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Integrated farming systems of valley regions: Food and nutritional security

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Abstract
Farming systems research is a multi-disciplinary holistic approach to solve the problems of food insecurity. Small and marginal farmers are the core of the Indian rural economy constituting 80 % of the total farming community but possessing only 36 % of the total operational land. The declining trend of per capita land availability poses a serious challenge to the sustainability and profitability of farming systems. Under such conditions, it is appropriate to integrate land-based enterprises such as dairy, fishery, poultry, duckery, apiary, field and horticultural cropping within the farm, with the objective of generating adequate income and employment for these small and marginal farmers under a set of farm constraints and varying levels of resource availability and opportunity. The integration of different farm enterprises can be achieved with the help of a linear programming model. For the current review, integrated farming systems models were developed, by way of illustration, for the marginal, small, medium and large farms of eastern India using linear programming. Risk analyses were carried out for different levels of income and enterprise combinations. The fishery enterprise was shown to be less risk-prone whereas the crop enterprise involved greater risk. In general, the degree of risk increased with the increasing level of income. With increase in farm income and risk level, the resource use efficiency increased. Medium and large farms proved to be more profitable than small and marginal farms with higher level of resource use efficiency and return per Indian rupee (Rs) invested. Among the different enterprises of integrated farming systems, a chain of interaction and resource flow was observed. In order to make farming profitable and improve resource use efficiency at the farm level, the synergy among interacting components of farming systems should be exploited. In the process of technology generation, transfer and other developmental efforts at the farm level (contrary to the discipline and commodity-based approaches which have a tendency to be piecemeal and in isolation), it is desirable to place a whole-farm scenario before the farmers to enhance their farm income, thereby motivating them towards more efficient and sustainable farming.

Keywords: food security, farming system, dairy, fishery, poultry, duckery

1. Introduction
Farming System Research/Extension (FSR/E) considers farmers and their problems in a comprehensive manner using an interdisciplinary approach that complements the existing research and development activities related to agriculture. Farming System Research helps to understand small farming systems and to improve the agricultural research and extension. These include the farm household and its needs, objectives, biological, economical and human dimensions. In developing countries (mostly in publicly funded research organisations such as the CGIAR centres such as CIMMYT, ICTA, IITA, ICARDA or IRRI). They wanted to address the fact that small holder farmers were not adopting the technical recommendations derived from disciplinary, commodity-oriented research. Recommendations derived from this type of research were targeted at commercial farms and were, in general, unfit for the priorities and conditions of smallholders. Thus, originally farming systems research focused on smallholders and resource poor farmers in developing countries. The goal of farming system research is to understand farmer's livelihood to consider the complexity of the real world in which farmers and farm families live and make decisions; to understand the complexity and diversity of farmer values and know-how. These influence their decision-making, their information processing, their combination of activities on- and off-farm, and ultimately their design of productive processes and the interaction with ecological processes. It is also intended to include multi-scale approaches, connecting the farm to the landscape, connecting the farm with the markets, the farmers and other rural stakeholders, livelihoods and territories. These interactions result in the diversity and heterogeneity of farming systems. Early farming

systems work was dominated by crops, which then widened to include livestock (esp. in less-favoured areas) and crop-livestock interactions as well as aquaculture and trees (agroforestry). Currently there are no limitations to what types of enterprises are considered (energy production, direct marketing, services, agro-tourism, health care, education, etc.). Also, there is no longer a focus on the effect of introducing a new technology. Assessing the repercussions of introducing a new enterprise in an existing system is just as important and may follow a similar pattern.

