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Case Study

INTEGRATED FARMING SYSTEMS: AN APPROACH FOR LIVELIHOOD SECURITY OF SMALL AND MARGINAL FARMERS

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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 gradually shrinking and number of operational holdings is increasing. It is imperative to develop strategies that enable adequate income and employment generation, especially for small and marginal farmers who constitute more than 85 % of the farming community. Under the gradual shrinking of land holding, horizontal expansion of land is not possible. Hence, vertical integration of land based enterprises within the socio-economic environment of the farmers will make farming more profitable and dependable. Therefore, Integrated Farming systems can be proved as viable approach represents an appropriate combination of farm enterprises, *viz*. crop production, horticulture, livestock, fishery, forestry, poultry and goatry *etc*. in specific farming situation to address the problems of sustainable economic growth of Indian farming communities. Hence, it is viewed as a powerful tool for natural and human resource management in developing countries like India. This is multidisciplinary whole farm approach and very effective in solving the problems of small and marginal farmers. This approach not only increase income and employment opportunity farm household but protect the environment through recycling of the crop and animal wastes within the farm itself. The literature related contribution of integrated farming systems in achieving sustainable rural livelihood has been reviewed carefully in this paper.

KEY WORDS: Integrated farming systems, Livelihood, Rural, Sustainable development.

INTRODUCTION

Indian agriculture has been shouldering the responsibility of providing food and nutrition to its teeming millions. Widespread occurrence of ill-effects of green revolution technologies in all intensively cultivated areas like Punjab and Haryana are threatening the sustainability of agricultural production systems and national food security. The gradual declining trend in size of land holding poses a serious challenge to the sustainability and profitability of the 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 livelihood issues. It is imperative to develop strategies and agricultural technologies that enable adequate income and employment generation, especially for small and marginal farmers who constitute more than 85 per cent of the farming community. The integrated farming system approach is considered to be the most powerful tool for enhancing the profitability of small and marginal farmers. These integrated farming systems required to be planned, designed, analyzed and implemented for increasing productivity, profitability and sustainability of the farm. 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 economical (jobs, saving 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 livelihood is 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 are combined 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 as they focused only 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 recognized that more attention must be given to the various factors and processes which either constrain or enhance poor peoples' ability to make economically, ecologically and socially sound living. The SRL concept offers a more coherent and integrated approach to poverty

alleviation. To achieve sustainable rural livelihoods, different livelihood capitals such as human, social, natural, physical and financial 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 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 where fresh animal waste is used to feed fish. Okigbo (1995) defined these systems as a mixed farming system that consists of atleast 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 at.* (2003) described IFS as concepts of minimizing risk, increasing production and profits along with improving the utilization of organic wastes and crop residues. It is clear that there are synergies and complements between enterprise that comprised a crop and animal component to form the basis of the IFS concept. In this respect, integration usually occurs when outputs (usually by-products) of one enterprise are used as inputs for 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 *at 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 (1 l.90%) and crop-livestock-agro processing (1.19%).

Why Integrated Farming Systems

A) Deteriorating resource Base

During post-green revolution period, attempts to solve food problem through excess use of agrochemicals, frequent irrigations and high cropping intensity had led to food contamination, ground water pollution, soil degradation and suffering of beneficial micro-organisms. In many regions, both surface and ground water is becoming unfit for human and animal consumption due to high concentration of pesticides residue. Available estimates revealed that nearly 120.72 million ha. of land in the country is being degraded. Intensified agriculture, coupled with indiscriminate use of irrigation water and fertilizer, especially in irrigated areas has led to soil abnormalities.

B) Adverse effect of Climate Change

The consecutive increase in green-house gases resulted in global warming. The Intergovernmental Panel for Climate Change (IPCC) projections on temperature predicted an increase of 1.8 to 4.0°C temp by the end of this century. Temperature and sea level changes will affect agriculture through causing direct and indirect effects on crops, soils, livestock, and fisheries along with other bio-pests. The apprehension of environmental changes in future is expected to be very high due to greater dependence on agriculture, misuse of natural resources, unscientific rearing of livestock population, faulty land use pattern and socio-economic factors that pose a great threat in meeting the food, fiber, fuel and fodder requirements. Recent studies done at the Indian Agricultural Research Institute, New Delhi indicated the possibility of 4-5 million tons wheat loss in future due to every rise of 1°C temperature. The integrated farming system could only be the way to mitigate the effect of climate change.

