

## SUSTAINABLE RURAL LIVELIHOOD SECURITY THROUGH INTEGRATED FARMING SYSTEMS - A REVIEW

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### ABSTRACT

This is a very complex and serious problem, when share of agriculture in gross domestic product is declining, average size of land holding is contracting and number of operational holdings is increasing. It is imperative to develop strategies that enable adequate employment and income generation, especially for small and marginal farmers who constitute more than 80 percent of the farming community. Under the gradual shrinking of land holding, horizontal expansion of land based enterprises is not possible. Hence, vertical integration land based enterprises within the socio-economic environment of the farmers will make farming more profitable and dependable. Therefore, Farming systems approach is a valuable approach to addressing the problems of sustainable economic growth for farming communities in India. Hence, integrated farming systems are viewed as a sustainable alternative to commercial farming systems particularly on marginal lands with the objective of reversing resource degradation and stabilizing farm incomes. The literature on the contribution of integrated farming systems in achieving sustainable rural livelihood security has been reviewed in this paper.

**Key words:** Integrated farming systems, Livelihood, Rural, Sustainable.

The Indian economy is predominantly rural and agricultural. Indian agriculture has responsibility of providing national as well as household food and nutritional security to its spilling over millions. Widespread occurrence of ill-effects of green revolution technologies in all intensively cultivated areas like Punjab and Haryana is threatening the sustainability of the important agricultural production systems and national food security. The declining trend in size of land holding poses a serious challenge to the sustainability and profitability of farming. The average size of the landholding has declined to 1.16 ha during 2010-11 from 2.28 ha in 1970-71. If this trend continues, the average size of holding in India would be mere 0.68 ha in 2020 and would be further reduced to 0.32 ha in 2030 (Agriculture Census, 2010-11).

This situation in India calls for an integrated effort to address the emerging issues. It is imperative to develop strategies and agricultural technologies that enable adequate employment and income generation, especially for small and marginal farmers

who constitute more than 80 per cent of the farming community. The integrated farming system approach is considered to be the most powerful tool for enhancing profitability of farming systems. These integrated farming systems required to be planned, designed, implemented and analyzed for increasing productivity and profitability. These systems also need to be socially acceptable, economically viable and eco-friendly. Integration of enterprises lead to greater dividends than single enterprise based farming, especially for small and marginal farmers. It also leads to improvement in nutritional quality of daily diet of farmers.

**What Is Sustainable Rural Livelihood:** Conceptually 'livelihood' denotes the means, activities, entitlements and assets by which people make a living. Assets are defined as natural (land and water), social (community, family and social networks), political (participation and empowerment), human (education, labour, health and nutrition), physical (roads, clinics, markets, schools and bridges) and economic (*jobs*, saving

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and credit). The sustainability of livelihoods becomes a function of how men and women utilize asset portfolios on both a short and long-term basis. Sustainable livelihoods are those that are able to cope with and recover from shocks and stresses such as drought, civil war and policy failure through adaptive and coping strategies (Jirli *et al.*, 2008). Capability, equity and sustainability combine in the concept of sustainable livelihood.

The concept Sustainable Rural Livelihood (SRL) is an attempt to go beyond the conventional definitions and approaches to poverty eradication. These had been found to be too narrow they focused only on certain aspects or manifestations of poverty, such as low income, or did not consider other vital aspects of poverty such as vulnerability and social inclusion. It is now recognised that more attention must be given to the various factors and processes which either constrain or enhance poor people's ability to make a living in an economically, ecologically and socially sustainable manner. The SRL concept offers a more coherent and integrated approach to poverty alleviation. To achieve sustainable rural livelihoods different livelihood capitals such as human capital, social capital, natural capital, physical capital and financial capital would play a greater role to cope with shocks and stresses and maintain or enhance the individual's capabilities and assets both in present and in the future without degrading the natural resource base.

