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Integrated Farming System (IFS): A Review

Shweta Khobragade[1*], Sanghamitra Mohapatra[1], M. Mahananda[2], Aarti Singh[1] and Anita Singh[1]

[1]Dept. of Extension education and Communication management, [2]Dept. of Child Development, ECHS, SHUATS, Prayagraj, Uttar Pradesh (211 007), India

Corresponding Author

Shweta Khobragade
e-mail: khobragade7sm@gmail.com

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Abstract

Adoption of Integrated Farming System (IFS) leads to sustainability and stability in farm income through multiple enterprises that aim at maximum utilization of available natural resources to meet the family needs. It aims at generating a threshold level of farm income required for the farm family to maintain sustained interest in farming thus preventing migration of people from the farming sector. Integrated Farming System which combines activities of food-crop farming with horticulture, animal husbandry, fisheries, forestry and other science related to farming on the same field at the same or almost the same time needs to be developed as a solution to food security problem resulting from decreasing food productivity and climate change. IFS itself is important for sustainable development of farmer by improving yield, economic return, employment generation, nutritional security and livelihood.

Keywords: Integrated farming system, livelihood development, sustainable agriculture

1. Introduction

'Farming' is a process of harnessing solar energy in the form of economic plant and animal products. 'System' implies a set of interrelated practices and processes organized into the functional entity, i.e. an arrangement of components or parts that interact according to some process and transforms inputs into outputs (Frescolo, 1988). "Farming system" is a complex inter-related matrix of soil, plants, animals, implements, power, labour, capital and other inputs controlled in parts by farming families and influenced in varying degrees by political, economic, institutional and social forces that operate at many levels (Mahapatra, 1992). The main purpose of the integrated farming system is to bring self-sufficiency in farmer's requirements of food and cash; increased income and employment opportunities; recycling of farm wastes and by products and increasing resource use efficiency through efficient management of resources (Mahapatra and Behera, 2004).

Integrated Farming System (IFS) is defined as a biologically integrated farming system that integrates natural resources and regulation mechanisms into farming activities to achieve maximum replacement of off-farm inputs, secures sustainable production of high quality food and other products through ecologically preferred technologies, sustain farm income, eliminates or reduces sources of present environment pollutions generated by agriculture and sustains the multiple functions of agriculture. Integration of two or more appropriate combinations of enterprises like crop, dairy, piggery, fishery, poultry, beekeeping, etc., for each farm according to the availability of resources to sustain and satisfy the necessities of the farmer. An integrated farming system (IFS) approach is not only a reliable way of obtaining fairly high productivity with a substantial fertilizer economy but also a concept of ecological soundness, leading to sustainable agriculture (Swaminathan, 1987). Farming in India is a financially perilous profession with the annual farm income subject to many uncertainties, integration of farming increases return but also increases risk towards return. Farm work involves physical stress and can even be physically hazardous. There is psychological stress associated with coping with the regulatory framework and the dynamics of managing a farm business. The greatest risks, however, are economic in nature. More than 80% of Indian farmers have land holdings below two hectares. This fragmented and small landholding makes farming a risky economical proposition even under the best of conditions. In reality, the conditions are hardly anywhere near the best. As research and farming communities became aware of the need To balance productivity with environmental and social outcomes, the concept of sustainable agriculture was increasingly promoted. Garibaldi et al. (2017) describe agricultural sustainability as a concept that considers the economic, environmental and social aspects of farming, while