The Farming Systems Approach (FSA), can be seen as a 'school of thought' that spans a wide range of theories and methods. Farming systems approaches share a number of key elements, as they are interdisciplinary in nature. Farming systems always combine natural and social sciences, e.g. agronomy, ecology, plant breeding, livestock sciences, economics, anthropology, rural sociology. FSA understands the farm and household as one system. This implies that much attention is given to interactions like those between technical and social components and resource allocation decisions, biotechnical and ecological processes. Also FSA have a dynamic approach: with on-going changes in public policies, society's expectations, market prices or local opportunities, research focuses on the ability of farmers to cope with uncertainty and complexity. A shift from the farm system per se to a hierarchy of systems within which the farm is one of a number of levels (crops, communities, region, markets, policy, etc.). Each level knows complex interactions (e.g. within a cropping system: crop plant population, soil, soil organisms, weeds, insects, pathogens, etc.; within a farm: crops, livestock, trees, household members). Similarly, there are complex interactions between different scale-levels (e.g. a cropping pattern is influenced by natural conditions (soil, climate), institutions, agricultural policy, world market prices, etc.). These multi-scale approaches have led to studies at the landscape level, as well as studies that focus on market chains. A farming system, by contrast, is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. Depending on the scale of the analysis, a farming system can encompass a few dozen or many millions of households. The interaction of natural resources, climate and population determines the physical basis for farming systems. During the early stages of development, increased population generally leads to an expansion in cultivated area and, in many cases, conflict between the different users of land and water resources. Once most good quality land is already exploited, further population increases tend to lead to the intensification of farming systems. As forests and woodlands come under greater pressure, biodiversity is threatened and there may be growing tension between development and conservation goals. These trends have often been exacerbated by colonial and post-colonial forces that have concentrated indigenous or minority peoples on poorer quality land - thus aggravating the degradation problem. New technology enters the rural agricultural sector from two major sources. Until 1972, farmers themselves were the main suppliers. Traditional production system evolved through their efforts in selecting plants, in perfecting such simple tools as the hoe and plow, and in designing crop mixtures and rotations over the years of farming. Yet in today's conditions shrinking natural resources and rapidly rising human populations, traditional production systems are increasingly failing to meet the food and income needs while some are in danger of breaking down altogether. In short, farmer's efforts alone are no longer enough. The second major source of new agricultural technology is science and its intervention. Through research, scientists increase their understanding of the basic physiological mechanisms that conditions plants and animal growth, of the genetic basis for desirable traits in crops and livestock, of the factors that contribute to resource degradation and of the policies and practices that can arrest this process and bring about sustainable increase in production in the rural areas. Farming System Research and Extension (FRS/E) need to be applied more widely to make agricultural production more relevant to the resource capacities of the farmers and environment. Various aspects of FSR/E including the concept, characteristics, associated models, issues concerned with adoption and its importance in the rural development. The economic and social benefits from agricultural research can be extremely high. The dramatic advances in productivity achieved in the green revolution in irrigated North West India in the late 1960s is perhaps the internationally best-known example. The green revolution strategy was evolved in an era when the problem of poverty and hunger was largely seen as problem of production, for growing more food. It concentrated mainly on those farmers and those areas with the greatest apparent potential for producing more food. If it favoured the better-endowed areas, this was justified since they presented the conditions in which the new high-yielding technologies generated on research stations could most readily be adopted. (Singh *et al*., 2013) [11]. Of late, there have been significant shift in understanding of poverty and hunger, and setting priorities. In terms of national economy, total food production remains very important, and it is estimated that the aggregate gross demand for food grains would be 225 million tonnes by 2000 AD. Attention has now shifted towards giving higher priority to raising and stabilizing production on rainfed lands which constitute about 70 percent of the total cropped area contributing roughly 45 percent of total food production. Attempts are now being made to direct our agricultural research towards the needs and interacts of those who were largely by-passed by the green revolution technologies, the 60 million farm families who are resource poor having less than 2 ha of land for providing social justice, increasing production and employment opportunities. Therefore, in the rural areas with its poor resource base and unique production problems, an approach other than the conventional green revolution strategies need to be thought of. Agricultural research organized traditionally in disciplinary or commodity lines and without adequately involving the social scientists has frequently lacked a farming systems perspective. Moreover, conventional research typically has been mostly conducted on research stations under conditions that are not representative of farmer's fields and with little or no farmer involvement. Experiments in farmer's fields ensure that technologies are formulated under farmer's conditions and overcome the difficulty of using experiment station results to make farmer recommendations particularly where experiment stations are not representative of the area because of intensive management practices or locations (Singh *et al*., 2007) [9].

