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Integrated farming system (IFS): A case study of an innovative farmer in Kerala

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Abstract
In India, rising population demands linked with reduced availability of agricultural resources ultimately result in declining productivity. This requires an urgent need to reorient agricultural research programmes from an individualistic enterprise approach to need developed holistic approach to the integrated farming system. An Integrated Farming System (IFS) is a mixed farming system created up at least two interdependent but logically connected sections of a crop and livestock enterprise. It is an eco-friendly approach in which the waste of one component becomes the input of another component, thus making more effective use of resources from the farm. An integrated agricultural system enhances financial well-being of small and marginal farmers, enhancing their commitment to social responsibilities like education and health care, as well as their ability to support themselves. The present study unwraps the findings of the specification of viability of the Integrated Farming System in Malappuram district of Kerala state.

Keywords: Integrated farming system, agriculture, innovative, progressive farmer

1. Introduction
India currently has 121 million agricultural holdings, of which 99 million are small, and 87 per cent are marginal (Meena *et al*., 2022) [1]. Smallholdings are not well suited to farm mechanisation, and these factors, along with the farming community's poor economic situation and lack of resources, are solely to blame for the slow expansion of the Indian agricultural sector. Our country's population is anticipated to reach 1370 million by 2030 and 1600 million by 2050 (Gupta *et al*., 2020) [2].
According to the country's current situation, land under cultivation may continue to decline, and by 2030, more than 20% of the existing cultivable area will be used for non-agricultural activities (Gill *et al*., 2005) [3]. The underpinning for the success of the agricultural system is the preservation of biodiversity, diversification of cropping and farming methods and maximal recycling (Singh and Ravisankar, 2015) [4]. Hence, there is a great need to create an area-specific Integrated Farming System (IFS) approach in order to address the multi-dimensional issues that are now present in agriculture and related industries.
In India, the availability of resources, agricultural practises and location-specific human demands for food, fodder, fuel and fibre influence the coexistence of various farming systems. Integrated Farming System (IFS) can be defined as the outcome of complex interactions between several interdependent components, in which a single farmer allocates specific quantities and quality of the four inputs of production that he has access to land, labour, money, and management (Mahapatra, 1994) [5]. IFS is one of the most effective methods for improving farm households' productivity, profitability, nutritional security, quality of life, employment creation and sustainability of the farm households, especially among small and marginal farming communities (Behera *et al*., 2013) [6]. IFS also promotes ecological soundness and long-term sustainable agriculture (Swaminathan, 1987) [7].
IFS, as a part of FRS (Farming System Research), promotes a change in farming practices to boost productivity in the cropping pattern and takes care of outstanding resource utilisation (Jayanthi, 2006) [8]. Under the gradual decline of land holding, it is vital to include land-based enterprises like fisheries, poultry, apiaries, field and horticultural crops, *etc*., into the farmers' bio-physical and socioeconomic environments in order to increase farming's profitability and dependability (Behera *et al*., 2004) [9]. Through IFS, environmental sustainability gets increased by reducing the use of harmful pesticides or artificial ingredients (Xavier, 2021) [10]. Here, the IFS strategy integrates several farm businesses and recycles crops by-products and residues on the farm itself in order to increase income and employment from small holdings

(Behera and Mahapatra, 1999; Singh *et al*., 2006) [11-12].
If effectively managed, integrated farming systems are frequently less risky and profit from synergies between enterprises, diversity in yield and environmental soundness (Lightfoot, 1990) [13]. In order to promote small and marginal farms throughout the country, IFS models have been proposed by a number of researchers (Rangaswamy *et al*., 1996; Behera and Mahapatra, 1999; Singh *et al*., 2017) [14, 15]. Hence, a study is undertaken to document the innovative practices in Integrated Farming System (IFS) by a progressive farmer in the Malappuram district of Kerala state.