**What Is Integrated Farming System (Ifs):** Edwards (1997) narrowly defined the system as an aquaculture system that is integrated with livestock and in which fresh animal waste is used to feed fish. Okigbo (1995) defined these systems as a mixed farming system that consists of at least two separate but logically interdependent parts of a crop and livestock enterprises. Jayanthi *et al.* (2000) based on experiences from Tamil Nadu, India, described these systems as a mixed animal crop system where the animal component is often raised on agricultural waste products while the animal is used to cultivate the soil and provide manure to be used as fertilizer and fuel. Agbonlabor *et al.* (2003) studied in Nigeria defined the IFS concept as a type of mixed farming system that combines crop and livestock enterprises in a supplementary and/or complementary manner. The difference between mixed farming and integrated farming is that enterprises in the integrated farming

system are mutually supportive and depend on each other (Csavas, 1992). Contrasting these definitions Radhammani *et al.* (2003) described IFS's as a component of farming systems which takes into account the concepts of minimizing risk, increasing production and profits whilst improving the utilization of organic wastes and crop residues. It is clear from the above that there are synergies and complementarity between enterprise that comprise a crop and animal component that form the basis of the concept of IFS. In this respect integration usually occurs when outputs (usually by-products) of one enterprise are used as inputs by another within the context of the farming system. Mangala (2008) revealed that the integrated farming practices adopted by respondents after implementation of Integrated Farming System Programme in Dharwad were agriculture-horticulture-forestry-dairy-vermicompost (62.14%), agriculture- horticulture-forestry-dairy-vermicompost-forage crops (21.43%), agriculture-horticulture-dairy-forage crops (7.86%), agriculture-horticulture-forestry-dairy-forage crops (5.00%) and agriculture-horticulture-dairy (3.57%). Ugwumba *et al.* (2010) identified that the integrated farming systems adopted by respondents were crop-livestock (47.62%), crop-fish (9.52%), crop-fish-livestock (29.76%), livestock-fish (11.90%) and crop-livestock-agro processing (1.19%).

#### **Why Integrated Farming Systems:**

**A) Deteriorating resource Base:** During post-green revolution period, our attempt to solve food problem and attain self-sufficiency in food production through excess use of agrochemicals, inevitable dependence on irrigation and high cropping intensity has led to contamination of food with harmful chemicals, pollution of ground water, degradation of soil quality and damage to agriculturally beneficial microorganisms. In many regions both surface and ground water are already becoming unfit for human and animal consumption due to high concentration of pesticide residues. Available estimates revealed that nearly 120.72 million ha of land in the country is degraded. Intensified agriculture, coupled with indiscriminate use of irrigation water and non-judicious fertilizer application, especially in irrigated areas of the country has led to various kinds of physical and chemical degradation of the soil.

**B) Climate Change:** The increasing green-house gases resulted in global warming. The Intergovernmental Panel for Climate Change (IPCC)

projections on temperature predicts an increase of 1.8 to 4.0 °C by the end of this century. Temperature and sea level changes will affect agriculture through their direct and indirect effects on crops, soils, livestock, fisheries and pests. The brunt of environmental changes is expected to be very high in India due to greater dependence on agriculture, limited natural resources, alarming increase in human and livestock population, changing pattern in land use and socio-economic factors that pose a great threat in meeting the food, fiber, fuel and fodder requirement. Recent studies done at the Indian Agricultural Research Institute indicated the possibility of loss of 4-5 million tonnes in wheat production in future with every rise of 1°C temperature throughout the growing period.

**C) Narrowed Biodiversity:** The narrowing of genetic biodiversity occurs as traditional crop varieties and local animal breeds are being replaced by modern ones. These new varieties/ breeds are certainly better matched to modern intensive agriculture, but rarely any consideration is given to preserving the bio-diversity of an agricultural ecosystem. In addition, the increased farming density tends to erode the biodiversity of flora and fauna in the agricultural ecosystems. For example, extensive adoption of rice-wheat monoculture in the Indo-Gangetic Plains has replaced the other traditional crops. Soil micro-flora is also adversely influenced on account of large-scale use of agro-chemicals and lack of recycling of crop residues in the region.

