The Pharma Innovation Journal 2022; SP-11(5): 1488-1496

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(5): 1488-1496

www.thepharmajournal.com
Received: 22-03-2022
Accepted: 03-05-2022

Anuraj Singh
Department of Agronomy, Lovely Professional University, Punjab, India

Sangramsing P Bainade
Assistant Professor, Department of Agronomy, Lovely Professional University, Punjab, India

Cheenu Kashyap
Department of Agronomy, Lovely Professional University, Punjab, India

Vivek Kumar
Department of Agronomy, Lovely Professional University, Punjab, India

Corresponding Author
Anuraj Singh
Department of Agronomy, Lovely Professional University, Punjab, India

Integrated farming system

Anuraj Singh, Sangramsing P Bainade, Cheenu Kashyap and Vivek Kumar

Abstract
Integrated farming system is an environmentally beneficial strategy in which waste from one sector is used as an input in another, allowing for more effective use of agricultural resources. As a mixed farming system, Integrated Farming System is a system made up of at least two distinct but conceptually is related components of an agriculture and livestock enterprise that are related to each other. IFS aids in soil health, weed control, and pest control, improves water efficiency, and keeps water clean quality. The use of toxic chemicals in an integrated farming system is prohibited. Pesticides, weed killers, and chemical fertilizers should all be avoided. Small and marginal farmers' economic conditions improve as a result of the integrated farming system, which enhances their education, health, and social obligations, as well as their overall livelihood security. Chemical use (fertilizers and pesticides) can be minimized using the IFS technique, resulting in chemical-free, healthy food for society.

Keywords: Integrated farming system, concept, goals, productivity, profitability, advantages, disadvantages

Introduction
According to the Economic Survey of India, between 1990 and 2007, food grain output grew at a rate of 1.2 percent, which is lower than the population growth rate of 1.9 percent. Our country's population is expected to reach 1370 million by 2030, and 1600 million by 2050. To meet future demand, we'll need to produce 289 and 349 mt of food grains during the next two years. According to the current situation in the country, the area under cultivation may continue to decline, with more than 20% of current cultivable land being converted to non-agricultural uses by 2030. (Gill *et al*., 2005) [2]. The difficulty is exacerbated in India by the falling average farm size and financial constraints that prevent larger agricultural investment because 80 percent of farmer families belong from small or middle class group. Productivity improvement could be a crucial answer for ensuring nutrition and food security for a large population. This entails the use of scientific agronomic methods and technologies to increase the productive potential of conventional agricultural systems.

During the twentieth century, agronomic practices such as the authorized use of inorganic fertilizers and pesticides increased productivity. Environmental degradation that is significant but unfavourable agriculture's operational costs have soared as a result raised doubts about the feasibility and long-term viability of the project (FAO, 2010; IAASTD, 2009) [106, 107]. Animals were once used as a source of food utilized to give direct meals or other services such as horses provide either power (draught animals) or transportation (horses) farming systems that are integrated animals were also involved engaged in an indirect capacity to perform weed and pest control services.

Animals could also provide resources like dung or leather, which could be sold directly or transformed into a value-added product, bringing money back into the business (Devendra and Thomas 2002) [105].

Unsustainable farming pollutes the environment, endangering the livelihoods of millions of small-scale farmers and their families. Increasing agricultural production systems for improved sustainability and economic returns is a vital strategy for developing countries to increase income, food, and nutrition security (Ravallion, 2007) [5].

IFS is a whole-farm integrative method that is successful in solving difficulties for small and marginal farmers. The goal of IFS is to increase small-scale farm employment and revenue by integrating multiple farm enterprises and recycling crop leftovers and byproducts on the farm. Farmers must have a steady source of income in order to live comfortably above the poverty level. To meet the challenges given by the current economic, political, and technical environment, progress in production or sustained growth in output is required.

In this context, a farming system approach is one of the most important solutions for dealing with this peculiar situation, as it allows for the careful management of various enterprises and the development of location-specific systems based on available resources, resulting in long- term development (Dashora and Hari, 2014) [7] in integrated faring system all firms are interlinked with each other that is the waste from the one can be used for the growth of other. According to IFS, waste from one type of agriculture can be used as a resource for another.

We not only remove waste, but we also ensure an overall boost in production for agricultural systems as a whole (CARDI, 2010) [13] IFS is a set of resource-saving strategies aimed at achieving acceptable profits and high and sustained production levels while reducing the negative consequences of comprehensive farming and preserving the environment (Lal and Miller, 1990, Gupta *et al.*, 2012) [33, 108].

IFS concept

IFS is a mixed farming system described as a crop and livestock enterprise that comprises of at least two different but logically interdependent sections (Okigbo, 1995) [83]. (Edwards, 1997 and Jitsanguan, 2001) [45, 94] describes the integrated farming system as crop aquaculture farming system in which the fishes are fed with fresh animal waste and along with that fishes leads to increase in the nitrogen and phosphorous content of the soil and plants (Giap *et al.* 2005) [51]. A farming arrangement is a collection of farm enterprises in which farm owners allocate resources for the most efficient use of the actual enterprises in order to boost the production and economic profit of farm. Crops, agroforestry, cattle, aquaculture, agri-horticulture, and sericulture are among the agricultural operations (Singh, 2004) [96]. IFS is defined by (Radhamani *et al.*, 2003) [95] as a component of farming systems that considers the notions of boosting productivity, reducing risk, and increasing profits while enhancing the utilisation of organic wastes and crop leftovers in the field.

IFS is a component of FRS (Farming System Research), according to (Jayanthi, 2006) [93], and it brings a transformation in farming techniques for enhancing productivity in the cropping pattern while also ensuring optimum resource availability.

As per Panke *et al.* (2010) [26], integration is done in such a way that the output of one enterprise / component becomes the input for the other enterprises with a high degree of valuable effects. According to the authors, the aim of IFS is to reduce waste from many subsystems on the farm, which enhances employment prospects, nutritional security, and income for rural people.