also promoting the resilience and persistence of productive farming landscapes. Integrated farming way with a variety of ideas and farming models aimed at the objective of growing more food (for profit) while also providing environmental and social benefits (Garibaldi et al., 2017; Plumecocq et al., 2018; Pretty and Bharucha, 2014). A partial list of concepts that have been proposed as a way of achieving agricultural sustainability; many of these ideas, such as integrated pest management, agroforestry, and organic agriculture are now quite familiar, whilst others, such as precision farming and sustainable intensification are becoming More common (Garibaldi et al., 2017). All of these terms have influenced the policy landscape at a variety of scales, as policy-makers constantly look for the best way of encouraging the adoption of an integrated farming system for sustainable agriculture in practice. The main objective of opting for different kinds of farming was to reduce dependency on external sources. However, following industrialization, farming became commodity-based depending upon agro-climatic conditions of the area and proximity to industries like sugar factory, soya processing plant, rice mill, oil mill, ginning mill, dal mill, etc., similarly poultry farming, dairy farming, piggery, beekeeping, fish cultivation, vegetable farming, fruit farming, floriculture, mushroom farming gained popularity in the peri-urban areas also to exploit the market of the products available in the city (Meena et al., 2018). However, with the pace of time, the sustainability of single commodity based farming became questionable because of fluctuating market trends and dependency on external inputs. The "green revolution" further intensified the crop-based farming system with indiscriminate use of fertilizers leading to a situation of fatigued land and reduced crop production.

The four primary goals of IFS are maximization of the yield of all component enterprises to provide steady and stable income, rejuvenation/amelioration of system's productivity and achieve agro-ecological equilibrium, avoid build-up of insect-pests, diseases and weed population through natural cropping system management and keep them at a low level of intensity and reducing the use of chemicals (fertilizers and pesticides) to provide chemical free healthy produce and environment to the society (Jayanthi et al., 2007). Adoption of an Integrated Farming System leads to sustainability and stability in farm income through multiple enterprises that aim at maximum utilization of available natural resources to meet the family needs. It aims at generating a threshold level of farm income required for the farm family to maintain sustained interest in farming thus preventing migration of people from the farming sector. IFS models have to be developed based on the agro-climatic situations, holding size, availability of resources like land, water, labour, marketing facilities, risk factors, family size, the ability of the farm family members to participate in the farming activity, their knowledge/skill level, etc. It is evident that profit margin varied with the ecosystem (rain-fed/ irrigated), management skill, and socio-economic conditions that affect the livelihood (Rathore et al., 2019). In the IFS system, a linked set of enterprises used so that the waste from one component becomes an input for another part of the system, which helps in reducing cost and improving the production or income of farmers. IFS provides that wastes from one form of agriculture become a resource for another form. Since it utilizes wastes as resources, we not only eliminate wastes but also secure an overall increase in productivity for the whole agricultural systems (Anonymous, 2010). IFS consists of a range of resource-saving practices that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of comprehensive farming and maintaining the environmental conditions (Lal and Miller, 1990; Gupta et al., 2012). There are many models developed by researchers in different corners of our country but there is an immense need forproper documentation and dissemination for the betterment of the poor and prosperity of our country both in the rural and urban sector. Therefore it is high time for the promotion of the IFS concept and knowledge in different agro-climatic pockets of our country to contribute towards the national agenda-doubling the income of the farmers as well as addresses the issue of malnutrition. The adoption of the Integrated Farming System (IFS) is the right approach in this direction and should be supported through institutional, extension, policy and marketing interventions in a systematic approach.

2. Integrated Farming Systems – The Practice Followed in The World

Proof for the advancement of horticulture, including both crop harvest and animal rearing, has been revealed in different pieces of the world going back some 10–12 thousand years, and has been named the "Neolithic Revolution". The continuous and inconsistent development from dependence on migrant chasing and assembling to rehearses that advanced more prominent food security is thought to have been affected by a few variables including ecological constraints/ openings or financial drivers.

In recent years, food security, livelihood security, water security as well as natural resources conservation and environmental protection have emerged as major issues worldwide. Developing countries are struggling to deal with the dual burden of climate change and globalization. It has been accepted that sustainable development is the only way to promote proper utilization of resources and environmental protection without affecting economic growth. Developing countries around the world are promoting sustainable development through newer agricultural practices which will help them in addressing socio-economic as well as environmental issues simultaneously. Within the broad concept of sustainable agriculture "Integrated Farming System" holds a special position.