**D) Multiplicity of Integrated Farming Systems:** Very often, almost all Indian farmers, in pursuit of supplementing their needs of food, fodder, fuel, fiber and finance resort to adopt integrated farming systems, majority of them revolving around the crops + livestock components. Livelihood of small and marginal farmers, comprising more than 80 per cent of total farmers, depends mainly on crops and livestock, which is often affected by weather aberrations. Under present scenario, in the absence of scientifically designed, economically profitable and socially acceptable appropriate integrated farming systems models, they are unable to harness the benefits of integration. An important consequence of this has been that their farming activities remain, by and large, subsistent in nature rather than commercial and many a times uneconomical.

**E) Low Rate of Farm Resource Recycling:** In the absence of adequate knowledge among farmers about techniques and benefits of recycling of farm, industrial and municipal organic wastes in agriculture, these remain unutilized. A vast untapped potential exists to recycle these solid and liquid organic wastes of farm origin. Recycling of crop residues may be a potential organic source to sustain the soil health. Incorporation of crop residues of either rice or wheat increases the yield of rice and nutrient uptake and also improves the physico-chemical properties of the soil, ensuring better soil environment for crop growth.

**F) Technology Adoption Gaps:** In our efforts to develop and improve upon existing technologies, involvement of people in conceptualization and extension of technologies would appear very important. The farm family had never been the focal point of our investigations. This top down approach had given a poor perception of the problems that they tried to solve. Due to poor extension mechanisms at national as well as state levels, many farmers, especially those at lower strata of social structure, remain uninformed about many of the development schemes and the desired impact of such schemes is not obtained. One of the reasons for poor rate of transfer of agricultural technologies is poor linkages between the different clientele groups of agriculture. Practically linkages among farmers, service providers, technological and financial institutions are either weak or nonexistent (NAAS, 2009).

Continuous production of crops without external inputs reduce the ability of the soil resource base to both provide and retain nutrients which often results in a decline in productivity (Willett, 1995; Craswell, 1998; Limpinuntana *et al.*, 2001; Noble and Ruaysoongnern, 2002). In addition, the reliance upon a few crops in combination with a high risk of crop failure due to a range of factors (i.e. disease, drought) exposes farmers to a high degree of variability with respect to yields and income and therefore risk (Reijntjes *et al.*, 1992; Ashby, 2001). Further, some authors indicated that commercial farming systems are a threat to the environment through a loss of genetic diversity and the possible negative impacts of these systems and their associated inputs (Ashby, 2001). No single farm

enterprise is likely to be able to sustain the small and marginal farmers without resorting to integrated farming systems (IFS) for the generation of adequate income and gainful employment year round (Mahapatra, 1992). Under the gradual shrinking of land holding, it is necessary to integrate land based enterprises like fishery, poultry, duckery, apiary, field and horticultural crops, etc. within the bio-physical and socio-economic environment of the farmers to make farming more profitable and dependable (Behera *et al.*, 2004).

The basic aim of IFS is to derive a set of resource development and utilization practices, which lead to substantial and sustained increase in agricultural production (Kumar and Jain, 2005). Hence, integrated farming systems are often viewed as a sustainable alternative to commercial farming systems particularly on marginal lands with the objective of reversing resource degradation and stabilizing farm incomes. Survey on Farming Systems in the country as a whole also revealed that milch animals (cows and buffaloes), irrespective of breed and productivity, is the first choice of the farmers as an integral part of their farming system. However, from economic point of view, vegetables and fruits (mango and banana in many parts of the country) followed by fish cultivation were the most enterprising components of any of the farming systems prevailed in the country. A number of success stories on integrated farming system models in different parts of the country suggested that farmers' income can be increased manifold by way of integration of enterprises in a farming system mode.

#### **Benefits Of Integrated Farming Systems:**

**1) Productivity:** IFS provides an opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises.

**2) Profitability:** Use waste material of one enterprise at the least cost as input for other enterprise. Thus, reduction in cost of production, form the utilization linkage of waste material and elimination of middleman interference in most input used.

**3) Sustainability:** Organicsupplementationthrough effective utilization of byproducts of linked component is done thus providing an opportunity to sustain the potentiality of production base for much longer period.

**4)Balancedfood:** IFS links components of varied nature enabling to produce different sources of nutrition for farm families.

