

Integrated farming systems

for risk resilience and higher income in rainfed agriculture

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Rainfed agriculture is predominant in arid, semi-arid and sub-humid regions of the country and has a crucial role to play in sustaining the economy and food security of India. At present, about 51% of the net-sown area is rainfed, contributing about 40% of the total food production, supporting 40% of human and 60% of livestock population. However, aberrant behaviour of monsoon rainfall, multiple nutrient deficiencies, declining groundwater table and poor resource base of the farmers are major constraints for low and unstable farm production in rainfed areas. In addition, climate variability including extreme weather events resulting from global climate change poses a serious threat to rainfed agriculture. The farming systems approach is considered as important and relevant especially for the small and marginal farmers. The integrated farming systems (IFS) approach has the potential to overcome multifarious problems of farmers including resource degradation, declining resource-use efficiency, farm productivity and profitability.

Keywords: Farm productivity, Integrated farming systems, Rainfed agriculture

FARMING system is a complex inter-related matrix of soil, plants, animals, implements, power, labour, capital and other inputs controlled in parts by farming families and influenced to varying degrees by political, economic, institutional and social forces that operate at different levels. The term farming system refers to a particular arrangement of farming enterprises that are managed in response to the physical, biological and socio-economic environment and in accordance with farmers' goals, preferences and resources. A common characteristic of rainfed integrated farming systems (IFS) is that they invariably have a combination of crop and livestock enterprises and in some cases include combinations of poultry, agroforestry, horticulture, apiary etc. Further, there are synergies and complementarities between different enterprises that form the basis of the concept of IFS. Integration usually occurs when outputs (usually by-products) of one enterprise are used as inputs by another within the context of the farming system. The synergy between enterprises increases with on-farm diversity and is fundamental to the IFS concept. Diversification of farming activities improves the utilization of labour, reduces unemployment in areas where there is a surplus of underutilized labour, enhances resilience to climate change, and provides a

source of living for those households that operate their farm as a full time occupation.

Farming systems are highly location-specific depending on the natural resources available in a given agro-climatic situation. The success of an IFS and its sustainability depends entirely on strengths and weaknesses of the internal factors like natural resources (soil and water), farm size, availability of recyclable residues, labour and external factors such as market prices, infrastructure and the level of post-harvest processing. Development and adoption of location-specific rainfed integrated farming system modules would result in: *in situ* recycling of organic residues including farm wastes generated at the farm to reduce the dependency on external inputs; reduction in cost of production through effective use of byproducts and enhanced input-use efficiency; minimize risk associated with dependence on a single farming enterprise; conservation of natural resources and; food security, employment generation, enhanced system productivity and income/unit area.

Watershed based farming systems

In rainfed areas, rainfall is the only source of water and its efficient utilization is important for successful

crop production. In the 1980s, All-India Coordinated Research Project for Dryland Agriculture (AICRPDA) centres provided technical support to ICAR Model Watersheds and many alternate land use systems such as agroforestry, agri-horticulture and silvi-pasture systems were developed to suit variable agroclimatic zones of the country. An initial evaluation of Model Watershed Programmes implemented by GOI-ICAR-State Departments during 1984–1988 at 47 locations across the country has clearly revealed the beneficial impact of watershed approach in terms of increased water availability (both surface and groundwater), increase in productivity of crops, increase in the availability of fodder and fuel, and generation of employment in rural (watershed) areas.

In regions with rainfall of 500–700 mm, the farming systems should be based on livestock with promotion of low water requiring grasses, trees and bushes to meet fodder, fuel and timber requirements of the farmers. In 700–1100 mm rainfall regions, crop, horticulture and livestock based farming systems can be adopted depending on the soil type and the marketability factors. Runoff harvesting is a major component in this region in the watershed based farming system. In areas where the rainfall is more than 1100 mm, IFS module integrating paddy with fisheries is ideal. There are several modules of rainfed rice cultivation along with fisheries in medium to low lands of rainfed rice growing regions in the eastern states of India.

Farmer/family centric farming systems

In this system, the focus is on the individual households particularly of small and marginal farmers and their livelihood security. In this approach, the strengths and weaknesses of the traditional farming systems followed by the farmers need to be assessed, based on which selective production enhancement and enterprise diversification interventions are introduced.

An integrated farming system module comprising 35.4% area under cereals, 25.7% under pulses, 21% under oilseeds, 17.3% under commercial crops and 1.2% area under fodders along with backyard poultry (6 birds per household) was found to be ideal for small and marginal farmers in Dharwad region of Karnataka. The poultry component played a major role in stabilizing the farmers' income during drought years.

The integrated farming system model in dryland vertisols at Kovilpatti (Tamil Nadu) showed that crop + goat (4) + poultry (20) + sheep (6) + dairy (1) recorded the highest net income (₹17,598/ha/year) followed by crop + goat + poultry + dairy (₹14,208/ha/year), while



Small ruminants in rainfed IFS

the conventional system having crop cultivation alone gave a net income of only ₹2,057/ha/year (Table 1). The animal waste from cows (20–22 kg/animal/day), sheep and goat (400–450 g/animal/day) and poultry litter (40 kg/batch of 20 broilers) were collected and applied to the field, which resulted in improved soil fertility and crop yields. Employment increased from 185 man-days/ha/year in the conventional cropping system to 389 man-days/ha/year in the integrated farming system model.

