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Integrated farming system in India: A holistic approach to magnify the economic status of innovative farmers

Swagatika Patra and Pinaki Samal

Abstract
In the present scenario, the population of India is increasing in a sky-rocketing manner and we could not expand our production areas. So, the challenge is to increase the productivity to feed the fast growing population. Conventional agriculture has caused economic problems associated with increased costs of energy-based inputs, lessened farm incomes etc. It has also produced ecological problems such as poor ecological diversity, soil erosion, and soil and water pollution. Integrated farming system (IFS) is considered as one of the best option towards intensification of small holder farm income to ensure sustainable livelihood. Integration of resources is made through a combination of land, water and animal resources of a farm through careful planning including recycling of bio-resources. Governments and development agencies have designed projects/programmes in promoting IFS through demonstration of successful models and other means. In the present article, an attempt is made to summarise different successful IFS models to contribute towards national agenda-doubling the income of the farmers.

Keywords: IFS, components, doubling income, successful models, review, diversity

Introduction
Monocropping is risky due to climate uncertainty as farmers invest heavily in single crop to get maximum return. The integrated farming system assumes greater importance to minimise the risk of monocropping and sound management of farm resources to enhance the farm productivity, reduce the environmental degradation and improve the quality of life for poor farmers and to maintain sustainability.

Integrated farming is a system which tries to imitate the nature's principle. In this system not only crops but, varied types of plants, animals, birds, fish and other aquatic flora and fauna are utilized for production. These are combined judiciously in such a way and proportion that each element helps the other. It ensures that wastes from one form of agriculture become a resource for another form. IFS is a labour intensive system. It is a dynamic approach which can be applied to any farming system around the world. It is very effective in solving the problems of small and marginal farmers. It not only supplements the income of the farmers but also help in increasing the family labour employment. IFS will lead to collective efforts among the farmers like collective purchase of inputs and collective marketing of produce, thus reducing their costs of production. The basic principle is to enhance the ecological diversity - by choosing the appropriate cropping methodology with mixed cropping, crop rotation, crop combination and inter cropping so that there is less competition for water, nutrition and space. Preserving and enhancing soil fertility, maintaining and improving a diverse environment and the adherence to ethical and social criteria are indispensable basic elements of integrated farming systems.

Concept of IFS
Integrated farming system (IFS) is a broadly used term to explain the suitability of a more integrated approach towards farming over monoculture approaches. In this system an inter-related set of enterprises are maintained and by-products or wastes from one production system becomes an input for another production system, which reduces cost and improves production and/or income [1]. Thus, IFS works as a system of systems [2]. FAO [3] stated that 'there is no waste', and 'waste is only a misplaced resource which can become a valuable material for another product' in IFS. For example, paddy straw, by-product from rice crop can be used as a valuable input for mushroom cultivation or dry fodder for dairy animals. Similarly spent of mushroom cultivation (used straw) can be used as a raw material in compost or vermicompost pits and by-products from dairy unit like dung can be used as fish feed or raw material for vermicompost unit. The farming system is essentially cyclic, organic resources - livestock - land - crops.

Therefore, management decisions related to one component may affect the others. The integrated livestock-farming system not only provides ecological sustainability and economic viability but also improves agricultural productivity to some extent.

Lal and Miller [4] defined farming system as a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirements of farm livelihood while preserving resource base and maintaining a high level of environment quality. On the other hand, a farming system is the complex interaction of a number of inter-dependent components, where an individual farmer allocates certain quantities and qualities of four factors of production, viz. land, labour, capital and equipments to which he has access [5].

Goals of IFS

1. Maximize yield of all component enterprises to provide steady and stable income.
2. Rejuvenation of system's productivity and achieve agro-ecological equilibrium.
3. Avoid build-up of insect-pests, diseases and weed population through natural cropping system management and keep them below ETL i.e. Economic Threshold Limit.
4. Reducing the use of chemicals (fertilizers and pesticides) to provide chemical free healthy produce and environment to the society.
5. To maintain sustainable production system without damaging resources/environment