**5) Environmental safety:**In IFS,waste materials are effectively recycled by linking appropriate components, thus minimize environment pollution.

**6) Income round the year:**Interaction of enterprises with crops, eggs, milk, mushroom, honey, fish, cocoons, etc. provides flow of money to the farmers round the year.

**7) Adoption of new technology:**Money flow round the year due to IFS gives an inducement to the small and marginal farmers to go for the adoption of new technologies.

**8) Saving energy:**Effectiverecyclingtechniquethe organic wastes available in the system can be utilized to generate biogas. Energy crisis can be postponed to the later period.

**9) Meeting fodder crisis:**Every piece of land is effectively utilized. Plantation of perennial fodder trees on field borders. These practices will greatly relieve the problem of non – availability of quality fodder to the animal component linked.

**10) Solving fuel and timber crisis:**Linkingagro-forestry appropriately the production level of fuel and industrial wood can be enhanced without determining effect on crop. This will also greatly reduce deforestation, preserving our natural ecosystem.

**11) Employment generation:**Combingcropwith livestock enterprises would increase the labour requirement significantly and would help in reducing the problems of under employment to a great extent. IFS provide enough scope to employ family labour round the year.

**12) Agro–industries:**Whenoneofproducelinked in IFS are increased to commercial level there is surplus value addition leading to development of allied agro–industries.

**13) Increasing input efficiency:**IFSprovidegood scope to use inputs in different components efficiently and effectively.

**Sustainable Rural Livelihood Security Through Ifs:** Lightfoot and Minnick (1991) reported that the integration of trees into these systems offered income security and ecological protection. Added to this, the use of diverse plants and animals broadened

possible sources of income generation. The generation of wastes and by-products from these entities were transferred between enterprises, thereby reduced the need for external inputs such as feeds and crop nutrients (Csavas, 1992; Little and Edwards, 2003). Animals on a farm provided inputs to other enterprises and constituted a source of meat and milk, a means of savings and a source of social status (Schierre *et al.*, 2002 and Little and Edwards, 2003). Diversification of farming activities improved the utilization of labour; reduced unemployment in areas where there was a surplus of underutilized labour and provided a source of living for those households that operated their farm as a full time occupation (Thamrongwarangkul, 2001; Van *et al.*, 2003). Liyanage *et al.* (1993) showed that the integration of legume-based pasture and dairy cattle indicated that the coconut palms in the integrated system yielded 17 per cent more nuts and 11 per cent more copra, while maintaining the nutrient status of the palm above the critical level, despite reduced application of fertilizer. Nutrients returned from 73 kg of fresh manure and 30 litres of urine/palm/year reduced the cost of fertilizer needs by 69 per cent. In regards to the animals, there was sufficient forage to promote 306 to 590 grams per head live weight increase and three to eight litres of milk per day during the first lactation. The integrated farming system was more sustainable and economically viable than the monoculture system. De Jong and Ariaratne (1994) indicated that dairying contributed most to the total gross margin of the 0.2, 0.4 and 0.8 ha units of 31, 63 and 69 per cent respectively, followed by crops (29%, 37% and 19%), poultry (22%, 0% and 9%), and goats (18%, 0% and 3%). The overall ratio of cash income per Sri Lankan rupee spent was 3.2 for dairying, 1.1 for poultry, 4.5 for goats and 9.9 for crops. Dairying and goats proved to be attractive cash earners with a high labour productively and high capital requirement, while manure to improve soil fertility and biogas to replace domestic fuel were important benefits. Poultry did little to improve farm income. Singh *et al.* (1993) revealed that economic analysis of different farming systems (one hectare of irrigated land or 1.5 ha of un-irrigated land) indicated that under irrigated conditions, mixed farming with crossbred cows yielded the highest net profit followed by mixed farming with buffalo and arable farming.

