the dry land tracts of Western Zone of Tamil Nadu.

Integrated farming system with two bullocks + one cow + one buffalo + 10 goats along with poultry and duck was the most beneficial system for the marginal farmers in rainfed regions of Chhattisgarh in Central India (Ramrao *et al.,* 2006)

Integrated farming system approach with combination of crops (rice, off-season tomato, cauliflower) and non-crop enterprises like poultry + paddy straw mushroom production + vermicomposting was sustainable system giving maximum net return and additional employment under rainfed risk prone situations in Deogarh district of Orissa (Barik *et al.,* 2010).

Components of integrated farming system in dry land: Arable farming ends in narrow profit or less margin to the farmers, warranting development and adoption of integrated farming systems involving various possible combinations of components.

Economic contribution: According to Acharya *et al.* (1987), buffaloes had a significant financial advantage in both irrigated and unirrigated areas. Pandey (1988) proposed the inclusion of dairy buffaloes to improve income and employment sustainability of existing cropping patterns in India.

On a sandy loam soil at Hissar in Haryana, Kadian *et al.* (1992) reported that net return was higher with linkage of buffalo enterprise followed by cows along with cropping. Arvind and Jain (1992) recommended the adoption of buffalo component on small farms in Punjab to increase farm income and labour employment. Deoghare and Bhattacharya (1993) reported that goat and sheep provided the most valuable source of income in the semiarid tropics and the sale of goat contributed 30.0 per cent of total farm income in India.

Milk yield was sustained in buffaloes when integrated with the crop component sorghum and cowpea raised at 2:1 ratio was reported by Gupta *et al*. (1994). Rangasamy (1995) revealed that integration of sorghum grain crop (0.20 ha) + sorghum fodder crop (0.20 ha) + Subabul and *Cenchrus ciliaris* as an intercrop (0.20 ha) + *Acacia senegal* and *Prosopis cineraria* (0.20 ha) with tellichery goats (20 + 1) increased the net income. Out of the total income

from the integrated farming system, 59 per cent was from goat rearing. The additional net income realized from integrated farming system was Rs.5672 ha^{-1} $year^{-1}$ as compared to cropping alone. The additional employment gained through integrated farming system over cropping alone was 314 man days ha^{-1} $year^{-1}$.

According to Devendra (1998), small ruminants like goat and sheep form an important economic and ecological niche in Asian mixed farming systems. Senthilvel *et al.* (1998) suggested the integration of cropping with rainfed fruit trees and goat rearing in dry land resulted in a considerable increase in income of small and marginal farmers of Southern Zone of Tamil Nadu. San Nu Nu and Deaton (1999) reported that integration of sheep in rubber plantation had a scope to increase the net income by 38 per cent in small holding.

Maximum net return of Rs. 12,593 was obtained from one hectare of wheat-sugarcane rotation with a buffalo in Rohtak (Singh *et al.*, 1999). While working on the profitability of different combination of farm enterprises, Basavaraj and Gangadharappa (1999) recorded an average net profit of Rs. 42984 ha^{-1} from sugarcane + dairying + sheep rearing.

In an integrated silvipasture based farming system for dry land, among the animal components, rearing goat recorded higher income followed by milch cows (Vairavan *et al.*, 2000). Radhamani (2001) reported that integration of crop + tree + goat system provided higher net return than cropping alone for Western Zone of Tamil Nadu under rainfed situation.

In the rainfed black soil areas in southern Tamil Nadu, tree legumes like *Leucaena leucocephala, Acacia senegal, Prosophis cineraria* and perennial fodder grass with inclusion of six goats yielded an additional income of Rs. 12500 per year from a farm area of 1.6 ha (Ramasamy *et al.*, 2007).

Employment generation: The various enterprises linked in the integrated farming system increase the scope for labour employment, especially in the dry land situation where the farm families remain unemployed for two thirds of a year as cropping occupies only a part of the year during the monsoon season.

Raising of crop alone generated 400 man days of employment as against 904 man days in integrated farming system with six buffaloes (Pandey and Bhogal, 1980). Goat rearing as a way of employment generation had been documented by Rai and Singh (1982).

Under dry land conditions, rearing of sheep or goat generated more employment opportunities. The sheep or goat rearing on grazing had always been profitable (Nehra *et al.*, 1992 and Singh *et al.*, 1993b) and also provided constant and regular employment to farm family. Singh (1996a) reported that the highest labour employment of 58.3 per cent was recorded with large flock goat rearing especially on grazing.