Now a days globally, integrated farming systems are effective systems that have traditionally been undertaken by farmers in countries that include Indonesia, China, Malaysia, .Vietnam, Rwanda and Thailand (Gliessman et al., 1981; Csavas, 1992; Tokrishna, 1992; Choosakul, 1999 and Praphan, 2001). However, in many countries, these traditional systems have been replaced by the establishment of commercial cash and staple crop production systems that have been promoted by governments (Ruaysoongnern and Suphanchaimart, 2001). Continuous production of crops without externalinputs reduces 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). 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 (Panke et al., 2010).

2.1. IFS in livelihood development

Sheikh et al. (2021) revealed that Integrated Farming System (IFS) is the main source of livelihood of nearly 65% of rural masses dependant on agriculture. IFS is holistic approach and considers interactions among the different component of IFS. Specialized Integrated Farming System (SIFS) has been developed with 4 components *viz*., basal crops, medium duration cash crops, super short/short duration cash crops and value addition. The study was conducted during 2009–2012 in villages of Barabanki and Raebareli districts of Uttar Pradesh, India. Out of 42 families for whom data was recorded and evaluated, 24 families followed the rice-wheat-oilseeds cropping system, reared cow/buffaloes (1-3 Nos.) and vegetables on part of the land. He also admitted that in the SIFS model, rural poultry, off-season vegetables and gladiolus were used for resource generation and expansion of the livelihood base. The result shows that input cost in subsequent years in traditional farming was more or less constant while it decreased by 25–35% in subsequent years in IFS models and thus especially the SIFS model proves to be profitable in the present scenario of decreased landholding. Contracts between expert yield and domesticated animals, poultry makers for the exchange of composts and less significantly, the feed can be an instrument to build the appropriation pace of incorporated cultivating (Wilkins, 2008). Integration of farm enterprises provides better livelihood in terms of increased food production, higher net income, improved productivity and reduced income imbalance between the agricultural labourer and urban factory worker. An increase in non-farm employment has also become essential for improving the income and living standard of the rural population (Biggs and Stephen, 1995; Sheikh et al., 2021). The farming system is the integration of farm enterprises to which a farm family allocates its resources in order to efficiently utilizes the existing enterprises for enhancing the productivity and profitability of the farm. Goswami et al. (2016) stated that the need for sustainable agricultural advancements remains at the forefront of global development practices, with small holder farms emerging as an essential factor in creating long-lasting improvements in food security, enhanced nutrition and economic development. Sustainable intensification and diversification in small farms can achieve these outcomes and often take the form of integration among farm resources to achieve sustainable livelihood, the proposed model of IFS implementation involves dynamic resourceintegration, within the larger context of rural development, and overall enhanced outcomes ofsustainable livelihoods at the community level through an integrated process-based approach (Gill et al., 2009).

Mynavathi and Jayanthi (2015) revealed that there is a need to recognize context (suitability of technology) and to pay more attention to relations within systems (system dynamics) and to defining criteria for sustainability. The paper links biophysical and socio-economic processes, gives a physical background for the anthropomorphic concepts of waste, and reviews aspects of objectivism and constructivism. It is argued that FSR can only advance if the full portent of these issues is considered in thinking about development of IFS. The complexity of the reality should make scientists think more carefully about the appropriate strategy that will get people out of poverty. By adopting integrated farming systems approach under Indian condition for higher equivalent yield, system productivity, system profitability and employment generation with assured livelihood and nutritional security, increasing climate resilient sustainability with a wide range of crops and cropping systems emerged as the best-integrated farming system (IFS) in terms of higher groundnut equivalent yield, system productivity, profitability and benefit: cost ratio. The integrated farming system, which is a synonym to family unit farming, provides a prospect to profitably engage the available manpower in the farm family to the fullest extent throughout the year leading to higher income and family satisfaction. A good IFS aims at least dependence on outside resources and well-organized recycling of available farm resources. Also, Behera and Dass (2013) find similar findings. Farming system research is recognized as a potential tool for the management of vast natural resources in developing countries for sustainable livelihood. The farming system, as a concept, takes into account the components of climate, soil, water, crops, farm wastes livestock, land, labour, capital, energy and other resources with the farm family at the centre managing agriculture and related activities (Shekinah et al., 2005). Rathore et al. (2019) also reported that a sustainable system that focuses on increasing farm productivity by increasing diversification, resource integration and creating market linkages also helps to a sustainable livelihood. Thousands of small and marginal family farmers in resource-poor regions in Asia and Africa have converted their farming to this sustainable farming system to diversify farm production, increase cash income,