Integrated Farming System Goals

IFS's four main Goals are

1. Maximization of all component enterprises' yields to ensure a consistent and stable income.
2. Achieve agro-ecological equilibrium by rejuvenating/improving the system's productivity.
3. Using natural cropping system management, avoid the build-up of insect pests, diseases, and weed populations and keep them at a low intensity.
4. Reducing the use of chemicals (fertilisers and pesticides) in order to provide society with chemical-free, healthy produce and an environment (Manjunatha, 2014) [81].

Farming System Vs. Integrated Farming System

The agricultural system, according to Rana and Pankaj [35], is an appropriate combination of farming activities such as cropping systems, horticulture, livestock, fishing, forestry, and poultry. They realised that the farmers' ability to profit from these activities was the most important issue for agriculture. They demonstrated that the agricultural system interacts with the environment, but that this interaction must not disrupt the ecological and socioeconomic equilibrium. Finally, they realised that agriculture has national as well as farmer (profit), consumer (food), and posterity (environmental sustainability) goals to achieve.

While these goals are essentially at odds, the agricultural system will assist expand the economy where it runs and enhance farmers' living standards in the country by seeking to optimise progress toward each. FSR (Farming System Research) component IFS promotes a change in farming operations for optimum crop output and optimal resource utilisation. In the IFS, farm waste is better repurposed for beneficial purposes.

Unlike the CFS, the IFS concentrates its efforts on a small number of interdependent, interconnected, and frequently interlinking production systems based on a few crops, animals, and related sub-professions. IFS aims to increase total productivity, sustainability, and gainful employment by using complementarities and synergies among various agricultural sub- systems/enterprises.

As a result, farmers are encouraged to switch from CFS to IFS in order to maximise resource usage and assure long-term production sustainability.

Components of IFS

(Thamizoli *et al.*, 2006) [97] discovered that combining forestry and agriculture, as well as farm- based allied sectors like as dairy, apiculture, goat rearing, and so on, can be used as a risk management method to deal with calamities such as lengthy drought seasons and major floods. In the Gajapati area of Orissa, (Mohanty *et al.*, 2010) [99] found that the IFS model includes field crops (rice, groundnut, maize, pigeon, pea, and ragi), horticulture crops (yam, banana, tapioca, and vegetables), chicken (Vanaraja breed), and vermicomposting. Crop + dairy, crop + dairy + goats + horticulture, crop + horticulture +goats, crop +dairy + vegetables, dairy + vegetables + horticulture, dairy + vegetables, and dairy + crop + companion animals are among the primary components in IFS, according to (Tripathi and Rathi, 2011) [98].

The prisoner from Erode district of Tamilnadu had goat +crop, goat +dairy + crop, goat + dairy, and goat +dairy +crop systems as the key components in IFS, according to (Manivannan *et al.*, 2011) [80]. Agriculture — Horticulture, Forestry, Dairy, Fish farming, Duck rearing are all components of IFS. Mushroom farming - sericulture, azolla farming, kitchen gardening, fodder production, and nursery Vermiculture, Pigeon Rearing, Apiary, Goat Rearing, and Poultry Production are all examples of seed production. Piggery, Rabbitry, and Sheep Rearing Addition of value (Lal *et al.*, 2018) [109]. The increasingly popular practise of aquaponics is an integrated method peculiar to small-scale farms. Aquaponics is a combination of fish culture (aquaculture) with soilless plant production that is commonly connected with greenhouse or other controlled environment production methods.

The increasingly popular practise of aquaponics is an integrated method peculiar to small-scale farms. Aquaponics is a combination of fish culture (aquaculture) with soilless plant production that is commonly connected with greenhouse or other controlled environment production methods. Nutrients obtained from fish excrement, with tilapia being the most common fish species used, are recirculated through the structure and used by plants to meet their nutrient requirements in this sort of production system. Large numbers of fish are typically reared in modest amounts of water to allow non-toxic nutrient concentrations to clump together (Rakocy *et al.*, 2006) [100].

Advantages

IFS is more beneficial to farmers than they may imagine. Produce more by maximising resource use, recycling waste, and utilising family labour. It is beneficial to any investigation since it not only provides an overview of previous work but also serves as a foundation for interpretation and debate of findings for future research. (Sasikala and colleagues, 2015) [101]. By integrating livestock into crop-based farming, (Ngambeki *et al.*, 1992) [104] demonstrated the system's profitability through greater financial advantages and better use of intermediate farm resources like as manure, draught power, and crop wastes. It has been noticed that the integration of various firms on the one hand, and the integration of various enterprises on the other hand, arble size land holding are less profitable as compared to various size of land holding, and hence create more jobs. When compared to the conventional rice cropping system, (Rangasamy *et al.*, 1996) [103] describes how integrating poultry, mushroom, and fish with rice cultivation over five years increased net farm income and on-farm labour. The comparative analysis also suggested that diversification and integration of resource management can be productive, profitable, and manageable, given access to labour and secure tenure.

According to (Ashby, 2001) [10], relying on a few crops in combination with a high chance of crop failure owing to a variety of variables such as disease, drought, and other factors exposes farmers to a high degree of fluctuation in yields and income, and hence risk. Animal excrement is also a great fertiliser, providing additional nutrients to the soil in addition to the simple chemical nutrients of N, P, and K. Manure continues to be the link between crop and animal production in the developing world as an input for crop farming methods.

The major problem is to find better techniques to boost production. benefits that manure can provide to society and the environment. Crop leftovers can be fed to animals, while increasing agricultural output can be achieved by utilising livestock manure by intensifying nutrients that increase soil fertility and decreasing the usage of artificial fertilisers (Gupta *et al.*, 2012) [44].

Due to the integration of several firms of varying economic importance, there is a greater level of sustainability in agricultural output. Recycling wastes as they accumulate in the system reduces reliance on external high-energy inputs, preserving natural and precious resources. Money progresses through the farming system. Eggs, edible mushrooms, milk, honey, silkworm cocoons, and other items are available to the farmer throughout the year. This will assist a resource-strapped farmer in escaping the clutches of moneylenders and/or agencies.