Advantages of integrated farming system

1) **Productivity**: By virtue of intensification of crop and allied enterprises, IFS provides an opportunity to increase economic yield per unit area per unit time.
2) **Profitability:** The use of by-product of one component as the input of other reduces the cost of production as well as eliminates middleman interference thereby increasing the B/ C ratio.
3) **Potentiality or Sustainability:** Organic supplementation through effective utilization of by products of linked component provides an opportunity to sustain the potentiality of production base for much longer periods.
4) **Balanced Food:** The linkage of various components having different nutritional value enables to produce a complete and balanced source of nutrition.
5) **Environmental Safety:** Adoption of IFS minimizes the environment pollution to a great extent as the waste materials of one component becomes the input of other.
6) **Recycling:** Effective recycling of waste material.
7) **Income Rounds the year:** The interaction of enterprises with crops, eggs, milk, mushroom, honey, cocoons silkworm provides income to the farmer throughout the year which reduces the financial crisis in the farmer's family.
8) **Adoption of New Technology:** Big farmers fully adopt the new technologies by the linkage of dairy / mushroom / sericulture / vegetable etc. which provides money flow round the year. This motivates the small/ original farmers to go for the adoption of technologies.
9) **Meeting Fodder crisis:** Every piece of land area is effectively utilized. Plantation of perennial legume fodder trees on field borders not only fixes the atmospheric nitrogen which upgrades the land fertility but also minimizes the problem of non – availability of quality fodder to the animal component.
10) **Employment Generation:** IFS provides ample scope to employ family labour whole round the year. The integration of different components in IFS would increase the labour requirement significantly which in turn reduces the problems of unemployment to a great extent.
11) **Agro – industries:** When the produce of one component in IFS are increased to commercial level then the produce of other components gets surplus adoption which leads to development of allied agro – industries.
12) **Increasing Input Efficiency:** The use of inputs in different components of IFS shows greater efficiency and high benefit cost ratio.

Successful Models

Mr. Henkpao is a tribal farmer in Tollen village, Churachandpur district of Manipur. He adopted a model which comprises four ha. of fenced area in the vicinity of the tribal settlement integrated with seven components. In 2011-12, the farmer had no water harvesting unit. In 2013-14, he could store 30,000.00 litres of water in the Jalkund. In improved practice, from four ha land he earned the total net returns Rs 3,63,500/ [(Paddy cultivation (2 ha)= Rs 82000, Groundnut production (0.5 ha)= Rs. 38000, Maize production as green cob (0.5 ha)= Rs. 23000, Vegetable production in rabi season (1 ha, Cabbage and Radish)=Rs. 150000, Fruit production (Fruiting not started)=Nil, Piggery= Rs. 37000, Poultry= Rs. 16000, Fishery= Rs. 17500] as compared to 105000 in 2011-12 [6].

Majish Gomango a successful tribal farmer in Orissa after adopting the IFS earned 7 times higher Net Monetary Return (NMR) as compared to traditional method of farming. His productivity as well as the profitability and sustainability got enhanced as compared to the conventional farming system. The benefit cost ratio of IFS was 2.70 whereas in traditional system it is 2.08 [7].

Integration of 7 different components namely, crop+ fish+ goat+ vermicompost+ fruit production+ spice production+ agro forestry results in the net return to the tune of Rs. 2, 30,329 annually with the Benefit Cost Ratio (BCR) of 1.07:1 and also the maximum per cent contribution of the components is the fish production (68.53 per cent) followed by vermicomposting (9.90 per cent), spices (8.46 per cent) and animal production (7.40 per cent). The BCR was found to be highest for the spice production (1.83:1) after fishery (2.25:1) followed by the vermicomposting (1.45:1) [8].

A research study was conducted at Agricultural Research Station, Siruguppa, Karnataka, in IFS comprising the components like cropping, vegetables, fishery, poultry and goat rearing during the wet and dry seasons of 2003- 04 and 2005-06 to study the productivity, profitability, energy flow, employment generation and water requirement of IFS over conventional rice-rice system. Integrated farming system approach recorded 26.3 and 32.3 per cent higher productivity and profitability, respectively over conventional rice-rice system. Among the components evaluated, the highest net returns was obtained from crop (63.8 %), followed by goat (30.9 %), fish (4.0 %) and poultry (1.3 %), respectively. Under the integrated farming system 275 Man days/ha/year and 1247 mm, respectively was the employment generation and water requirement [9].