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 will certainly be matched to modern intensive agriculture, but rarely any consideration was given to preserving the bio-diversity of an agricultural ecosystem. In addition, the monoculture farming tends to erode the biodiversity of flora and fauna in present agriculture. For example, extensive adoption of rice-wheat monoculture in Indo- Gangetic Plains has replaced the other traditional crops. Soil micro-flora is also been adversely affected due to heavy use of agro-chemicals and lack of crop residues recycling. The IFS with multiple enterprises and round the year farming can be realistic towards increasing biodiversity.

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 85 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 integrated farming systems models, farmers were unable to harness the real 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 times proved uneconomical.

E) Low Rate of Farm Resource Recycling

In absence of adequate knowledge among farmers about techniques and benefits of recycling, industrial and households' organic wastes in agriculture, remain unutilized. A vast untapped potential exists to recycle these solid and liquid organic wastes of farm origin. Recycling of crops residue 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, nutrient uptake and also improves the physic-chemical properties of the soil which ensures better soil environment for crop growth.

F) Technology Adoption Gaps

In order to develop and improve existing technologies, involvement of people in conceptualization and transfer 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 who are at lower strata of social structure, remained unaware about many of the developmental schemes, so that the desired impact of such schemes are not obtained. One of the reasons for poor rate of transfer of agricultural technologies is poor linkages between the different 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 reduces the ability of the soil resource base which often results in declining productivity (Willett, 1995; Craswell, 1998; Limpinuntana *et al.*, 2001; Noble and Ruaysoongnern, 2002). Nevertheless, growing of only few creates risk of crop failure due to a range of factors (*i.e*. disease, drought) which exposes farmers to a high degree of variability in yield (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 (Mahapatra, 1992). Under the gradual shrinking of land holding, it is necessary to integrate land based enterprises like dairy fishery, poultry, duckery, apiary, along with 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 of commercial farming systems particularly on marginal lands with the objective of reversing resource recycling 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, are the first choice of the farmers as an integral part of their farming. However, from economic point of view, vegetables and fruits (mango and banana in many parts of the country) followed by fish cultivation are the most prevailing components 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.

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 and increase three to eight litres of milk per day during the first lactation. The integrated farming system is 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 from 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 productivity 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 economics 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 utilization 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 consumption can be found 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 labour employments 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 achieved from these structured studies manifested that received regular inputs such as genetic resources, labour, irrigations and information are somewhat removed from reality. In most cases the availability and access to these inputs was variable and often contingent on factors that were beyond the control of the farmer. Radhamani (2001) reported 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 of groundnut-blackgram-maize with integration of other enterprises such as dairy, fish, poultry and rabbit rearing resulted higher net income as compared to conventional cropping system. Ravi (2004) stated that agriculture with poultry, with sheep rearing and 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 like agriculture + sheep was most profitable among the selected farming systems with annual net returns of 0.43 Lakhs and 0.76 lakhs/farmer under small and medium category, 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) which concluded that economic returns from agri-horticultural system, that was increased by 16.5 to 136.2 per cent over 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 nutritional security of the farmers and sustains soil productivity through recycling of organic sources 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, the net income was increased under IFS, which might be due to insitu recycling of resources. The net return from inclusion of allied enterprises under IFS is about Rs 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 workday employments. 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. It was also noticed that residue generated under traditional cropping system, is far less as compared to 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 farming with reference 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 income. Majority of the farmers in the study area practiced partial integration. Results revealed that all types of IFS combinations are profitable over existing practices. Net farm income realized more by the farmers who maintained crop- livestock-fish integration. It implying that farmers who want to achieve full integration, earn more and to escape from poverty will target the integration of more enterprises including crops, livestock, fisheries, processing and even biogas. Farm cash income was positively be influenced by farmer's age, their 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 also be enhanced by actionable and suitable policy framework that will facilitate to reduce cost of inputs and increase farmers knowledge and their 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 percent of the organic farmers almost consider that the risk of market price crisis affects them lesser than conventional farmers. The organic farming helps to increase amount of organic matter in the soil which contributes to conserve better humidity. It makes organic farmers less vulnerable to the menace of drought. Similarly, vegetative covers contribute to reduce the vulnerability against irradiation and 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 switching from traditional to integrated farming mode and that could exploit the benefits of resource integration.