and improve the quality and quantity of food produced and the exploitation of unutilized resources. It usually takes three to four years to establish a well-integrated farm with market linkages to ensure nutrition and the livelihood of a family.

2.2. IFS to improve sustainable development

Declining profitability of farming is a major concern especially in the arid and semi-arid regions. The IFS has great promise for improving the profitability by reducing the cost of production and/ or enhancement of productivity by adopting sustainable management. The IFS has the ability to reduce cost of production through recycling wastes as by-products of one enterprise becomes input to other enterprises (Manjunath and Itnal, 2003, Ravisankar et al., 2007) and minimizing the need for external inputs (Ryschawy et al., 2012; Wilkins, 2008). Meena et al. (2018) reported that the system of agriculture is based on the idea of enhancing peoples capacity to manage change by developing their ability to learn, how to learn, to improve problem situations and to communicate effectively. It draws on the concept of experiential learning and systems thinking and practice as well as the scientific method and encourages intuitive, creative activity, as well as logical, systematic thinking. The concept of integrated system research takes various enterprises and resource inputs at the farm into consideration for planning production of crops, selecting cropping systems and combining various enterprises to develop integrated farming systems having sustainable agriculture production.Cropyields affected by climate change are projected to be different in various areas, in some areas crop yieldswill increase, and for other areas, it will decrease depending on the latitude of the area and irrigationapplication IFS approaches sustainability to agriculture (Gangwar et al., 2013).

Crop residues can be used for feeding to animal, while enhancing the agricultural productivity should be done through utilization of manure from livestock by intensifying nutrients that improve soil fertility as well as reducing the use of chemical fertilizers (Gupta et al., 2012). Greater sustainability in production on farms due to the integration of diverse enterprises of different economic importance. Recycling of wastes being built in the system helps to reduce dependence on external high-energy inputs thus conserving natural and scarce resources. The farming system provides a progress of money to the farmer in sustainale mean round the year by way of disposal of eggs, edible mushroom, milk, honey, silkworm cocoons, etc. This will help to reduce dependency on single enterprises and reduce the risk of money lenders also (Devendra, 2002). Integrated farming system is a resource management strategy to achieve economic and sustained production to meet the diverse requirement of farm household while preserving resource base. IFS can be practiced as micro business by farm youth for attaining regular income. IFS reduces the risk of failure as often one component or one crop based business leads to market instability. The other advantages of IFS include effective recycling of residues within the farm there by reducing the cost of production per unit area (Khan et al., 2012).

2.3. IFS to improve nutritional food security

As per the Economic Survey (2018–19), India needs to take big initiatives to improve its food security as it faces supply constraints, water scarcity, small landholdings, low per capita GDP and inadequate irrigation. According to the National Food and Nutrition Security Analysis report, malnutrition amongst children in India is projected to remain high, despite all the progress made in food security. Presently, the status of agriculture and the dependent farmers are very poor, which requires the introduction of appropriate farming technologies, especially suitable Integrated Farming Systems (IFS) and high yielding technologies in order to provide livelihood and food security to the people of the region.

Patel et al. (2020) revealed that integrated farming system with cropping system along with other subsidiaries livestock, boundary plantation, seasonable vegetables, horticultural crops, vermin compost and farm pond is the most beneficial system which can augment the income of small and marginal farmers to improve their socioeconomic status with assured livelihood and nutritional security for long term in North Gujarat Agro Climatic Zone. Implementation of the Integrated Farming System leads to sustainability and constancy in farm income through multiple enterprises that aim at the utmost utilization of available natural resources to meet the family desires.