2. Materials and Methods
The present study adopts a case study method to have an in-depth analysis of a particular situation. Young (1996) [17] stated that the case study method is a comprehensive study of a social unit comprised of a person, a group, a social institution, a district or a community. In simple terms, a case study can be defined as a technique for considering a very wide field of study into a single and manageable subject.
In the present study, an innovative, progressive farmer Mr C. M. Mohammed, addressed from the Malappuram district of Kerala state, was purposively selected. He is ever innovative and motivating to other farmers to adopt the latest technologies. His farm was already demonstrated as the best example of doubling farmer income through crop production, fish rearing, dairy farming, goat rearing and poultry farming. The organic waste recycling system and automated irrigation system he follows in his 10 acres of land are highly unique.
He bagged the National best coconut farmer award in 2012, State best farmer award in 2008, the Karshakasree award in 2009, the L M Patel farmer award in 2016 and the Jagjivan Ram Abhinav Kisan Puraskar award in 2018. His wife, P. E. Shakeela also engaged in the integrated farming sector along with him and won the State's best Mahilatilakam award. The farmer was personally interviewed by visiting his farm, and data was collected with the help of a semi-structured interview schedule.

3. Results and Discussions
Modern farmers aim to reduce expenses while maximising output. Because of this, it's critical to carefully consider and comprehend the best ways to operate a farm. Mr C. M. Mohammed practising Integrated Farming System (IFS), owns a garden land of 10 acres with several horticultural and fodder crops. On his farm, he also owns 0.13-acre water bodies with irrigation capacity, along with 20 HF breed cows, 100 Malabari breed goats, 120 BV380 and Karingozhi poultry layer birds, 2000 poultry broiler birds, 100 Ducks, 25 Goose, 5 Emu, 10 number of Honey bee colony *etc*. For the past 20 years, the 10-acre farm has been under organic cultivation.
The farm also has machinery like a banana shredder, grass chopper, brush cutter, copra extractor, copra cutter, oil expeller, oil filter, coconut milk extractor, coconut scrapper, flour roaster, cream separator and a milking machine. The certain other unique features of the farm were an organic waste recycling system, automated irrigation system, hydroponics unit for fodder production, in situ composting, vermicomposting, biogas production, water harvesting pond, and aquaponics unit for fish cultivation. Let's look at the various Integrated Farming System (IFS) components of the farm in detail:

3.1 Crop component
3.1.1 Horticultural crops
Coconut is the main crop in the cropping system. There are 400 harvesting coconut plants in the 10-acre field. Fifty palms are given for neera tapping, which gives an average of 1-litre neera/day. So from a palm, Rs 1500/month is obtained as profit. Around 200 plants are given for tender nuts. The yield is around 200 nuts per palm, and it is sold at Rs 15/nut. The remaining 150 coconut palms are harvested at a mature stage and are completely milled to coconut oil. The average yield is around 160 dry nuts per year. The return comes to around Rs 20/nut. The yield and system of production are stabilised over 20 years by organic farming. The total annual income from 400 coconut palms will come to around Rs 20 lakh. The expenditure comes to around 25 per cent. The production cost will come to around Rs 5 lakh. The net income will be around Rs 15 lakh. The Benefit Cost ratio is 4.
Pepper is the main intercrop and is grown in a coconut tree. There is around 200 pepper vine. Each pepper vine gives 8 kg green pepper, which in turn gives 3 kg dry pepper. The market price is around Rs 500/kg. There are 200 areca nut plants which give 80,000 nuts, and the same is sold at Rs 1.5 per nut. The average areca nut yield is 400 nuts/tree. Nutmeg gives a yield of around 12 kg nutmeg/tree. The 50 nutmeg plants alone give a return of Rs 1000/ tree. The 800 papaya plants give 50 kg of fruits per day, and the fruits are sold at Rs 40/kg. Besides, the 40 sapota plants, 1000 each of Dioscorea and Amorphophallus, together with medicinal and aromatic plants, give considerable income.