2. Existing farming systems: This paper covers mostly mountainous regions of North East India (NEI). It includes the Arunachala Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura states. A farming system is the result of complex interactions among a number of inter-dependent components, where an individual farmer allocates certain quantities and qualities of four factors of production, namely land, labor, capital and management to which he has access (Mahapatra, 1994) [6]. "The household, its resources and the resource flows and interactions at the individual farm levels are together referred to as a farm system" (FAO, 2001) [7]. Farming systems research is considered a powerful tool for natural and human resource management in least developed countries such as India. This is a multidisciplinary whole-farm approach and very effective in solving the problems of small and marginal farmers. The approach aims at increasing income and employment from small-holdings by integrating various farm enterprises and recycling crop residues and by-products within the farm itself (Behera and Mahapatra, 1999; Singh *et al*., 2006) [1, 8]. The most commonly existing farming system in north east hilly regions are given below in the table 1 and table 2.

Table 1: Farming systems of highly hilly areas

SI. No.	Farming Systems	Major crops/breeds	Important features
1.	Agri-AH-Horti-Fishery	Paddy, Potato, Vegetable, Aquaculture, Pig, Poultry	Rain fed irrigated, Deep Soil, Monoculture of Paddy, Tropical climate.
2.	Horti- Agri-AH	Citrus, Ginger, TRC-Paddy, Maize	Tropical to Subtropical Climate, Rainfed irrigated. Hot summer and moderately cool winter.
3.	Agri-AH	Paddy, Maize Pig, Cattle, Poultry	Tropical to Subtropical Climate, Rain fed irigated
4.	Agriculture+ Livestock farming (Agri-AH)	Rice, Maize, Orange, Pineapple, Local and Jersey cow, Hampshire and local Pig, poultry etc.	Family farming, State farming (MBF, Sagalee) and SSF, Sonajuli, Home consumption and commercial farming
5.	Agriculture + Horticulture	Rice, Maize Mustard, Pineapple, Ginger, Cabbage and chilly	Family farming, Personal farming, Home comsumption and commercial farming.
6.	Livestock farming + Agriculture + Horticulture	Both jersey and local cow, Pigs (Hampshire) and local, Poultry, Rice, Maize, Orange, Pineapple, vegetables	Family farming, Personal farming, Home comsumption and commercial farming
7.	Silviculture + Agriculture + Horticulture	Teak, Gamari, Albizzia sp., Rice, Maize, Sugarcane, Orange Pineapple	State farming (SFRI, Itanagar), Family Farming
8.	Livestock farming + Fisheries + Agriculture + Horticulture	Fisheries (Rohu, catla, Mrigal), Pig, Poultry, Cattle, Rice Maize, Potato, Pineapple, and others locally consumed vegetables.	Family farming, Commercial farming

***Source*:** Sanjeev *et al*. (2010) [10]

Table 2: Farming systems of medium and low hilly areas

SI. No.	Farming System	Major crops/breeds	Major Feature
1.	Agriculture	Rice-potato/mustard/ Pea/blackgram Rice+Soybean Maize+Soybean	Better use of growth resources including light nutrients and water. Suppression of weeds, reduce plant and disease incidence. Yield stability and high economic return
2.	Horticulture	Banana+turmeric/ Ginger Treebean+turmeric/ Ginger Guava+turmeric/ Ginger Pineapple+guava +turmeric/ Ginger Banana	Banana/Guava/ Tree bean given shade to ginger and turmeric. Better utilization of resources improvement of soil health and agro-ecosystem. Yield stability and high economic return.
3.	Agri-Horti.	Maize+banana+alocasia Rice+Rice bean Sugarcane+Mustard +Onion Tree bean+ginger/ Turmeric+guava	Space more effectively. The tree bean have foliage tolerant of strong light and high evaporative demand and give required shade to ginger/turmeric. Yield stability and high economic return.
4.	Agri+Horticulture +livestock	Maize+banana alocasia+pig (Hampshire)	Alocasia, banana stem and maize are fed to pigs. The litter of pigs serves as manure for banana and other crops**.**
5.	Agri+ Fishery	Rice+magur+IMC	Fish fingerlings of IMC are release in the paddy fields in a ring bunded fields during their growth and put back in the ditches around when the paddy fields become dry.