Khan et al. (2012) noticed that using integrated livestock-fish systems to resolve the environmentally safe manure disposal of feed lot type animal husbandry farms will certainly gain momentum in India with the proliferation of such ventures. It is likely that fish farming combined with animal husbandry can be developed on large-scale in India where small-scale rural fish farming already exists. The integrated farming systems are potentially important in raising the income level as well as the standard of living of small-scale farmers. Most of the farmers are lacking technical knowledge which must be remedied by realistic technical assistance. Waste management, limited sources management, crop planning with organic farming residue increase sustainability in crop. Kumar et al. (2018) addition of organic residues in the form of animal and plant wastes help in improving the soil health and thereby productivity over a longer period of time with lesser environmental hazards with increased profit margin. IFS model comprising of crop components, dairy, poultry and fishery is the most suitable and efficient farming system model giving the highest system productivity for irrigated agro-ecosystem of the northeastern plain zone while suitable IFS model for Indian Central Himalaya region is fishery+poultry+vegetable farming which has considerable potential to provide food security, nutritional benefits, employment generation and providing additional income to resource poor small farmers. In general, IFS enables the agricultural production system

sustainable, profitable (3–6 fold) and productive in long term. About 90–95% of nutritional requirement is self-sustained through resource recycling which curtails the cost of cultivation and increases profit margins and employment. Therefore, it is imperative to state that to sustain food and nutritional security, the IFS approach is promising and will conserve the resource base through efficient recycling of residues and wastes within the system.

2.4. IFS for employment generation

The increase in gross return, net return and No. of man days was due to the practices of different farming systems in a year and that lead to additional income to the farmers. Similar results were reported by Jhana and Pems (2011) and Sachinkumar et al. (2012). Patel et al. (2020) projected results about Integrated Farming System to employment generation was more as compared to the normal farming system.The preliminary research investigations under the IFS approach advocated the benefits of productivity improvement by 30–50% and more than double increase in employment generation than arable farming depending upon the number and kind of enterprises and their management. The integration is made in such a way that the product of one component should be the input for other enterprises with a high degree of complementary effects on each other. The fodder fed to the cattle produces milk. The dung, urine and litter produce farmyard manure and energy used for crops and fishpond (Lightfoot et al., 1993; Singh et al., 2011). IFS is the most promising option for small and marginal farmers. It not only enhances the nutritional and economic status of farm families but also increases employment opportunities and makes optimal use of farm resources. There are many models developed by researchers in different corners of our country but there is an immense need forproper documentation and dissemination for the betterment of the poor and prosperity of our country both in the rural and urban sector.

2.5. Challenges and opportunities to integrated farming system

The increasing cost of agricultural production coupled with issues of the World Trade Organization is threatening the existence of marginal and small farmers in India. Patra (2016) admitted that one could imagine the survival of Indian agriculture, especially for small and marginal farmers through the adoption of Integrated Farming Systems (IFS) on scientific lines. Traditionally, farmers in India had been practicing an integrated system of farming. But, now there is a need to popularize scientific IFS models among farmers to tackle the present agricultural situation in India. However, success depends upon the understanding of input-input and product-product relationships. Reduction in popularity of practicing agriculture as an integrated system is due to several constraints faced by the farmers. The constraints vary across different agro-climatic zones. The scientific interventions should be demonstrated by extension agencies tonarrow down the limitations through enhancement of productivity and income. The efforts of the Government are also required to subsidize IFS models for achieving the target of doubling the farmers' income.The farmers are more vulnerable in selecting the right choices, owing to a misunderstanding on whether the two outputs have complementary, supplementary or competitive relationships.