Mixed farming with Haryana cows made a loss. Kumar *et al.* (1994) showed that the comparative productivity and economies of dairy enterprises (mixed farming with three crossbred cows on one hectare of canal irrigated land versus mixed farming with three Murrah buffaloes) indicated that mixed farming with crossbred cows under canal-irrigated conditions was more efficient for the utilisation of land, capital, inputs and the labour resources of the farmer. They also studied the financial viability of a poultry and fish culture system and concluded that under the prevailing conditions, higher incomes and on farm labor use can be achieved by integrating different enterprises on the farm. Similarly, Rangasamy *et al.* (1996) studied the integration of poultry, fish and mushroom with rice cultivation over a five-year period. The study concluded that the integrated system that included the aforementioned three components increased net farm incomes and on-farm labor when compared with the conventional rice cropping system. Radhamani *et al.* (2003) reviewed several studies on the financial viability of integrated farming system and concluded that they positively influenced the economic viability of these systems. The results from these structured studies that received regular inputs such as genetic resources, labour, irrigation and information are somewhat removed from reality. In most cases the availability of and access to these inputs was variable and often contingent on factors that were beyond the control of the farmer. Radhamani (2001) reported that the additional employment gains (314 man days/year) through integrated farming system with crop+goat under rainfed vertisols. Devasenapathy *et al.* (1995) identified that integrated farming groundnut-black gram-maize and groundnut-gingelly-ragi with integration of other enterprises such as dairy, fish culture, poultry and rabbit rearing resulted in higher net income as compared to conventional cropping system. Ravi (2004) stated that agriculture with poultry, agriculture with sheep rearing and agriculture with sericulture were the important farming systems identified in the study area. The relative profitability of the selected farming systems both in small and medium farms was studied and it revealed that the farming system, agriculture+sheep was most profitable among the selected farming systems with an annual net returns of ₹ 0.43 Lakhs/farmer and ₹0.76 lakhs/farmer in small and medium farmers,

respectively. Nageswaran (2009) showed that the five treatments of crop + dairy (3 milch cows), crop + poultry (6 layers), dairy cum poultry (3 milch cows + 6 layers), improved cropping alone and farmers' cropping alone were taken. Of all the treatments, In Paiyur, dairy based farming gave the maximum income (₹ 12,180/ha/yr) and employment (518 man days/yr). In Yercaud, dairy cum poultry farming gave the maximum income (₹13,822/ha/yr) and employment (556 man days/yr). Dwivedi (2007) concluded that economic returns from agri-horticultural system it was increased by 16.5 to 136.2 per cent than sole cropping under different fruit crops. Availability of fuel wood, fodder, fruit, small timber and food grains from the same piece of the land increased. Standard of living increased in terms of better food and clothing, constructed a pucca house, pucca well and cemented irrigation channels, purchased a motor bike and recovered from the loans took from Regional Rural Bank. Jayanthi *et al.* (2009) concluded that Integrated Farming System for different situations enhances productivity, profitability and nutrition security of the farmers and sustains soil productivity through recycling of organic source of nutrients from the enterprises involved. The mean maize grain equivalent yield was about 9,417 kg/acre/year under traditional cropping system whereas under IFS, the maize grain equivalent yield was about 22,754 kg/acre/year. As compared to traditional cropping system, IFS brought increased revenue, which might be due to resource recycling. The net return from inclusion of allied enterprises in IFS is about ₹ 60,141 and the increase in income over traditional cropping system was about 43.6 per cent. IFS treatments generated more workdays of employment compared with the traditional system involving cropping and dairy. Cropping in traditional system generated 25 workdays per acre per year, while the various cropping systems under IFS generated 49 workdays of employment. A maximum of 183 workdays per acre per year was generated from animal components in IFS, whereas in traditional cropping system it is only about 80 workdays. In the traditional cropping system, the residue generated is less as compared with IFS. The system of crop+milch cows+goat+guinea fowl+biocompost and vermicompost could provide better bio-resource utilization and recycling. Based on the farmer participatory research, it was