The demand of the chemical fertilizers get automatically reduced as the recycling of organic wastes. Furthermore, biogas production can meet the energy needs of a home. As a result, IFS contributes significantly to the resolution of energy issues (Manjunatha, 2014) [81].

Problems

According to Devendra *et al.* 2011 [38], dairy goats are frequently overlooked in development efforts, despite their importance in some nations. The spread and intensification of smallholder dairy production is fueled by the constant need for milk. However, this demand is associated with difficulties in milk handling and distribution, problems in maintaining hygiene and environmental pollution. The major constraints faced by the producers are, inter alia, choice of strains, breeds and availability of animals; fodder & feed resources as well as improved feeding systems; advanced breeding & reproduction, animal health care activities; management & maintenance of animal excreta; organized, functional marketing channels; and sufficient market outlets.

According to Pushpa *et al.* 2011 [102], the most significant constraint for 86.19 percent of respondents was a lack of coordinated extension services. The lack of demonstration of the integrated farming system was the second major limitation, cited by 80.95 percent of respondents. The third major stumbling block was a lack of understanding of corporate integration (67.62 percent). The other two restrictions connected to the third constraint were a lack of information on the types and sizes of firms to be included (55.24 percent) and a lack of understanding on successful farm waste recycling (33.81 percent). Inadequate credit facilities and a lack of composite credit facilities were cited by 67.62 percent and 49.52 percent of respondents, respectively.

Limited scientific knowledge in animal rearing, unavailability of advanced breeds in local markets, and insufficient financial support were among the constraints identified by (Kadam *et al.* 2010) [110]. Thirty percent of respondents complained of a lack of adequate market facilities and the absence of cooperative societies; twenty percent, six percent, and four percent of respondents mentioned limited scientific knowledge in animal rearing, unavailability of advanced breeds in local markets, and insufficient financial support, respectively.

Thamrongwarangkul *et al.* 2001 [76] noted that resource deprived farmers were unable to invest more capital because farmers always need fast returns so that they can manage the expensives of their family. High start-up expenses, according to Tipraqsa *et al.* 2007, may deter farmers from moving to integrated farming and reaping the benefits of resource integration.

Productivity and profitability

Crop- Aquaculture farming system

This type of farming system is mainly followed in china, japan, Indonesia, Thailand, Philippines. Many reports suggests that by the adoption of Rice + Fish farming it would be very beneficial. It helps in increasing the fertility of soil as fish helps in increasing the availability of phosphorous and nitrogen in the soil. And on the other hand fish will get benthic, planktonic and periphyton type of food from the rice field. (Mustow 2002) [92] as it would be helpful in fulfilling both the fish and rice demands. Integrated fish and rice farming sytem is very successful in lowland rice because there is proper utilization of fertilized water and food chain. This system maintains the utilization of farm resources and

also helpful in maintaining the food security. This type of farming system not only helpful in adoption of different type of farming system but also helps in increasing the economical status of the farmers.

Balusamy *et al.* (2003) [15] explained that the rice + azolla + cum fish aquaculture is the most widely adopted method in crop aquaculture farming system. In this the input cost is very less as compared to the output cost. As in rice field utilized the aquatic productivity of rice when rice bottom is highly fertilized it helps in production of zoo and phytoplankton which is utilized by fish.

Different type of farming system but also helps in increasing the economical status of the farmers

Ways of farming system	Increase in percentage	Increase in yield rupee/hectare
Rice + azolla + fish	25.7%	8817/ha
Rice + fish	6.9%	3219/ha
Rice Farming	0%	Normal yield

Model proposed in Tamil Nadu (source Balusamy *et al.* 2003) [15]

(Bisht 2011) [83] also worked Rice- Fish farming system in Indian Central Himalayan and an average net gain he get is rupee 36823 annually with an investment of rupee 11925. If we do the economic analysis it clearly shows that the increase in income is 200%. This show that Rice+ Fish farming is very advantageous to farmers at both nutritionally and economically.

Crop livestock farming system

Crop wastes can be used for animal feed in an integrated crop livestock farming system, while manure from livestock can boost agricultural output by increasing nutrients that improve soil fertility and decreasing the usage of artificial fertilisers (Gupta *et al.* 2012) [44]. Excreta from animals contain a variety of nutrients (including nitrogen, phosphorus, and potassium) as well as organic matter, which are essential for soil structure and fertility. Bhatt and Bujarbaruah, (2005) [63] analysed different sources of manure available in Intensive integrated farming system developed in Umiam and found higher N,P,K, Ca, and Mg in farmyard manure, poultry manure, goat manure, vermi-compost, pig manure, liquid manure, cow dung, duck droppings, and Azolla pinnata in the range of N (%): 0.65- 5.20, P (%): 0.35- 1.46, K (%): 0.18-3.60, Ca (%)- 0.75-4.15, Mg (%)- 0.07-3.96 within the system's recycling.