Despite the benefits of integrating farming, there has been a trend toward increased agricultural specialization in developed countries, whereby crop and livestock enterprises have become increasingly disconnected (Wilkins, 2008; Hilimire, 2011). Although mixed crop-livestock systems continue to dominate the landscape in Australia, there has been a shift toward crop-only systems over recent decades. However, some of this trend is attributed to relative crop and livestock prices and could be slowed or reversed if relative prices change (Bell and Moore, 2012). In places where agriculture has become more specialized, additional capital investments may be necessary if re-integration is to occur, and this may serve as a barrier to the adoption of these systems. Integrated systems often require more labor, and may thus be challenged if there is a decreasing labor supply in agricultural sectors or increasing labor costs. While there has been renewed interest in integrated farming systems in the U.S., it remains to be seen whether this results in an increase in these systems. The current interest in cover crops, which serve a number of functions including forage in crop-livestock systems, has led to research and development of new technology such as specialized equipment for interseeding cover crops into existing cash crops. Such innovation is necessary to utilize cover cropping in large scale farms and will help to foster adoption of these systems by allowing integration to occur while retaining scale economies. However, the costs of these new technologies can serve as barriers to adoption.

3. Conclusion

IFS is the most promising option for small and marginal farmers. It not only enhances the nutritional and economic status of farm families but also increases employment opportunities and makes optimal use of farm resources which results in more productivity. IFS enable the agricultural production system sustainable, profitable (3–6 fold) and productive on long term. About 90–95% of nutritional requirement is self-sustained through resource recycling which curtails the cost of cultivation and increases profit margins.

4. References

Anonymous, 2010. A mannual on integrated farming system. Caribbean Agricultural Research and Development Institute, (Ministry of Economic Development, Belize), 1–58.

Behera, U.K., Dass, A., 2013. Integrated farming system for research in India: an overview.Indian Farming 48(3), 16–28.

Bell, L.W., Moore, A.D., 2012. Integrated crop-livestock

systems in Australian agriculture: trends, drivers and implications. Agricultural Systems 111, 1–12.

Biggs, Stephen, D., 1995. Farming system research and rural poetry: relationshipbetween context and content. Agricultural Systems 47, 161–174.

Choosakul, S., 1999. Challenging crisis with sustainable farming. Sustainable resource management project northeast region, Mahasarakham, Thailand.

Craswell, E.T., 1998. Sustainable crop and soil management on sloping lands. Paper presented at the International Symposium on Asian Agriculture in the 2nd Century. Food and Fertilizer technology Center for the Asian and Pacific, Taipei, Taiwan, ROC, 9–12 June.

Csavas, I., 1992. Regional review on livestock-fish production systems in Asia. In: Mukherjee, T.K., Moi, P.S., Panandam, J.M., Yang, Y.S. (Eds.), Proceedings of the FAO/IPT Workshop on integrated livestock-fish production systems, 16–20th December 1991, Institute of Advance Studies, University of Malaya, Kuala Lumpur, Malaysia.

Devendra, C., 2002. Crop-animal systems in Asia: Implications for research. Agricultural Systems 71, 169–177.

Frescolo, W., 1998. A hierarchical classification of farm systems. Experimental Agriculture 24, 399–419.

Gangwar, L.S., Saran, S., Kumar, S., 2013. Integrated poultry-fish farming systems for sustainable rural livelihood security in Kumaon Hills of Uttarakhand. Agricultural Economics Research Reviews 26(Conference Number), 181–188.

Garibaldi, L.A., Gemmill-Herren, B., D'Annolfo, R., Graeub, B.E., Cunningham, S.A., Breeze, T.D., 2017. Farming approaches for greater biodiversity, livelihoods, andfood security. Trends in Ecology and Evolution (Amst.) 32(1), 68–80.

Gill, M.S., Singh, J.P., Gangwar, K.S., 2009. Integrated farming system and agriculture sustainability. Indian Journal of Agronomy 54(2), 128–139.

Gliessman, S.R., Garcia, R., Amador, M., 1981. The ecological basis for the application of traditional agricultural technology in the management of tropical agro-ecosystem, Agro-Ecosystems 7, 173–185.