Shri P. Kottaisamy belonging to Kutchanur village in Uthamapalayam Taluk of Theni district in Tamil Nadu has 6 hectare of cultivated land with adequate supply of irrigation

and used to cultivate banana, cotton, coconut and groundnut by using heavy doses of fertilizers and pesticides. He adopted Integrated Farming System (IFS) in 2000 under the technical guidance of KVK Theni. He integrated his farm with horticultural crops, cereals and livestock. He mainly used organic inputs in his farm. For this purpose, he established infrastructure with the production capacity of 15000 Kg cattle manure (50 cows), 3000 kg dried FYM, 500 kg enriched FYM, 20 t vermicompost, 6 t cattle feed mill (20 hp service motor), 25 t chaffed fodder (2 chaff cutters), 1500 hr use of mechanical weeders per month. He opted for consultancy programme to various places inside and outside the state on IFS. He had provided employment opportunity to 15 women and 5 men who are continuously working in his farm. This IFS is a successful initiative because of its sustainability since 2000. There are about 200 farmers, farm women and rural youth and students from various parts of India who have come and visited his farm and undergone training programme on various organic inputs preparation varying from one day to one week [10].

Sri. Purnachandra Das is one of the farmer of Baladuan village of Anandpur cluster of Keonjhar district (Odisha) who adopted the integrated aqua-horticulture on pond dikes and adjoining areas, promoted by the Central Horticultural Experiment Station, Bhubaneswar. He raised papaya seedlings of red lady variety (25 numbers) in his dike area. After one year he got approximately 1.0 to 1.2 quintal papaya fruits per plant on an average. He harvested papaya fruits twice in the year and grossly he got 60 quintal papaya. Totally he got Rs.38000.00 from papaya cultivation in excluding home consumption. He also cultivated poi, bitter gourd, cucumber as intercrop in papaya and earned Rs.8000.00, Rs.5000.00 and Rs.2000.00respectively [11].

Farming system involving tuber crops (0.4ha)

During the year 2014-15, participatory research on farming system involving tuber crops (0.4 ha model) under rainfed ecology was conducted in Khanjuguda (village), Chakapada (Block), Kandhamal (District), Odisha state (Table 1) [12].

Table 1: Integrated farming system components yield and economics (0.4 ha)

S. No.	Crop/animal	Area (ha)	Yield (kg)	Rice equivalent yield (kg)	Gross Income (Rs)	Expenditure (Rs)	Net income (Rs)	Employment Generation (man-days)
1	Rice	0.20	381	381.0	11430	5500	5930	44
2	Maize	0.03	62	31.0	930	350	580	3
3	Ragi	0.02	25	16.7	500	250	250	2
4	Redgram	0.02	14	23.3	700	250	450	2
5	Sweet potato	0.04	516	172.0	5160	1400	3760	6
6	Yam bean	0.03	514	257.0	7710	1200	6510	6
7	Greater yam	0.02	376	250.7	7520	2000	5520	10
8	Colocasia	0.02	305	203.3	6100	1400	4700	6
9	Elephant foot yam	0.008	115	76.7	2300	700	1600	3
10	Cassava	0.002	38	12.7	380	250	130	2
11	Vegetable (Amaranthus, Bhendi, Bitter gourd, Ridge gourd etc.)	0.01	237	158.0	4740	1500	3240	12
12	Backyard poultry	20 (nos.)	47	156.7	4700	2000	2700	10
Total		0.4	2630	1739.1	52170	17400	34770	106

Integrated farming system for waterlogged area management

A study was conducted for development of pond based integrated farming system for management of waterlogged area in Khurda district. There was a patch of 3 ha area under severe water logging. The climatic parameter analysis and water balance study resulted the design dimensions of the experimental ponds which were 27 m x 27 m, 30 m x 30 m, and 34 m x 34 m at the top with 2 m depth and side slope 1:1 in experimental plot 1, 2 and 3 respectively. Under on-dyke horticulture activities, there were 114 papaya, 89 banana, and 16 coconut plants around 1st pond, 69 banana, 9 papaya and 4 coconut plants around 2nd pond and 70 banana plants were planted around the 3 rd pond (Plate 1). Besides another 90 banana plants were planted in adjacent area. The different varieties of tissue culture banana planted are G-9, Bantala and Robusta. Papaya variety was “farm selection”.

In the first year under on-dyke horticulture activities vegetable such as bottle gourd in 386 m ^{2} area (7.8 t/ha), tomato in 252 m ^{2} area (2 t/ha) and brinjal on 66 m ^{2} (1.52 t/ha) were taken up. Different varieties of paddy such as Khandagiri, Swarna, Surendra and CR-1009 were grown in four different plots showed average yield of 2.72 t/ha.