Average labour employment per household per year from goat, sheep, buffalo and crop farming were 23.3, 1.9, 33.1 and 41.1 per cent respectively in Uttar Pradesh (Deoghare, 1997). In arid zone of Rajasthan, additional employment was generated through adoption of silvipastoral or hortipastoral systems with sheep or goat rearing (Gajja *et al.*, 1999).

According to Radhamani (2001), the additional employment gained through integrated farming system with crop + goat was 314 mandays ha^{-1} $year^{-1}$ under rainfed vertisols. Sivamurugan (2001) stated that integration of cropping with dairy + biogas + mushroom generated the highest employment of 875 mandays.

Integrated farming system in dry lands with sorghum + cowpea, *Leucaena leucocephala* + *Cenchrus ciliaris*, *Acacia senegal* + *Cenchrus ciliaris* with integration of goat generated an additional employment of 113 mandays ha^{-1} annually. Integration of crop + dairy + biogas + silviculture + spawn production could generate an additional employment of 562 mandays than cropping alone under irrigated garden lands. A herd of 200 goats under integrated farming system provided full time employment for two persons throughout the year (Ramasamy *et al.*, 2007).

Resource recycling: In small holder farming systems, crop and livestock complements and competes with each other in terms of natural resource use.

Vikaraman Nair *et al.* (1976) observed that there was little loss of nutrient from the field as those fodder crops removed were returned in the form of cattle manure in integrated farming system. Senthilvel *et al.* (1998) have reported that recycling of goat manure to cropping enhanced the productivity and soil fertility at Aruppukottai, Tamil Nadu. Recycling of wastes in a crop-livestock integration contributing to enhance the soil fertility through nutrient recycling and organic enrichment of soil had been reported by Sajise (1998) and Devendra (2000) in dry land and rainfed environments. Alam *et al.* (2000) stated that the manure availability of 12 tonnes from a pair of draught cattle integrated in the farm was diverted to crop area to maintain soil fertility.

Integrated farming system provides excellent opportunity for organic recycling and it reduces farmer's dependency on external or market purchased inputs. It offers

good scope for recycling of crop byproducts and residues to the livestock and livestock waste as valuable manure to crop activity (Vairavan *et al.,* 2000). Application of 50 per cent nitrogen through fertilizer and 50 per cent through goat manure enhanced the soil fertility status and provided better opportunity for recycling of manure to the crops was observed by Radhamani (2001) under vertisols of Western Zone of Tamil Nadu.

Jayanthi *et al*. (2003) reported the effect of integration of dairy and goat components along with cropping for better utilization of resources. Crops and crop wastes were used as a feed resource for animals and the manure from the livestock enterprises were recycled as a source of nutrients to the crop, thereby supplying the nutrients harvested back to the soil. Integration of crop with pigeon, goat, buffalo, agroforestry and farm pond combination resulted in enhanced residue generation and increased efficiency of waste recycling (Esther Shekinah *et al*., 2005).

Enterprise combination in a farming system resulted in higher nutritive output than cropping alone. Highest residue addition (11583 kg year^{-1}) was possible with crop + pigeon + goat + buffalo +agroforestry + farm pond with a nutrient value of 105.9, 46.2 and 76.9 kg NPK respectively (Ramasamy *et al.,* 2007). Recycling of crop residues and animal manure from integrated farming system components about 5.3 tonnes of compost was obtained with 1.6 tonnes as vermicompost and 3.7 tonnes as biocompost. This could supply 26.0, 22.3 and 26.0 kg NPK to field and fodder crops through biocompost and 39.4, 10.5 and 18.0 kg NPK to vegetable crops as vermicompost in one acre of land area (Jayanthi *et al.,* 2007)

Integration of seasonal vegetable (bitter gourd – tomato – bottle gourd) with food crop (rice – potato - onion), goat and vermicompost resulted in higher productivity than cropping alone under irrigated upland condition. Recycling of vermicompost and goat manure in the system not only reduced the cost of cultivation by saving fertilizer but also improved the soil health (Shivani *et al.,* 2010).

CONCLUSION

After reviewing the farming situation, the result indicated that there is a lack of proper linkages between the different components existing in the system. Technological interventions have indicated an overall improvement in the system with increased economic status of the farming family. Integrated farming systems approach is profitable and more sustainable than the conventional sole cropping system. Study of the physical indicators helps in the evaluation of the enterprise combination in farming systems. Through the quantification of physical indicators *viz.,* employment generation, nutritional status, energy equivalents and the resource and residue recycling, optimization of enterprise combination was possible. The nutritional security offered by the systems apart from the efficient bioresource utilization, residue recycling and employment generation makes such approaches effective for farmers of the dryland tract.

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