Goswami, R., Dasgupta, P., Saha, S., Venkatapuram, P., Nandi, S., Yildiz, F., 2016. Resource integration in smallholder farms for sustainable livelihoods in developing countries, Cogent Food & Agriculture 2(1), 1–15, DOI: 10.1080/23311932.2016.1272151

Gupta, V., Rai, P.K., Risam, K.S., 2012. Integrated crop-livestock farming systems: a strategy for resource conservation and environmental sustainability. Indian Research Journal of Extension Education 2, 49–54.

Hilimire, K., 2011. Integrated crop/livestock agriculture in the United States: a review. Journal of Sustainable Agriculture 35, 376–393.

Jayanthi, C., Vennila, C., Nalini, K., Vivek, G., 2007. Farmer participatory integrated farming system for improving livelihood of small and marginal farmers. In: proceedings of third national symposium on integrated farming systems and its role towards livelihood improvement held at PDCSR, Modipuram from October 26–28, 1–3.

Jhana, K.M., Pems, D.E., 2011. The impact of integrated aquaculture-agriculture on small scale farm sustainability and farmers livelihoods: Experience from Bangaladesh. Agricultural Systems 104, 392–402.

Khan, M.H., Kumar, S., Kadirvel, G., Basumatary, R., Bharti, P.K., Dubal, Z.B., 2012. Livelihood improvement of small and marginal farmers through integrated approach of broiler rabbit production in north-east India. International Journal of Bio-resource and Stress Management 3(3), 419–423.

Kumar, S., Bhatt, B.P., Dey, A., Shivani, Kumar, U., Idris, M., Mishra, J.S., Kumar, S., 2018. Integrated farming system in India: Current status, scope and future prospects in changing agricultural scenario. Indian Journal of Agricultural Sciences 88(11), 1661–1675.

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

Lightfoot, C., Bimbao, M.P., Dalsgaard, J.P.T., Pullin, R.S.V., 1993. Aquaculture and sustainability through integrated resources management. Outlook on Agriculture 22(3), https://doi.org/10.1177/003072709302200303.

Mahapatra, I.C., 1992. Farming systems research challenges and opportunities. Eastern Indian Farming System Research and Extension. Newsletter 6(4), 3–10.

Mahapatra, I.C., Behera, U.K., 2004. Methodologies of farming systems research. In: Panda, D., Sasmal, S., Nayak, S.K., Singh, D.P., Saha, S. (Eds.), Recent advances in rice-based farming systems, 17-19th November 2004. Cuttack, Orissa, Central Rice Research Institute, 79–113.

Manjunath, B.L., Itnal, C.J., 2003. Integrated farming system in enhancing the productivity of marginal rice (*Oryza sativa*) holdings in Goa. Indian Journal of Agronomy 48, 1–3.

Meena, L.R., Kumar, D., Meena, L.K., Singh, K., Singh, S.P., Panwar, A.S., 2018. Integrated farming system model for doubling farmers' income in western Uttar Pradesh. Indian Farming 68(3), 17–19.

Mynavathi, V.S., Jayanthi, C., 2015. Dry land integrated farming system - A Review. Agricultural Reviews 36(1), 67–72.

Panke, S.K., Kadam, R.P., Nakhate, C.S., 2010. Integrated farming system for suatainable rural livelihood security. In: 22nd national seminar on "Role of extension in integrated farming systems for sustainable rural livelihood, 9th-10th Dec, Maharastra, 33–35.

Patel, K.M., Patel, P.K., Desai, L.J., Patel, K.N., Patel, S.A., Chaudhary, H.L., 2020. Integrated farming systems for livelihood security of small and marginal farmers.

Multilogic in Science 10(33), 600–603.

Patra, A.K., 2016. Concept, scope and components of integrated farming system. Training Manual- a model training course on root and tuber crop based integrated farming system: A way forward to address climate change and livelihood improvement, 8–13.