Table 1: Income – Expenditure statement of crop components

Crops (2021)	Total Income (lakhs)	Total Expenditure (lakhs)	Profit (lakhs)	BC Ratio
Coconut	19.8	4.95	14.85	4.00
Pepper	3.00	0.90	2.10	3.33
Arecanut	1.20	0.24	0.96	5.00
Nutmeg	6.00	2.00	4.00	3.00
Papaya	6.00	2.00	4.00	3.00
Others	1.00	0.25	0.75	4
Total	37.00	10.34	26.66	3.57

3.2 Animal components
3.2.1 Modern dairy unit
The dairy unit has 20 HF-breed cows. Around 180 litres of milk is obtained from the 20 cows in the dairy unit around the year. The milk is sold at Rs 55/litre. An automatic drinker system is installed to give pure drinking water to the cattle. A fodder bank is maintained to ensure sufficient green fodder for the cows. Choppers are used to cut green grass and various farm wastes. Seven-day-old germinated maise is given @ 1.25 kg per day per animal. The concentric feed given is coconut cake from the copra mill and rice bran. Mats are used on the floor. The milking is done using a milking machine. Fan and music systems are also installed to give the cow a congenial atmosphere. The farm management system is so designed that with one labour, the entire dairy unit can be effectively managed. The monthly veterinary check-up is also done.

3.2.2 Goat rearing
Around 100 numbers of Malabari breeds of goats are reared in the goat unit. The goats are fed with jack fruit leaves, for which around 200 jack plants are planted. The indigenously

designed goat-rearing unit has a fence all around. This makes the goat move freely during the daytime. The goat manure is pulverised and used as organic manure. The goats are marketed when they reach around 15 kg in one year. Around 50 numbers of goats are sold every year. The sale price is Rs 400/kg.

3.2.3 Poultry farming

The poultry unit has both egg-laying birds and broiler birds. In the case of egg-laying birds, both the cage system and open-rearing system are practised. The common breeds are BV380, Karingozhi, *etc*. There are about 120 numbers of BV380 birds and Karingozhi. Around 80 eggs are obtained every day. Regarding the broiler unit, there is a capacity to grow around 2000 birds. The average duration of a growing cycle is 45 days. Around six cycles are grown during a year. The average weight of a bird at selling is 2.25 kg. The sale price is Rs 120/kg. Ducks are also reared in a fenced system with a natural pond. Two emu birds are also there, whose egg fetches around 500 rupees each.

Table 2: Income – Expenditure statement of animal components

Animals (2021)	Total Income (lakhs)	Total Expenditure (lakhs)	Profit (lakhs)	BC Ratio
HF Breed cows	35.64	21.38	14.26	1.66
Malabari goat	3.00	1.50	1.50	2
Poultry	32.40	19.44	12.96	1.66
Total	71.04	42.32	28.72	1.67

3.3 Fisheries sector

3.3.1 Aquaponics unit

The aquaponics unit has a capacity of 2 lakh litres of water and is spread over an area of 100 square meters. Around 7000 Gift tilapia fish is grown as an intensive culture. The fish is harvested when the weight reaches 400 grams. The fish is sold at Rs 200/kg. The feed and management cost comes to around 80 per cent. It takes around six months to reach the harvesting stage. Water from the water harvesting pond is pumped daily to the aquaponic unit through the automated irrigation system. Around 25 per cent of the water in the tank is replaced daily. The water from the aquaponic unit will go through the automated irrigation system for irrigating the plants. Two sets of the motor with timers ensure proper aeration in the unit. Floats are used to regulate water levels. The average annual income from the fisheries sector will come to around Rs 10 lakh. The production cost will come to around Rs 8 lakh. The net income will be around Rs 2 lakh. The Benefit Cost ratio is 1.25.