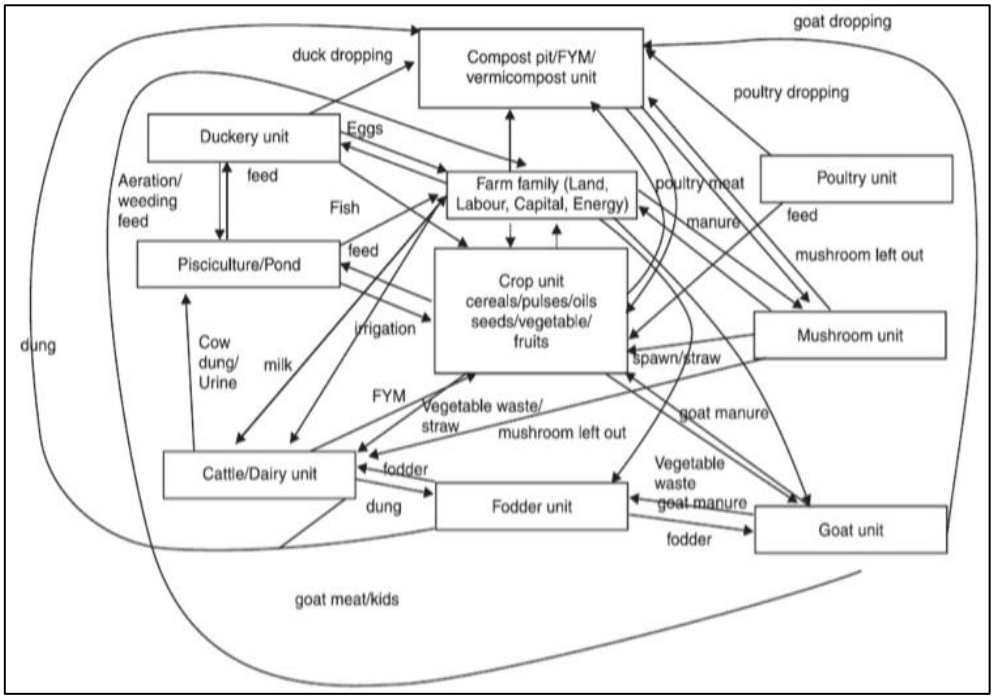

Fig 1: Input-Output flow diagram existing under the developed IFS module [Kumar *et al.* (2011)] [86]

Kumar *et al.* (2011) [86] noted that nutrient recycling has boosted nutrient efficiency at the farm level by using wastes/by-products of crops/animals as inputs for another component. Figure. 1 shows the input-output flow diagram. Organic residues in the form of recycled animal and plant wastes could also aid in increasing soil health and hence productivity over a longer period of time while posing less environmental risks (Gill *et al.* 2009, Kumar *et al.* 2017) [1, 87]. Integration of crop sequences with animal components boosted overall system profitability, even on a small farm of 0.50 ha in Umiam, Meghalaya, with a 32 percent slope (converted into terraces), contributing more than 55 percent of total farm income and making the system economically more beneficial (Panwar 2014) [85]. By providing monetary income, boosting family nutrition, and recycling crop wastes and livestock waste into useful nutrient sources for crops, the inclusion of animal components in the system established a positive link on sustainability (Saxena *et al.* 2003) [57]. Dhiman *et al.* (2003) [84] stated that integrating cattle with crops on a watershed and individual holding basis improved the traditional farming system sustainabily and environmentally. In the North Telangana zone, a farming system that included agricultural and dairy created more than 200 percent more jobs than agriculture alone. Agriculture and dairy had the highest net returns, followed by agriculture and poultry and agriculture and sheep (Reddy 2005) [56].

Crop poultry farming system

Crop poultry integrated farming system plays important role in increasing the income of farmers. Poultry waste like (duck

droppings) can increase the profit percentage of farmers upto 20% by enhancing the physical properties of the soil like infiltration rate, porosity and bulk density. (Mathew and Varughese 2007) [91].

Crop-fish-poultry farming system

Channabasavanna *et al.* 2002) [88] found that rice-fish-poultry combinations produced the highest net revenue (>'157000/ha) while also improving soil health in integrated farming system studies in Sirupura. According to Channabasavanna and Biradar (2009) [89], the nutritional status of soil NPK improved from 187 kg/ha to 262 kg/ha (40%) in the rice-fish poultry system, 29.3 kg/ha to 33.6 kg/ha (14%) in the traditional system, and 503 kg/ha to 530 kg/ha (5.4%) in the rice-fish poultry system (rice-rice). The rise was 11.5 percent as compared to traditional systems. Similarly, IFS demonstrated a rise in P and K content.

Ramrao *et al.* (2006) [90] investigated a crop-livestock integrated farming system for marginal farmers in rainfed regions of Chhattisgarh in Central India to find a sustainable mixed farming model that is economically viable by integrating different components such as crop, livestock, poultry, and duck on almost two acre land holding. With a net income of '33076 per year against arable farming, a model with 2 bullocks + 1 cow + 1 buffaloes + 10 goats + 10 poultry + 10 ducks plus crop cultivation was the best (crop farming) alone (7843 per year) with a cost-to- benefit ratio of 1:2.238 and a 316-day employment cycle.

In the upland model, a Cashew (Variety Bhaskara) + Pine apple (Variety Giant Kew) system in the upper elevation; a local coconut cultivar intercropped with elephant foot yam/papaya (local selection) and noni (*Citrus aurantifolia*) in the middle elevation; and a high-yielding arecanut variety Mangala with tissue cultured banana intercrop in lowlying areas integrated with poultry Solaiappan *et al.* (2007) [59] investigated different farming system models alongside conventional cropping and discovered that the model with poultry (20) + goat (4) + sheep (6) + dairy (1) produced the highest levels of organic carbon (0.35 percent), available soil N (134 kg/ha), soil P (8.5 kg/ha), and soil K (378 kg/ha) at the conclusion of the study.

Conclusion

Integrated farming systems (IFSs) are well-known around the world for their long-term viability and profitability. Small and marginal farmers should explore adopting IFSs in large numbers. They must be shown why single-product farms make it difficult for them to meet their food and other fundamental needs.

Farm income is slowly declining due to shrinking land holdings and continued non-integrated agriculture. Crops, dairy, fisheries, poultry, mushrooms, horticulture, sericulture, and other agricultural components must be integrated into a single farm unit to preserve farm income.

IFS is a comprehensive strategy that takes into account interactions between the various IFS components as well as the environment. IFS is also a one-of-a-kind waste recycling system in that nothing is wasted; the trash or by-product of one system becomes the feed for other systems. Labor-intensive enterprises like as dairy, poultry, fruits, vegetables, sericulture, mushrooms, and other labor-intensive enterprises can improve employment generation (man- days) on an IFS farm, particularly for family labour. Furthermore, spending on external inputs will be reduced. IFS is both economically and environmentally viable.