***Source*:** Sanjeev *et al*. (2010) [10]

3. General production constrains

Non-availability of seed of newly developed high yielding varieties followed by imbalanced use of fertilizer are major constraints in enhancing the crop productivity under crop production component of improved package of practices as constraint. Kadam *et al*. (2003) [5], Singh and Singh (2005) [12] and Choudhary *et al*. (2007) [3] also reported similar findings. About 87.7% farmers reported lack of crossbred and exotic breed animals, followed by lack of artificial insemination and medical facilities for cattle as major constraints in livestock enterprise. The lack of availability of improved good planting materials suitable for local conditions was reported by 87.5% of framers as the important constraint in the horticulture component. Imbalanced use of fertilizers lack of knowledge of improved package of practices was the reason of low productivity of horticultural crops for 78.1 and 68.7% farmers. About 91% farmers could not get seeds of newly developed high yielding varieties. About 84% farmers faced imbalanced use of fertilizers as constraint and about 51% farmers felt lack of knowledge. To implement the agricultural technology interventions, farming system study is very crucial and hence, improves agricultural technology interventions in the area. Past experiences show that most of the time technologies disseminated to the farmers did not bring the required change on the livelihood of the farming community. This is mainly due to lack of detail farming system analysis of the environment in which the technology are disseminated. Moreover, farmers` perspectives have been not adequately considered in the development and dissemination of technology to alleviate their problems. Therefore, conducting farming system study is very important to develop and disseminate appropriate agricultural technologies that fit to the environment, which is also important for further agricultural research and development intervention in the area. (Sanjeev *et al*., 2010) [10]

3.1 Agriculture
1. Traditional cropping without scientific management practices (All FS)
2. Poor soil fertility (All FS)
3. Rodent, termite, stem borer, gall midge, gundhi bug, leaf folder, and leaf roller attack in paddy (All FS)
4. Poor yield of local varieties of paddy, pulses and oilseed (All FS)
5. Non adoption of fertility management practices in all crops (All FS).
6. Attack of stem borer/ top borer in maize (All FS)
7. Lack of irrigation facility (All FS)
8. Lack of knowledge regarding production and use of organic manures
9. Lack and soil conservation techniques.
10. Lack of knowledge about IPM/ INM of different crops (All FS)
11. Lack of knowledge about scientific agronomic practices for different crops (All FS)

3.2 Horticulture
1. Poor performance of local and of fruits and Vegetables (All FS).
2. Lack of availability of quality planting material citrus, pineapple, litchi (All FS).
3. Lack of knowledge about propagation technique of banana, citrus, litchi (All FS).
4. Lack of knowledge about scientific orchard management technology of citrus, pineapple (All FS).
5. Lack of knowledge about scientific nursery raising technique in vegs. (All FS)
6. Lack of knowledge about nutrient mgt. technique of citrus, litchi, pineapple, and banana (All FS).
7. Lack of knowledge about insect-pest & disease mgt. technique of fruits and vegetables (All FS).
8. Lack of knowledge on fruits & vegetables. Preservation & processing (All FS)
9. Lack of awareness on utilization of underexploited crops (All FS)
10. Lack of knowledge & awareness on scientific 0f ornamentals flowers (All FS)
11. Lack of knowledge & awareness on cultivation of mushroom, (All FS)