Constraints in adoption of Integrated Farming Systems

Lightfoot (1997) suggested that the main constraints in adoption of integrated farming systems in the Philippines and Ghana were the long transition period that often occurs in implementation of integrated production system is labour shortages, especially due to the small family, which effectively prevented in adoption of integrated farming techniques. Lack of secure land rights and disincentives also restrained them to adopt integrated farming systems. Nageswaran (2009) reported that the shortcomings perceived by the farmers are need to be addressed and be facilitated in procuring improved breeds of livestock to enhance dairy related activities and the income of the farm, timely availability of fish seed and fish feed, low cost and energy efficient device for pumping out irrigation water, information about government schemes and credit support from financial institutions. As the IFS practicing farmers were scattered over the region, it may be desirable that cluster wise IFS farmers associations will be formed which will play a vital 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 organizing 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 gradually reducing the farm income, and causing agrarian distress. A large number of smallholders have to move for 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 be considered as specialist agriculture producers until an assured market and the reliability of income is cleared, and appeared. That will facilitate in integration of various enterprises. This will improve the efficiency in family labour, 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 among 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 will provide major challenges for sustainable agricultural development through integrated farming systems in the future.

REFERENCES

Bhati, T.K. (1997) Integrated farming systems for sustainable agricultural on drylands. In: Sustainable Dryland Agriculture, CAZRI Publications, pp. 102-105.

Gill, M.S., Samra, J.S. and Sing, Gurbachan (2005) Integrated farming system for realizing high productivity under shallow water-table condtions. Research bulletins, Department of Agronomy, PAU, Ludhiana, pp. 1-29.

Korikanthimath, V.S. & Manjunath, B.L. (2005) Resource use efficiency in integrated faming systems. In: Proceeding of A symposium on Alternative Farming systems: Enhanced income and employment generation options for small and marginal farmers PDCSR, Modipuram, pp. 109-118

Lal, R. & Miller, F.P. (1990) Sustainable farming for tropics. In: Sustainable agriculture: Issues and Prospective. Vol. 1 (Ed.) R.P. Sing, pp. 69-89, Indian Society of Agronomy, IARI, New Delhi.

Manjunath, B.L. & Itnal, C.J. (2003) Farming system options for small and marginal holdings in different topographies of Goa. Indian Journal of Agronomy 48 (1): 4-8

Narain, P. & Bhati, T.K. (2005) Alternative Farming system: Issue and opportunities in arid ecosystem. In : Proceeding, National Symposium on Alternative Farming Systems held at PDCSR, Modipuram, 16-18 September, 2004, pp.57-64

Radha, Y., Eshwara Prasad, Y. & Vijayabhinandana, B. (2000) Study on income and employment generation on agricultural based livestock farming systems. Paper presented at VIII Annual Conference of AERA at TNUASU, Chennai, 28-29 December, 2000.

Singh, C.B., Renkema, J.A., Dhaka, J.P., Singh, Keran. And Schiere, J.B. (1993) Income and employment on small farmers. In: Proceeding An International workshop on Feeding of Ruminants on fibrous crop residues: Aspects of Treatment, Feeding, nutrient evaluation, research and extension. Karnal, Haryana, 4-8 February, 1991, pp. 67-76.

Singh, Gurbachan (2004) Farming systems options in sustainable management of national resources. In: Proceedings National Symposium on Alternative Farming Systmes held at PDCSR, Modipuram, 16-18 September, 2004, pp. 80-94.

Singh, Rajender, Singh, Narinder, Phogat, S.B., Sharma, U.K., Singh, R. & Singh, N. (1999) Income and employment potential of defferent farming system. Haryana Agricultural University Journal of Research 29 (3-4): 143-145.

Thankur, R.C. & Badiyala, D. (2005) Farming systems issues and opportunities in north-wetern Himalayas. In: Proceeding National Symposium on 'Alternative Farming Systmes', pp. 72-79 (Eds: A.K. Singh, B. Gangwar and S.K. Sharma). Project Directorate For Farming Systems Research, Modipuram.

Virozi Rao, S.T. & Bose, S.C. (2002) 'Integrated Farming System approaches for Sustainable Agriculture'. Presented at 32nd Research and extension advisory council meeting of ANFR Agricultural University, Rajendranagar, Hyderabad, 26-27 December, 2007.