References

1. Gill MS, Singh JP, Gangwar KS. Integrated Farming system and agriculture sustainability. Indian Journal. 2009;54(2):128-139.
2. Gill MS, Samra JS, Singh G. Integrated Farming System for realizing high productivity under shallow water table conditions. Research Bulletins, Department of Agronomy PAU, Ludhiana, 2005, 1-29.
3. Ravisankar N, Pramanik SC, Rai RB, Nawaz Shakila, Biswas Tapan KR, Bibi Nabisat. Integrated farming system in hilly upland areas of Bay Islands. Indian Journal of Agronomy. 2007;52(1):7-10.
4. Kumar S, Singh SS, Shivani, Dey A. Integrated farming systems for Eastern India. Indian Journal of Agronomy. 2011;56(4):217-304.
5. Ravallion M, Chen S. China's (Uneven progress Against Poverty, Journal of Development Economics. 2007;82(1):1-42.
6. Ramrao WY, Tiwari SP, Singh P. Crop-livestock integrated farming system for augmenting socio-economic status of smallholder tribal farmers of Chhattisgarh in Central India. Livestock Research for Rural Development, 2005, 17(8).
7. Dashora LN, Singh H. Integrated Farming System- Need of Today. International Journal of Applied Life Sciences and Engineering. 2014;1(1):28-37.
8. Channabasavanna AS, Biradar DP, Prabhudev KN, Hedge M. Development of profitable integrated farming system model for small and medium farmers of Tungabhadra project area of Karnataka. Karnataka J Agric. Sci. 2009;22(1):25-27.
9. Gupta AK, Yadav D, Dungdung BG, Paudel J, Chaudhary AK, Arshad R. Integrated farming system. International Journal of Engineering Applied Science and technology. 2020;4(9):134-137.
10. Ashby JA. Integrated research on food and the environment: An exit strategy from the rational fool syndrome in agricultural science. Ecol. Soc, 2001, 5.
11. Kumar S, Bhatt BP, Dey A. Integrated farming system in india: current status, scope and future prospects in changing agricultural scenario. Indian Journal of Agricultural Sciences. 2018;88(11):1661-1675.
12. Sheikh MM, Riar TS, Kanak Parvez AKM. Integrated Farming Systems: A review of farmers friendly approaches. Asian Journal Agricultural Extensions, Economics & Sociology. 2021;39(4):88-99.
13. CARDI, A Mannual on Integrated Farming System. Caribbean Agricultural Research and Development Institute, (Ministry of Economic Development, Belize), 2010, 1-58p.
14. Ponnusamy K, Devi MK. Impact of Integrated Farming System Approach on Doubling Farmers' Income. Agricultural Economics Research Review. 2017;30:233-240.
15. Jayanthi C, Balusamy M, Chinnusamy C, Mythili S. Integrated nutrient supply system of linked components in lowland integrated farming system. Indian Journal of Agronomy. 2003;48(4):41-46.
16. Behera UK, Panigrahi P, Sarangi A. Multiple Water Use Protocols in Integrated Farming System for Enhancing Productivity. Springer Link. 2012;26:2605-2623.
17. Mamun AS, Nasrat F, Debi MR. Integrtaed Farming

Sytem Prospectus in Bangladesh. Journal of Environmental Science and Natural Resources. 2011;4(2):127-136.
18. Nayak PK, Nayak AK, Panda BB, Lal B, Jambhulkar NN. Ecological mechanism and diversity in rice based integrated farming system. Science direct. 2018;91:359-375.
19. Puspha J. Constraints in various integrated farming system. Agricuture Hind Agricultural Research and Training institute. 2011;5(3&4):370-374.
20. Tiprasqsa P, Craswell ET, Noble AD, Schmidt VD. Resource Integration for multiple Benefits: Multifunctionally of integrated farming sytsemin Northeast Thailand. Agricultural System. 2007;94:694-703.
21. Khasyap P, Singh MP, Singh VK, Prusty AK, Mishra RP. Resource integration for livelihood and nutritional security of farmers of Tehri Himalayas of India. Indian Journal Agricultural Science. 2017;87(9):1196-1202.
22. Mukherjee D. Potential integrated farming system model in mid hill region of west Bengal situation. Annual Agriculture Research. 2015;34(3):264-268.
23. Manujatha SB, Shivmurthy D, Sunil A, Nagaraj MV, Basavesha KN. Integrated farming sytem: An holistic approach: A Review. 2014;3(4):30-38.
24. Ansari MA, Prakash N, Baishya LK, Punitha P, Yadav JS, Sharma PK. Comparative Study on Conventional and improved integrated farming system for stable production, income generation and employment oppurtunity among tribal farmers in hilly region of manipur. Journal of Agricultural Sciences. 2013;83(7):765-772.
25. Singh JP, Gangwar B, Kochewad SA, Pandey DK. Integrated farming system for improving of small farmers of western plain zone of Uttar Pradesh. SAARC Journal of Agriculture. 2012;10(1):45-53.
26. Pankhe SK, Kadam RP, Nakhate CS. Integrated Farming System for sustainable rural livelihood security. 22nd National Seminar on Role of Extension in Integrated Farming System for Sustainable livelihood, 2010, 33-35.
27. Patel RH, Dutta S. Integrated farming system approach for sustainable yield and economic efficiency. Agricultural Review. 2004;25:219-224.
28. Uddin MT, Khan MA, Islam M. Integrated farming and its impact on farmers livelihood in Bangladesh. SAARC Journal Agriculture. 2015;13(2):61-67.
29. Shukla KS, Tripathi CM. Study of Integrated Farming Sytem- A Case Study. International Journal of Engineering and Technology. 2019;6(4):5299-5303.
30. Varughese K, Mathew T. Integrated farming System for sustainability in coastal ecosystem. Indian Journal of Agronomy. 2009;54:120-127.
31. Singh R, Riar TS, Gill JS. Integrated farming systems and socio-economic characteristics of Punjab Agriculture University. Awardee Farmers. Asian Journal of Agricultural Extension, Economics & Sociology. 2017;16(3):1-5.
32. Kumar S, Bhatt BP, Dey A, Shivani U, Kumar MD, Idris JS, *et al.* Integrated farming system in India: Current status, scope and future prospects in changing agricultural scenario. Indian Journal of Agricultural Sciences. 2018;(11):1661-75.
33. Lal, R. and Miller, F.P. Sustainable Farming for tropics. In: Singh, R.P. (Ed) Sustainable agriculture: Issues and Prospective. Indian Society of Agronomy, IARI, New Delhi. 1990;1:69-89.
34. Kumar R, Patra MK, Thirugnanavel AB, Deka CD, Chatterjee T, Borah R, *et al.* Comparative evaluation of different integrated farming system models for small and marginal farmers under the Eastern Himalayas. Indian Journal of Agricultural Sciences. 2018;11:1722-29.
35. Rana SS, Pankaj C. Integrated Farming System. Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 2013, 1-90.
36. Rana SS. Recent Advances in Integrated Farming Systems. Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 2018.
37. Khalid UB, Shahbaz P, UlHaq S, Javeed S. Economic Analysis of Integrated Farming Systems on Farm Income. A case Study of Sahiwal District, Punjab, Pakistan. International Journal of Management and Economics. 2017;3(11):1434-1444.
38. Devendra C. Smallholder Dairy Production Systems in Developing Countries. Asian- Australia Journal of Animal Science. 2011;14:104-11.
39. Dhaka BL, Jat RA, Poonia MK. Integrated Farming System Approach for Natural Resource Management. Indian J Fertilizer. 2009;5:31-34.
40. Jagadeeshwara K, Nagaraju Y, Bhagyavathi Nagaraju K. Livelihood improvement of vulnerable farmers through Integrated Farming Systems of Southern Karnataka. 2011;4(3):145-146.
41. Poorani A, Jayanthi C, Vannila C. Farmer participatory research on integrated farming system. In: National seminar on Innovation in farming systems research and extension of exclusive development 24-25 Nov, Madras Veterinary College, Chennai, 2011, 153.
42. Nageswaran M, Selvaganapathy E, Subbiah VR, Nair S. Demonstration and Replication of integrated Farming Sustems at Chidambaram. Report of M.S. Swaminathan Research Foundation (MSSRF), Chennai, 2009, 16-53p.
43. Bhalerao RA, Cgarge KV, Patil VG. Profile of the farmers practicing livestock based farming system: 22nd national seminar on Role of Extension in Integrated Farming Systems for sustainable rural livelihood, 9th - 10th Dec. Maharashtra, 2010, 29.
44. Gupta V, Rai PK, Risam KS. Integrated crop-livestock farming systems: A strategy for resource conservation and environmental sustainability. Indian Research Journal of Extension Education. 2012;2:49-54.
45. Edwards P. Sustainable food production through aquaculture. Aquaculture Asia. School of Environment, Resources and Development, Asian Institute of Technology (AIT), Pathumthani, Thailand, 1997, 2.
46. Jayanthi C. Integrated farming system: A path to sustainable agriculture. 2nd edition, Published by Department of Agronomy, Directorate of Soil and Crop Management Studies, Tamil Nadu Agriculture University Coimbatore, 2006, 1p.
47. Jayanthi C, Balusamy M, Chinnusamy C, Mythili S. Integrated nutrient supply system of linked components in lowland integrated farming system. Indian Journal of Agronomy. 2003;48:241-6.
48. Shanmugasundaram VS, Balusamy M. Rice-fish- Azolla An Integrated Farming System in low land wetlands. Farming Systems. 1993;9:105-7.