3.3 Fishery
1. Lack of suitable region specific fish farming technology with respect to different altitude of Lohit district.
2. Lack of knowledge about different aspects of scientific fish culture.
3. Lack of knowledge about composite fish culture (All FS)
4. Lack of knowledge about low cost integrated fish farming systems (All FS)
5. Lack of awareness about scientific fish husbandry practices (All FS)

3.4 Animal Husbandry
1. Parasitic infection of pig and goat (All FS)
2. Poor feeding in respect of cattle, poultry and pig (All FS)
3. Use of local breed of cattle, pig and poultry (All FS)
4. Lack of knowledge about scientific rearing system of poultry and pig (All FS)
5. Lack of knowledge on scientific disease management of cattle, pig & poultry (All FS 6)
6. Lack of knowledge about quality feed (All FS)
7. Use of local breeds of poultry and pig (All FS)
8. Lack of awareness about improved breeds (All FS)
9. Lack of knowledge about integration of different enterprises (All FS)

4. Research gap Identified in Farming Systems
4.1 Agriculture
1. Varietal evaluation for direct sown upland paddy
2. Varietal evaluation for transplanted paddy
3. Varietal evaluation for greengram / blackgram
4. Varietal evaluation for rapeseed / mustard
5. INM for upland paddy on hill slope
6. IPM for upland paddy on hill slope
7. Resource management technology
8. Cropping system research

4.2 Horticulture
1. Varietal evaluation of fruit and vegetable crops.
2. Poor performance of local var. of fruits and vegetables
3. INM for Fruits and vegetables
4. IPM for upland paddy on hill slope
5. Lack of availability of quality planting material.
6. Lack of standardized propagation technique of fruits crop.
7. Lack of efficient orchard management technology
8. Lack of efficient nutrient mgt. technique.
9. Lack of efficient insect-pest & disease mgt.

4.3 Fishery
1. Lack of suitable region specific fish farming technology
2. Lack of knowledge about different aspects of scientific fish culture

4.4 Animal Husbandry
1. Lack of knowledge on scientific management of livestock
2. Parasitic infection
3. Poor livestock feed
4. Poor performance of local breed.
5. Improper housing

5. Nutrients flow as affected by cropping systems
In India, besides agriculture's contribution to GDP, the sector typically generates about 75% of employment (especially for women), about 70% of export revenues and about 90% of national food need. Attempts to increase agricultural production and food consumption are destabilized by rapid population growth. Consequently, crop productivity is declining as a result of intensive farming, which leads to soil loss through erosion and declining soil fertility. Furthermore nutrient mining is extensive on many smallholder farms of India and is worsened by continuous cropping, inadequate nutrient replenishment in relation to plant demand, and high rates of soil erosion, leaching and removal of crop residues from the fields. As a result, soil fertility has continued to decline to levels that are currently prohibitive to profitable agriculture. Advancing food security and environmental sustainability in farming systems require an implementation of integrated soil fertility management that minimize the mining of soil nutrient reserve and degradation of soil physical and biological properties. Sustainability of agricultural systems is regarded as key to the development of sustainable agriculture-management systems which is a major

global concern due a number of environmental factors. Thus Integrated Soil Fertility Management (ISFM) is widespread as a strategy that can address the complexities and peculiarities of soil fertility management on smallholder farms, help low resource endowed farmers mitigate problems of poverty and food insecurity by improving the quantity of food, income and resilience of soil productive capacity. Nutrients flow analysis is a key to plan, implement and monitor ISFM technologies for sustainable soil fertility management. Studies have revealed that North East India has one of the most severe declining nutrient rates in Asia. Without investment in land improvement, soil erosion and soil fertility decline will continue, leading to low agricultural productivity and hence increased food insecurity and reduced cash income. Nutrient-balance assessments are valuable tools for delineating the consequences of farming on soil fertility as well as to assess the sustainability of agro-ecosystems and provide information to answer the question whether changes in productivity are to be expected. Furthermore such analyses help in the design of effective policy which supports improved soil fertility management by small-holder farmers. In addition, in case of imbalances, the major in- or outgoing fluxes can be identified and nutrient management and/or land-use strategies may be adapted accordingly. In other words it is important to calculate and monitor nutrient flows to quantify the impact of integrated nutrients management systems on soil fertility and sustainable agricultural productivity. However there are a limited number of long-term studies monitoring the nutrient status of soils, nutrient balances, and crop productivity in North East India.