3.4 Other innovations in the farm

3.4.1 Water harvesting pond

There is a pond in an area of 500 square meters lined with stone for water harvesting. The excess water from the field will be collected and stored in the water harvesting pond. The water thus collected is pumped to the aquaponics unit daily. From the aquaponics unit, the water is circulated to the 10-acre crop field. Since the complete field is under a drip irrigation system, the water requirement per day is around 50000 litres.

3.4.2 Automated irrigation system

The 10-acre farm has been covered under an automated drip irrigation system from 2005 onwards. To have a uniform distribution of water, the field is divided into 12 different units. Each unit will be irrigated for 20 minutes daily. For this, a special mechanism to control timers has been developed in mobile phones. Floats are used to monitor water levels. The water from the aquaponics unit is collected in an overhead tank for irrigation. There is a two-layer sedimentation unit and a three-layer filtering unit to monitor water quality. The filtering unit has a hydro cyclonic filter, sand filter and disc filter.

3.4.3 Hydroponics unit

To give protein-rich diet quality fodder to the cows, germinated maise seedlings are fed on a daily basis. There are 20 cows in the dairy unit. So 25 kg of maise seeds (1.25 kg/cow/day) are germinated every day. The maise seeds are grown in the hydroponics unit for seven days. The hydroponics unit was indigenously designed by combining various cost-effective technologies. The drizzling of water is automated every hour for 5 seconds in every tray. The seven-day-old maise seedlings are fed to the cows. This has resulted in an increase in milk production.

3.4.5 Organic waste recycling system

The uniqueness of the farm is the organic waste recycling system. All plant and animal waste are recycled and brought back to the field. The dung from the dairy unit is first added to the biogas unit. The slurry from the biogas unit is added to the organic waste recycling pit. There is a separate unit where Panchagavya and Dasagavya are prepared in bulk quantity. The fish amino acid is also prepared in another system. Both are added to the organic waste recycling system. The urine and washing water from the dairy unit are directed through a separate pipeline to the recycling pit. Through separate sets of valves, the quantity of all these is monitored. Hereafter, through a slurry pump, the waste materials are used for irrigating the 10 acres of the field. Thus, management of waste in the farm is easily achieved, and zero waste is left out.

3.4.6 Biogas production unit

There is a biogas production unit with a capacity of around a 5-meter cube. The cow dung from the cow shed is added to the biogas unit. There is a well-developed pipe system that helps the process be easy. The biogas is used as fuel in the house. The waste from the bio-gas unit is again used in the organic recycling system.

3.4.7 Compost production

The organic waste produced in the field is composted in situ. There are around 20 pits distributed at various parts of the field. The pits are of width 180 cm and depth 150 cm with convenient length. The various farm wastes along with cow dung slurry, are left in the pit for two months for composting. It is noticed that around 70 per cent of decomposition takes place in two months' time. This is further used for vermicomposting.

Earthworm nursery in an area of around 100 square meters is maintained for the purpose. Over-ripened papaya and cow dung are used as feed for the earthworm. The earthworm, thus multiplied, is used to decompose the compost. It will take around one month to complete the decomposition. The compost thus developed is sieved. An automated sieving machine is developed for this purpose. This is further enriched with Trichoderma and Neem cake. Around 20 tonnes

of vermicompost is prepared and sold from the farm @ Rs 10/kg in a year.

4. Conclusion

Integrated Farming System (IFS) needs to be pursued with more vigour and convinced with realistic changes at multiple levels, which may need long-term transformation. By putting a fresh emphasis on methodological and technical factors, it can complement the current agricultural system extremely well. IFS is a more profitable farming system that integrates better resource management, optimum nutrition and feeding, disease control and management.

This case study result demonstrated the efficacy of the farmer's Integrated Farming System (IFS) model, which he utilised to combine all the parts of his farm and utilise them effectively with good planning and management. Mr C. M. Mohammed income doubled, improved his standard of living, received various awards and led to long-term sustainability. This study sets an example of motivation to other farmers and new farm graduates to follow similar agricultural practices in a methodical and well-thought-out way.

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