concluded that IFS approach is better than traditional system in its contribution to productivity, profitability, economics and employment generation for small and marginal farmers of Tamil Nadu. Ugwumba *et al.* (2010) in their study highlighted the impact of IFS on farm cash income. Majority of the farmers in the study area practiced partial integration. Results revealed that all types of IFS are on the average profitable. Net farm income realized by farmers who maintained crop-livestock-fish integration was the highest. Implying that farmers who want to achieve full integration and thus earn more income and escape from poverty will target the combination of more enterprises including crops, livestock, fisheries, processing and even biogas. Farm cash income was positively influenced by farmer's age, level of education, years of experience and type of integration. It was, however, negatively influenced by household size, cost of farm inputs and gender of farmer. Farm cash income can be improved by policy towards measures that will reduce cost of inputs and increase farmers knowledge and technical skills. Fraser *et al.* (2005) concluded that the greater diversity is believed to increase the ability of systems to withstand shocks and thereby decrease vulnerability. It has been demonstrated that temporal stability of a natural ecosystem increases with increasing species diversity. Also, for agricultural systems, it has been suggested that a greater diversity can decrease vulnerability, but empirical evidence is lacking. Felipe (2007) concluded that a 40 per cent of the organic farmers almost consider that the risk of crisis of market prices affects them less than to conventional farmers. The organic farming helps to increase amount of organic matter in the soil which contributes to conserve better the humidity. It makes organic farmers less vulnerable to drought. Similarly, vegetal covers contribute to reduce the vulnerability against irradiation frosts. It affirmed that organic farmers have minor risk sensation than conventional farmers. Venkatadri *et al.* (2008) showed that about 98 per cent of the farmers opined that livestock rearing reduces vulnerability in drought years, a 97.8 per cent expressed that dairy farming provides sustainable livelihoods, a 97 per cent of the sample respondents indicated that farmers suicides are less in dairy developed areas and commercial agriculture increased suicidal rate in A.P. (96.0%).

Integrated farming systems were found to outperform the normal or commercial farming systems in all four dimensions of a multifunctional agriculture: food security, environmental security, economic security and social security. The findings support the notion that diversification and integration of resources on farms is feasible in both economic and ecological terms. The analysis indicated that integrated farming does not, however, diminish the need for external inputs. High start-up cost might constrain farmers from switching to integrated farming and from exploiting the benefits of resource integration.

#### CONSTRAINTS IN ADOPTION OF INTEGRATED FARMING SYSTEMS:

Lightfoot (1997) suggested that the main constraints to adoption of integrated farming systems in the Philippines and Ghana were the long transition period that often occurs when implementing an integrated production system, labour shortages, especially where the family size is small, which effectively prevented them from adopting integrated farming techniques, lack of secure land rights and disincentives to adopting integrated farming resulting from government subsidies, credits for fertilizers, and herbicides. Nageswaran (2009) reported that the shortcomings perceived by the Integrated Farming System (IFS) farmers were support for procuring improved breeds of livestock would help in enhancing dairy related activities and add to the income of the farm, timely availability of fish seed and fish feed, low cost and energy efficient device for pumping out water for irrigation, information on government schemes and credit support from financial institutions. As the IFS practising farmers were scattered over the region it may be desirable that cluster wise IFS farmers associations will be formed which will play a vial role in addressing the problems

faced by the farmers and developing the scale of operation that will help in the farmers in negotiating or accessing various external institutions. This will also help in organising training programmes for the IFS farmers.

#### CONCLUSION

The profitability of Integrated Farming Systems is well known to the world and can be considered for its wide spread adoption by small and marginal farmers. Declining size of landholdings without any alternative income augmenting opportunity is resulting in fall of farm income, and causing agrarian distress. A large number of smallholders have to move to non-farm activities to augment their income (NCAER, 2009). Research efforts so far have paid dividends, but mainly through medium and large farm holders. However, under the changing scenario a paradigm shift in research is inevitable with more focus towards small and marginal holders in farming systems perspective. The role of integrated farming systems is easily overlooked when agriculture is examined through western eyes. Nevertheless, smallholders may not consider becoming specialist agriculture producers until an assured market and the reliability of income is clear, and most appear to prefer to integrate the various enterprises. This creates efficiencies in family labour usage, use of residues and farm nutrient recycling. Potential improvements and increased productivity from the various enterprises can only come from a better understanding of the nature and extent of the interactions various enterprises and natural resources, economic benefits, as well as the impact on the livelihoods of small farmers and the environment. Research on these aspects provides major challenges for sustainable agricultural development through integrated farming systems in the future.

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