Hilly area of North East India has been the focus of a debate concerning the ability of the environment to support increasing populations primarily dependent on farming and livestock for their livelihoods. This debate has centred on the sustainability of integrated farming practices in the light of competition for use of resources between farmers and herders, and the need to increase agricultural output to provide for the increasing populations. It is feared that as present population densities increase, land degradation will result. Soil fertility declines as a result of cultivation, and land cannot support extended periods of agriculture unless it is left fallow for long periods of time in jhum cultivation systems, or large inputs of nutrients are added to the soil to compensate for the nutrients removed through cultivation. Traditionally, small-holder farmers in hilly areas of India have improved soil fertility through fallowing of land, or the use of manure and small amounts of fertilizer under integrated farming systems. However it is feared that these methods may not be sufficient to maintain soil fertility in the light of recent population increases.

Amounts of nutrients into cost values, based on the price of inorganic fertilizers, and considered the cost of the nutrient deficit in relation to the value of the harvested crop. The result was that the value of the deficiency of nutrients was equal to 40% of the value of harvested products. The permanent traditional cropping systems typically offer low returns, and will probably continue to be entirely dependent on soil mining, so that long term sustainability seems quite unlikely. Nutrient balances by countries, using national statistics, FAO yearbooks etc. For heterogeneous countries such as India, the overall figure is hard to relate to a specific farming system, and it was admitted that ``the supranational scale inevitably encompassed numerous assumptions, estimates, simplifications and aggregations''. However, the results of many studies also showed that nutrient mining was occurring. The review of research in India concluded that traditional farming systems, using little or no fertilizer but involving fallow, seem to have kept soils at low or stable fertility for the last 30±50 years, at low yields (500± 600 kg/ha of millets and groundnut). As populations increase, it is necessary to determine how farmers can increase yields while maintaining soil fertility. It has been noted that some areas of North India support farming in areas of higher population density. In hilly areas of North India, only a few areas supported rural population densities greater. Since then rural populations have increased all over North East India, and concern has mounted over the sustainability of these developing farming systems. The areas of high population density which have supported farming since the 1960's or earlier merit further investigation, to determine if they represent sustainable farming practices, and what can be learned from them.

Partial nutrients flow and balance from various studies show that nutrient depletion is a major problem in the study area. Highest amount of nutrients are significantly allocated in wetland fields of low valley lands which highlights the affirmation that the value and marketability of the crops produced are therefore critical factors in the decision to invest in soil fertility improvement in integrated farming systems. Thus farmers may not necessarily be concentrating nutrients around their homestead because of the short distance. Rather, farmers apply nutrients in plots which they perceive to be fertile and secure to produce satisfactory yields. N, P and K balances are negative in bean, maize-bean, cassava, groundnut, maize, onion, sorghum and tomato and positive in rice, banana and banana-bean cropping systems. The results from different experiments in India especially North East India brought the following recommendations forward: Famers in study area should adopt Integrated Nutrients Management strategies under integrated farming systems which perceived as the judicious manipulation of nutrient inputs (mineral fertilizers, organic inputs, deposition, nitrogen fixation, sedimentation and subsoil exploitation of nutrients by deep-rooted crops or trees), outputs (harvested or marketable farm products, residues/manures, leaching, gaseous losses, erosion and human wastes) and internal flows. Finding of this study provides a starting point of sustainable integrated soil fertility management strategies policies development. A special attention should be put to fertility management and alternative solution for less fertile soil (uplands in particular), especially for farms that have reduced land size.