Integration of sheep rearing in a crop based farming system offers gainful employment in rainfed areas. Agri-sheep farming involving cotton on one ha of arable land and rearing of 10 lambs gave a net return of ₹27500/ha as compared to growing cotton alone (₹8700/ha) in Warangal district of Telangana. Similarly, in eastern and central dry zones of Karnataka, the net income from rainfed groundnut based production system ranged from ₹5,059/ha with crop production alone to ₹22,000/ha with groundnut + dairy + sheep (8–10) for marginal farmers. With respect to small and large farmers, the crop + dairy system recorded higher net income, whereas the crop + sheep farming system was more economical for medium farmers. In scarce rainfall zone of Andhra Pradesh at Anantapur, the highest net returns were recorded with groundnut cultivation (2 ha) + poultry (₹43,360) followed by groundnut cultivation + dairy (3 buffaloes) (₹40,606) while sole crop of groundnut (2.6 ha) recorded the net returns of ₹14,872/ha.

The net income from individual and combined farm enterprises among different categories of 120 farmers in rainfed areas of Karnataka revealed that the small farmers realized higher net income (₹31,000) from crop + dairy + dryland horticulture + sheep compared to other farming system modules. Similarly, both medium and

Table 1. Performance of different farming system models at Kovilpatti, Tamil Nadu

Farming system	Net income (₹/ha/year)	Benefit:cost ratio	Employment (man-days/ha/year)	Sustainability index
Crop alone	2057	1.28	185	-23.0
Crop + goat + poultry	8274	1.92	297	12.3
Crop + goat + poultry + dairy	14208	1.72	343	46.1
Crop + goat + poultry + sheep	7265	1.47	343	66.6
Crop + goat + poultry + sheep + dairy	17598	1.75	389	65.3

large farmers realized higher net income (₹49,250 and ₹1,05,000, respectively) from integrated farming systems involving crop + dairy + dryland horticulture + sheep than other systems. For the southern transitional agro-climatic zone of Karnataka, a one acre farming system model was developed on a micro-watershed basis by integrating agriculture, horticulture, agroforestry, silvi-pasture, green manure crops, hedge plants, kitchen garden, apiary, cattle, fish and poultry components besides rainwater harvesting from the nearby farm building. This model has demonstrated the synergies realized by integrating food, fodder, fruits, fibre, fuel and fish components for meeting nutritional and economic security on a sustainable basis. Similarly, a farming system involving crop + dairy + sheep + poultry + sericulture + fodder generated a higher net income (₹1,15,584/ha) closely followed by crop + dairy + sheep + goat + fodder system (₹1,04,078/ha) compared to other farming system models under rainfed conditions of Chamarajnagar district (Karnataka).

In Banaskantha district (Gujarat), in a rainfed farming system of 1.76 ha, introduction of improved crop varieties, integrated nutrient management, *in situ* moisture conservation, mineral nutrition to livestock and cultivation of napier grass on bunds improved the system productivity by 18.8% compared to traditional farming system and gave higher net returns (₹92444/year) and employment generation (353 man-days/year) compared to traditional farming system (₹77800/year).

In Tumakuru district (Karnataka), different interventions such as improved variety of finger millet (GPU 28), intercropping in pigeonpea + cowpea (1:1), vaccination (FMD), mineral mixture, deworming, trace minerals for infertility animal, hormone treatment, treatment for mastitis, and improved fodder variety (COFS 29 multi-cut) in a rainfed farming system of a marginal farmer (1 ha) improved the crop yields

compared to traditional farming system. Further, the interventions improved the system productivity, employment generation and net returns compared to