Plumecocq, G., Debril, T., Duru, M., Magrini, M.B., Sarthou, J., Therond, O., 2018. The plurality of values in sustainable agriculture models: diverse lock-in and coevolution patterns. Ecology and Society 23(1), 21.

Praphan, N., 2001. Resilient of indigenous knowledge, fight to world crisis. Isan alternative farming network, Ubonratchathani, Thailand.

Pretty, J., Bharucha, Z.P., 2014. Sustainable intensification in agricultural systems. Annals of Botany 114(8), 1571–1596.

Rathore, V.S., Tanwar, S.P.S., Kumar, P., Yadav, O.P., 2019. Integrated farming system: Key to sustainability in arid and semi-arid regions. Indian Journal of Agricultural Sciences 89(2), 181–192.

Ravisankar, N., Pramanik, S.C., Rai, R.B., Nawaz, S., Biswas, T.K., Bibi, N., 2007. Study of an integrated farming system in hilly upland areas of Bay Islands. Indian Journal of Agronomy 52, 7–10.

Ruaysoongnern, S., Suphanchaimant, N., 2001. land-use patterns and agricultural production systems with emphasis on changes driven by economic forces and market integration. In: Kam, S.P., Hoanh, C.T., Trebuil, G., Hardy, B. (Eds.), Natural resource management issues in the Korat basin of northeast Thailand: An overview. Proceedings of the planning workshop on ecoregional approaches to natural resource management in the korat basin, northeast Thailand: towards further research collaboration, held on 26–29th October 1999, KhonKaen, Thailand. Los Banos (Philippines): International Rice Research Institute, 67–77.

Ryschawy, J., Choisis, N., Choisis, J.P., Joannon, A., Gibon, A., 2012. Mixed crop–livestock systems: an economic and environmental-friendly way of farming?. Animal 6, 1722–1730.

Sachinkumar, T.N., Basavaraj, H., Kunnal, L.B., Kulkarni, G.N., Mahajanashetty, S.B., Hunsyal, C.S., Hosamani, S.V., 2012. Economics of farming System in Northern Transitional Zone of Karnataka. Karnataka Journal of Agricultural Sciences 25(3), 350–358.

Sheikh, M.M., Riar, T.S., Kanak Pervez, A.K.M., 2021. Integrated farming systems: A review of farmers friendly approaches. Asian Journal of Agricultural Extension, Economics and Sociology 39(4), 88–99.

Shekinah, D.E., Jayanthi, C., Sankaran, N., 2005. Physical indicators of sustainability-a farming systems approach for the small farmer in the rain-fed vertisols of western zone of Tamil Nadu. Journal of Sustainable Agriculture 25(3), 43–65.

Singh, J.P., Gangwar, B., Pandey, D.K., Kochewad, S.A., 2011. Integrated farming system model for small farm holders of Western Plain Zone of Uttar Pradesh. PDFSR Bulletin No. 05, pp. 58. Project Directorate for Farming Systems Research, Modipuram, Meerut, India.

Swaminathan, M.S., 1987. Inaugural address. In: International symposium on sustainable agriculture. International Rice Research Institute, Las Banos, Philippines.

Tokrishna, R., 1992. Integrated livestock-fish farming systems I Thailand. In: Mukherjee, T.K., Moi, P.S., Panadam, J.M., Yang, Y.S. (Eds.), Proceedings of the FAO/IPT Workshop on Integrated Livestock-Fish Production Systems, 16-20th December, 1991. Institute of Advanced Studies, University of Malaya, Kuala Lumpur, Malaysia.

Wilkins, R.J., 2008. Eco-efficient approaches to land management: a case for increased integration of crop and animal production systems. Philosophical Transactions of the Royal Society B: Biological Sciences 363(1491), 517–525.

Willett, I.R., 1995. Role of organic matter in controlling chemical properties and fertility of sandy soil used in lowland rice in Northeast Thailand. In: Lefroy, R.D.B., Blair, G., Craswell, E.T. (Eds.), Soil organic matter management for sustainable agriculture. ACIAR Proceedings 56, 109–114.