49. Shanmugasundaram VS, Balusamy M, Rangaswamy A. Integrated farming system research in Tamil Nadu. Journal of Farming Systems Research and Development. 1995;1(1, 2):1-9.
50. Ganesan S, Chinnaswamy KN, Balasubramaniam A, Manicksundaram P. Studies on rice-based farming systems with duck-cum fish culture in deltaic region in Thanjavur district of Tamil Nadu. Farming Systems News Letter. 1999;1(2):15.
51. Giap DH, Yi Y, Lin CK. Effects of different fertilization and feeding regimes on the production of integrated farming of rice and prawn Macrobrachium rosenbergii. Aquaculture Research. 2005;36:292-9.
52. Korikanthimath VS, Manjunath BL. Integrated farming systems for sustainability in agricultural production. Indian Journal of Agronomy. 2009;54(2):140-8.
53. Kulkarni SR, Upperi SN, Hurali S, Ahmmed Z, Goudar SB. Sustainable livelihood improvement of farmer through integrated farming system. Proceedings of National Symposium on Agricultural Diversification for Sustainable Livelihood and Environmental Security, held during 18-20 November 2014 at Ludhiana, Punjab, 2014, 574.
54. Kumar S, Singh SS, Meena MK, Shivani, Dey A. Resource recycling and their management under integrated farming system for lowlands of Bihar. Indian Journal of Agricultural Sciences. 2012;82(6):504-10.
55. Kumar Sanjeev, Subhash N, Shivani Singh SS, Dey A. Evaluation of different components under Integrated Farming System (IFS) for small and marginal farmers under semi-humid climatic environment. Experimental Agriculture. 2012b;48(3):399-413.
56. Reddy MD. Predominant farming systems and alternatives in Andhra Pradesh. Journal of Farming Systems Research Development. 2005;11:217-27.
57. Saxena DC, Singh NP, Satapathy KK, Panwar AS, Singh JL. Sustainable farming systems for hill agriculture. (In) Proceeding of National Seminar Approaches for Increasing Agricultural Productivity in Hill and Mountain Ecosystem', held during 18-20 October, 2001at Barapani, 2003, 73-85.
58. Sharma SK, Sharma RK, Jajoria D, Kumar A. Enhancing income and resource conservation through micro farming systems. (In) Proceedings of National Symposium on Agricultural Diversification for Sustainable Livelihood and Environmental Security, held during 18-20 November 2014 at Ludhiana, Punjab, 2014, 561-2p.
59. Solaiappan U, Subramanian V, Maruthi SGR. Selection of suitable integrated farming system model for rainfed semi-arid vertic Inseptisols in Tamil Nadu. Indian Journal of Agronomy. 2007;52(3):194-7.
60. Tiwari SP, Ravi R, Nandeha KL, Vardia HK, Sharma RB, Rajgopal S. Augmentation of economic status of Bastar tribals through integrated (crop, livestock, poultry, duck, fish) farming system. Indian Journal of Animal Sciences. 1999;69(6):448-52.
61. Behera UK, Mahapatra IC. Income and employment generation of small and marginal farmers through integrated farming systems. Indian Journal of Agronomy. 1999;44(3):431-9.
62. Behera UK, Babu A, Kasechele H, France J. Energy self-sufficient sustainable integrated farming systems for livelihood security under changing climate scenario. (In) Proceedings of National Symposium on Agricultural Diversification for Sustainable livelihood and Environmental Security, held during 18-20 November 2014 at Ludhiana, Punjab, 2014, 576.
63. Bhatt BP, Bujarbaruah KM, Patnayak A, Mandal BK, Vinod K, Venkatesh MS, *et al.* Rice based integrated farming system in the North East. Agroforestry in North East India: Opportunities and Challenges, 2005, 575-87pp.
64. Bisht D. Integrated fish farming for food, nutritional security and economic efficiency in mid hills of Indian Central Himalaya. Research Journal of Fisheries and Hydrobiology 18: 1-6. Biswas C and Singh R. 2003. Integrated farming system: An intensive approach. Intensive Agriculture. 2011;41(7-8):22-3.
65. Bohra JS, Kushwaha S, Sing SR, Singh RP, Singh SK, Singh S, *et al.* Watershed based integrated farming system modules for livelihood security of small and marginal farmers of Vindhyan region. (In) Proceedings of National Symposium on Agricultural Diversification for Sustainable Livelihood and Environmental Security, held during 18-20 November 2014 at Ludhiana, Punjab, 2014, 547-8p.
66. Edwards K. The importance of integration in sustainability agricultural systems. Agriculture Ecosystem and Env. 2003;27:25-35.
67. Agbonlabor MU, Aromolaran AB, Aiboni VI. Sustainable soil management practices in small farm of Southern Nigeria: A poultry-food crop integrated farming approach. Journal of Sustainable Agriculture. 22:51-62.
68. Dhaka BL, Jat RA, Poonia MK. Integrated Farming System Approach for Natural Resource Management, Indian J Fertilizer. 2009;5:31-34.
69. Mahadiket RP, Bhairamkar MS, Desai AN. Profile of the farmers plasticising the backyard poultry farming system: 22nd national seminar on Role of Extension in Integrated Farming Systems for sustainable rural livelihood, 9th - 10th Dec. Maharashtra, 2010, 30-31.
70. Prasad SC, Lakra V, Prasad C. Integrated Farming Systems for enhancing sustainable rural livelihood security in Sahibganj and Pakur districts of Jharkhand. In: International conference on innovative approaches for agricultural knowledge management global extension experiences, 9-12th Nov, National Agricultural Science Complex, New Delhi, India, 2011.
71. Nageswaran M, Selvaganapathy E, Subbiah VR, Nair S. Demonstration and Replication of integrated Farming Systems at Chidambaram. Report of M.S. Swaminathan Research Foundation (MSSRF), Chennai, 16-53.
72. Bhalerao RA, Cgarge KV, Patil VG. Profile of the farmers practicing livestock based farming system: 22nd national seminar on Role of Extension in Integrated Farming Systems for sustainable rural livelihood, 9th-10th Dec. Maharashtra, 2010, 29.
73. Vinodakumar SN, Desai BK, Channabasavanna AS, Rao S, Patil MG, Patil SS. Relative performance of various integrated farming system models with respect to system productivity, economics and employment generation. Int J Agric Sci. 2017;(2):348-52.
74. Bosma RH, Udo HMJ, Verreth JAJ, Visser LE, Nam CQ. Agriculture Diversification in the Mekong Delta: Farmers' Motives and Contributions to Livelihood. Asian Journal of Agricultural Development. 2005;2(1&2):49-66.
75. Phong LT, Tri LQ, Udo HMJ, Nhan DK, Van Mensvoort