6. Economics of Farming Systems

Economic analysis of different sub-systems exhibited higher economic return from Dairy (Econ. B: C 6.93), Plantation (Econ. B: C 6.75) and Piggery-based farming systems (Econ. B: C 6.06) than existing cropping systems in Hilly tracts of Bengal. Vegetable became an income generating systems in almost all the regions of the state and vegetable based sub-systems registered higher economic return in Lateritic red soil zone (Econ. B: C 4.76), Coastal saline belt (Econ. B: C 7.02), Old alluvial zone (Econ. B: C 6.29), New alluvium or Gangetic alluvium tract (Econ. B: C 3.69) and Terai zone (Econ. B: C 4.44). Orange became a profitable fruit crop in Hilly tracts, where orange based sub-farming systems exhibited economic return of 3.46. Sugarcane became popular in Lateritic red soil region that generated a return of 2.85. Fishery and betel vine-based sub-farming systems dominated in the Coastal saline zone of the state, exhibiting an economic return of 4.42 and 3.88 respectively (Chatterjee *et al*., 2013)

[13]. Baruipur sub-division is famous for guava cultivation where fruit-based farming systems showed high economic return (6.44) in this region. Jute cultivators dominated the north Bengal and Gangetic alluvium tract of the state, but Terai zone exhibited better economic return from this short-duration cash crop (Econ. B: C 3.33). Old alluvium tract exhibited an Economic B:C of 2.60 for jute-based sub-systems. New alluvial zone is famous for vegetables cultivation and orchard (Banana and Papaya). Fruit based sub-systems also exhibited a higher economic return (3.99) (Table 3). All types of farmers in several pockets of the state have shifted to vegetables and fruit cultivation, owing to better irrigation and extension support, in recent times (Mitra and Pathak, 2008). Overall, diversified farms showed a relatively higher cost-benefit ratio. Increasing dependence on costly external inputs has rendered an increase in cost of cultivation for less diversified farms, relative to system net return, irrespective of farm types

A characterization survey of 144 farmers was conducted during 2010-11 in Chittorgarh and Rajsamand districts of southern Rajasthan. Crop-livestock and croplivestock-horticulture farming systems were adopted by 66 and 34% of the farmers. Among different enterprises, crop production contributed 71 to 74% to total income of crop-livestock farming system and 23-29% in crop-horticulture-livestock farming system. The contribution of livestock in total income of farming system ranged from 23 to 29%. Horticulture contributed 11 to 35% to the total income of farming system. Large farmers received Rs. 49,852 and Rs. 37,385 ha-1 more net income than small and medium category of farmers, respectively, from crop-animal husbandry farming system and Rs. 87,710 and Rs. 51,161 ha-1 more from crop-animal husbandry-horticulture farming system, respectively. Study revealed that 91% of the farmers in Chittorgarh and Rajsamand districts face non-availability of quality seed as a major constraint. Lack of cross-bred and exotic breed animals resulted in low productivity of animals for 87.5% of the farmers. About 87.5% farmers suggested the need for making available good quality planting material for horticultural crops (Singh *et al*., 2013) [11].

Four major types of farms, based on the source from which maximum gross income was earned by the farmers, were identified. These were – rice-based farming system (34 households), vegetable-based farming system (70 households), fishery-based farming system (10 households) and farming system based on off-farm income (20 households) (Goswami *et al*., 2014).

7. Conclusion

It is concluded that the integrated farming system approach is the unique system for food and nutritional security of peoples living in hilly regions of the country specially North Easter part of India. Integrated farming systems provide health food which is free from all the contaminations and provide all the necessary nutrient requirement for human. It is not only provide health food for human but also increase in soil fertility and productivity of hilly soils through addition of various crop residue to soils directly and in the form of manures as farm yard manure, compost and green manuring etc. The integrated farming systems are only options to farmers in hilly areas to sustain a long period productivity and production. In such regions we cannot suggest intensive farming system because of limited natural resources as land, labour and capital and low fertile soil having acidity problems, no irrigation facility and, lack of fertilizers, seeds, modern crop techniques.

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