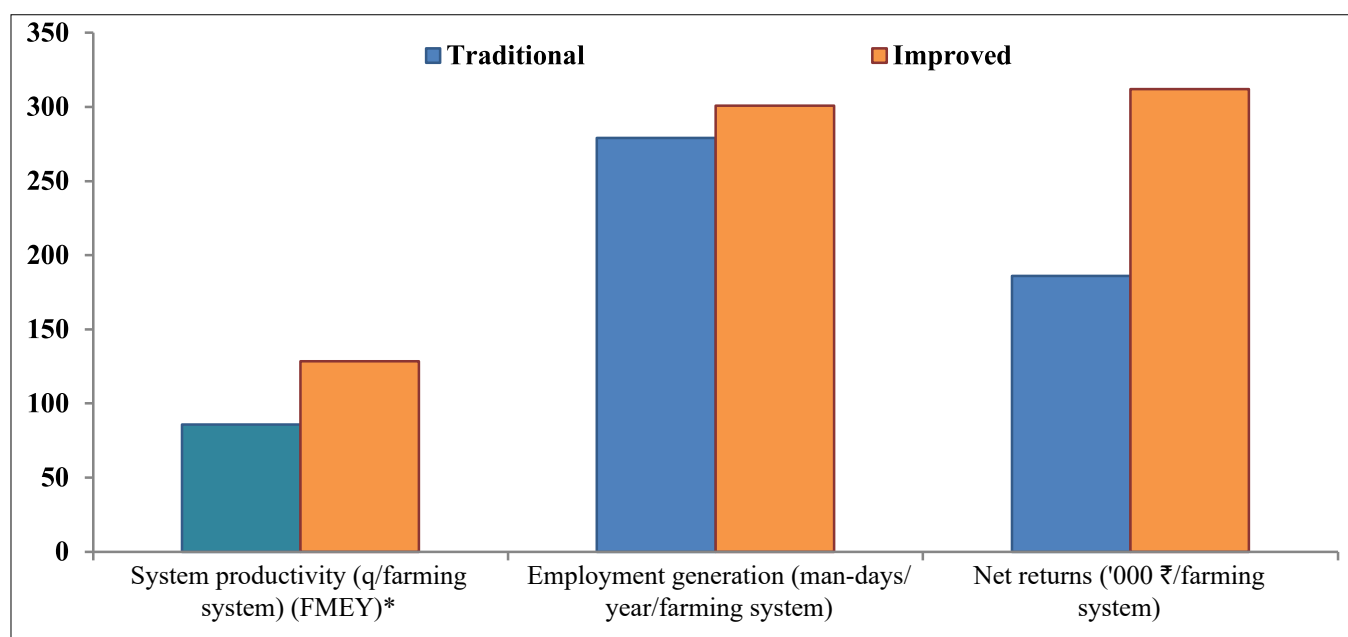


Performance of finger millet var. GPU-28

traditional farming systems.

In rainfed rice-based farming system in Odisha, conserving excess water in the refuges at the downstream of rice field and rearing of fish recorded the highest net returns (₹21,197/ha) with B:C ratio of 2.78 as compared to the growing of rice alone (₹15,294/ha). In Jharkhand, rice + fish (mixed carps)-wheat system enhanced the net returns (₹58,557/ha) as compared to the farmers' practice of rice-fallow system (₹2,770/ha). In another study in Jharkhand, fish-cum-pig rearing along with paddy cultivation increased the net returns (₹53,100/ha) with a B:C ratio of 4.12 as compared to farmers' practice of rearing fish alone in the ponds (₹12,125/ha).

The livestock based farming systems in rainfed agriculture are complex and generally based on traditional socio-economic conditions. An understanding of production factors (livestock, capital,



Effect of different interventions on performance of rainfed farming system of a marginal farmer (FMEY: finger millet equivalent yield)

feed, land and labour) and processors (description, diagnosis, technology design, testing and extension) that affect animal production is pre-requisite for livestock integration. The productivity of livestock in farming systems in rainfed agriculture can be improved by increased fodder production as an intercrop with cereals, relay and alley cropping, forage production on bunds, improving the feed value of stover by chopping, soaking with water, urea treatment, strategic supplementation of concentrate, urea molasses etc. Establishment of fodder banks in areas where surplus fodder is available, artificial insemination, removing low grade animals through castration and adoption of preventive measures like vaccination and de-worming through health camps improve the productivity of milch animals.

In Chhattisgarh, a mixed farming (crop-livestock) module of 1.5 acre for marginal farmers was developed with the employment generation of 316 man-days, net income of ₹33,076/year against crop cultivation alone with employment generation of 165 man-days and net return of ₹7,843/year. Similarly, the integrated farming system with 4 bullocks + 2 cows + 2 buffaloes + 25 goats along with other subsidiaries like poultry and duck was the most beneficial system which can augment the income of tribals in Chhattisgarh.

SUMMARY

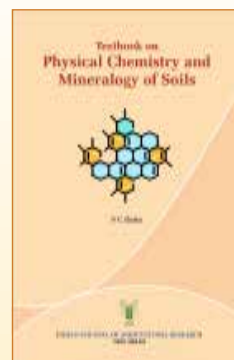
Climate change and climate variability are expected to adversely impact natural resources quality and agricultural productivity. The farming systems approach is considered as important and relevant especially for the small and marginal farmers as location-specific IFS will be more resilient and adaptive to climate variability. The IFS approach also has the potential to overcome diverse problems of farmers including resource degradation, declining resource-use efficiency, farm productivity and profitability. On-station and on-farm research in different regions of the country has resulted in identification of a number of climate resilient and profitable IFS models for rainfed regions. These models need to be validated and replicated in respective domain areas. Although the advantages of IFS are well established, there are still several constraints in upscaling the IFS models. The most important is the location specificity of the models and declining family labour availability for farming. Post-harvest processing and establishing market linkages adds further value to the farming systems approach.

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Textbook on Physical Chemistry and Mineralogy of Soils

Physical chemistry of soil and soil mineralogy are the two pillars which form the basic foundation of soil science. Once the students become familiar with these basic concepts, they can easily understand the other properties of the soil, say physical and biological properties, pedology and soil fertility. To become an expert of soil fertility, comprehensive knowledge of all the soil properties is essential which in turn is supported by the knowledge of physical chemistry of soils and soil mineralogy.

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