MEF, van der Zijpp AJ, *et al*. Integrated agriculture aquaculture systems in the Mekong delta, Vietnam: an analysis of recent trends. Asian Journal of Agricultural Development. 2008;4:51-66.
76. Thamrongwarangkul A. For out Thailand. Annual report on sustainable community development for good livelihoods and environmental project. Khon Kaen University. Bangladesh Agricultural Research Council (BARC*)*. Land Degradation Situation in Bangladesh, Soil Division, BARC, Dhaka, Bangladesh, 1999, 2001, 105-112pp.
77. Walia SS, Kaur N. Integrated Farming System - An Ecofriendly Approach for Sustainable Agricultural Environment: A Review. Greener Journal of Agronomy, Forestry and Horticulture. 2013;1(1):001-011.
78. EISA. European Initiative for Sustainable Development in Agriculture. European Integrated Farming Framework. A Technical Report, 2012, 1-108p.
79. Boller EF, Avilla J, Joerg E, Malavolta C, Wijnands FG, Esbjerg P. Integrated Production: Principles and Technical Guidelines IOBC/wprs Bulletin. 2014;27(2):1-12.
80. Manivanam A, Mathialagan P, Narmatha N. Goat based farming system in Tamil Nadu, 2011, 163p.
81. Manjunatha SB, Shivmurthy D, Sunil AS, Nagarj MV, Basavesha KN. Integrated farming System – An Holistic Approach: A Review. Research and Reviews: Journal of Agriculture and allied Sciences, 2014. e-ISSN: 2319-9857. p-ISSN: 2347-226X.
82. Okigbo BN. Major Farming systems of the lowland savanna of SSA and the potential for improvement. In Proceedings of the IITA/FAO workshop, Ibadan, Nigeria, 1995.
83. Bisht Deepa. Integrated fish farming for food, nutritional security and economic efficiency in mid hills of Indian Cental Himalayan. Research Journal of Fisheries and Hydrobiology. 2011;18:1-6.
84. Dhiman KR, Bujarbaruah KM, Satapathy KK. Integrated farming system for sustainable development of rainfed agriculture in North Eastern Region. (In) Proceedings of International conference on world Perspective on short rotation Forestry for Industrial and rural development, held during 7-13 September 2003 at Solan, Himachal Pradesh, 2003, 154p.
85. Panwar AS. Livestock based farming system for small and marginal farmers of north-eastern hill region. (In) Proceedings of National Symposium on Agricultural Divarication for Sustainable Livelihood and Environmental Security, held during 18-20 November at Ludhiana, Punjab, 2014, 531-32.
86. Kumar Sanjeev, Singh SS, Shivani Dey A. Integrated farming system for eastern India. Indian Journal of Agronomy. 2011;56(4):297-304.
87. Kumar Sanjeev, Shivani, Samal SK, Dwivedi SK, Manibhushan. Enhancement in productivity and income sustainability through integrated farming system approaches for small and marginal farmers of Eastern India. Journal of Agri Search. 2017;4(2):85-91.
88. Channabasavanna AS, Itnal CJ, Patil SG. Productivity, economics analysis and changes in physico-chemical properties as influenced by integrated rice-based farming system. Indian Journal of Agronomy. 2002;46(1):1-5.
89. Channabasavanna AS, Biradar DP, Prabhudev KN, Hegde M. Development of profitable integrated farming system model for small and medium farmers of Tungabhadra project area of Karnataka. Karnataka Journal of Agricultural Sciences. 2009;22(1):25-7.
90. Ramrao WY, Tiwari SP, Singh P. Crop-livestock integrated farming system for the marginal farmers in rainfed regions of Chhattisgarh in central India. Livestock Research for Rural development, 2006, 18(7). Article102. http://www.lrrd.org/lrrd18/7/ramr18102.htm.
91. Mathew T, Varughese K. Nutrient flow and economics of integrated farming system practiced in the coastal region of Kerala. (In) National Symposium on Integrated Farming Systems and its Role towards Livelihood Improvement under Indian Context, held during 26-28 October 2007 at RARS, Durgapura (Jaipur) RAU, Farming System Research and Development Association, Modipuram, 2007.
92. Mustow SE. The effects of shading on phytoplankton photosynthesis in rice-shields in Bangladesh. Agriculture, Ecosystems and Environment. 2002;90:89-96.
93. Jayanthi C. Integrated farming system: A path to sustainable agriculture. 2nd edition, Published by department of Agronomy, Directorate of Soil and Crop management studies, Tamil Nadu Agricultural University, Coimbatore, 2006, 1p.
94. Jitsanguan T. Sustainable agriculture systems for small scale farmers in Thailand: implications for the environment, 2001. Available at: http://www.agnet.org/library/eb/509/ (Accessed 1 February, 2012).
95. Radhamani S, Balasubramanian A, Ramamoorthy K, Geethalakshmi V. Sustainable integrated farming systems for dry lands: A review. Agricultural Reviews. 2003;24:204-210.
96. Singh G. Farming systems options in sustainable management of national resources. In: Proceedings National Symposium on Alternative Farming Systems held at PDCSR, Modipuram, 16–18 September, 2004, 80-94.
97. Thamizoli PR, Rengalakshmi K, Senthilkumar, Selvaraju T. Agronomic Rehabilitation and Livelihood Restoration of Tsunami Affected Lands in Nagapattinam District of Tamil Nadu. M.S. Swaminathan Research Foundation Chennai, 2006, 31p.
98. Tripathi SC, Rathi RC. Livestock farming system module for hills. In: Souvenir. National symposium on technological interventions for sustainable agriculture, 3rd -5th May, GBPUAT, hill campus, Ranichuri, 2011, 103-104.
99. Mohanty D, Patnaik SC, Jeevan Das P, Parida NK, Nedunchezhiyan M. Sustainable livelihood: a success story of a tribal farmer. Orissa Review, 2010 Sept, 41-43.
100. Rakocy JE, Masser MP, Losordo TM. Recirculating aquaculture tank production systems: aquaponics – integrating fish and plant culture. Stoneville, MS: Southern Regional Aquaculture Center. Publication, 2006, 454.
101. Sasikala V, Tiwari R, Saravanam M. A review on integrated farming system journal of international academic research for multidisciplinary ISSN: 2320-5083. 2015, 3(7).
102. Pushpa J. Constraints in various integrated farming systems. Agriculture Hind Agricultural Research and Training Institute, Madurai (T.N.) India. 2011;5(3&4):370-374.

103. Rangaswamy A, Venkatswamy R, Premshekhar M, Jayanthi C, Palaniappan SP. Integrated farming systems for rice based ecosystem. Madras Agricultural Journal. 1996;82(4):290-293.
104. Ngambeki DS, Deuson RR, Preckel PV. Integrating livestock into farming systems in northern Cameroon. Agricultural Systems. 1992;38:319-338.
105. Devendra C, Thomas D. Crop–animal interactions in mixed farming systems in Asia. Agricultural Systems. 2002;71:27-40.
106. FAO. Sustainable crop production intensification through an ecosystem approach and an enabling environment: capturing efficiency through ecosystem services and management, FAO Committee on Agriculture, 2010 June, 16-19.
107. IAASTD. Agriculture at the Crossroads, International Assessment of Agricultural Knowledge, Science and Technology for Development, Washington, DC, Island Press, 2009.
108. Gupta V, Rai PK, Risam KS. Integrated Crop-Livestock Farming Systems: A Strategy for Resource Conservation and Environmental Sustainability. Indian Research Journal of Extension Education. 2012;(sp2):49-54.
109. Lal M, Patidar J, Kumar S, Patidar P. Different integrated farming system model for irrigated condition of India on basis of economic assessment: A case study: A review International Journal of Chemical Studies. 2018,6(4):166-175. ISSN: 2349–8528 E-ISSN: 2321–4902.
110. Kadam SS, Hatey AA, Nikam TR, Landge SP, Palampalley HY. Constraints of IFS in Kankan region of Maharashtra- A case study. In: 22nd national seminar on Role of Extension in Integrated Farming Systems for sustainable rural livelihood, 9th -10th Dec. Maharashtra, 2010, 101p.