In subsequent years on an average 220 bunches of banana were harvested. Different varieties of paddy such as Khandagiri, Swarna, Surendra and CR-1009 were grown in four different plots. During k h a r if the yield of Khandagiri was 2.1 t/ha, Surendra gave 3.2 t/ha and Swarna showed average yield of 2.7 t/ha. During rabi Khandagiri paddy gave a yield of 2.3 t/ha. Different vegetable were taken as on-dyke horticultural activities as well as intercrops such as brinjal (6.25 t/ha), cowpea (1.5 t/ha), Bean (2 t/ha), ladies finger (4.9 t/ha) and 200 kg of bottle gourd was also obtained [13].

Integrated farming system in Mahanadi delta (Odisha State)

A unit was developed in Khentalo village of Barmania Pat (waterlogged area) where water logging was up to 2 m depth. Out of 2.47 ha waterlogged area of the farmer, 1.64 ha was converted into grow-out pond for fish and prawn culture while vegetable, flower and fruits were grown on 0.83 ha of raised embankment all around the pond since 1989. Poultry sheds were also constructed for rearing 4000 birds in such a way that their droppings could fall into pond as organic manure and feed for fish. Gross and net returns from fish and prawn culture alone during 2002 were Rs. 6, 17,160 (Rs. 3, 76,317 per ha) and Rs. 3, 31,065 (Rs. 2, 01,868 per ha) respectively. This accounted to Rs. 14.00 per m ^{3} of water productivity in the pond system alone. The farmer initially invested Rs. 1,23,910 in 1988 towards construction of the pond plus infrastructure and earned a net return of Rs. 40,554

per ha of whole system in 1989, which gradually increased up to Rs. 1,32,894 per ha in 1997 [13].

IFS in cyclone affected coastal Odisha

IFS around sub surface water harvesting structure was implemented in participatory basis for 22 locations in coastal waterlogged ecosystem devastated by 1999 super cyclone where saline aquifer exists beyond 3-7 m below ground level, and fresh water aquifer floats over it. This fresh water was harvested by constructing sub surface water harvesting structures up to a depth of 3 m and the stored water was utilized for aquaculture and irrigation of the crops grown on the bund and in surrounding area. Introduction of integrated farming system approach (aquaculture, water chest nut, on dyke horticulture and vegetables in the pond command area) in those structures resulted in gross water productivity of Rs. 12.93 to Rs. 47.20 per m^3 of water used. The impact of this technology resulted in construction of 135 such new structures (SSWHS) by farmers in the coastal tract of Erasama. Consequently, significant increase in crop production (3-4 fold), water productivity (Rs. 12.93-Rs. 47.20 per m^3) and cropping intensity (103-230%) has led to the socio-economic upliftment of the resource-poor farmers with diversified livelihood options. The findings can be replicable in different waterlogged eco-systems of India [13].

Duck-fish integrated system

The duck-fish integration system is usually employed by many farmers, in such areas, where the underground water-table is usually good and standing water is available in the water-body, during most parts of the year. As a major advantage of the Integrated Duck - fish farming, not only it increases fish production but also cuts down the cost of fish culture operations considerably. Where average cost of production in conventional poly-culture with supplemental feeding and inorganic fertilization was Rs. 2.93/kg in Eastern India researchers have recorded the cost of production nearing Rs. 1.61/kg from a duck-fish integrated farming system [14].

IFS with backyard poultry

The rural poultry framing can be associated with integrated farming. Two models have been tried in Odisha through the NAIP. In the NAIP component- 3 livelihood projects operated under OUAT an integrated farming model was tested for three years (2011-13) with crop, vegetables, mushroom, poultry and pisciculture taking 20 farmers in three districts of Odisha like Dhenkanal, Phulbani and Kalahandi [15]. The integrated model was divided into two categories taking 0.8 ha and 1.6 ha of land. The net return in the 0.8 ha model was Rs. 1,37,907 vs. Rs.12, 739 in the conventional method and total may days created was 555 vs. 204 [16]. Similarly in the IFS model of 1.6 ha of land holding the net return was 1, 98, 968 vs. 17,052 and the employment generated in man days was 899 vs. 400 in the conventional method [17].

Inspite of the above models Economic viability of various Integrated Farming System Research models developed in different states of the country are summerised below.

Table 2: Economic viability of Integrated Farming System Research models developed in different states of the country

State	Prevailing system	Net Return	Integrated Farming System	Net returns	References
Karnataka	rice – rice system	21599	Rice-fish (pit at the center of the field) – poultry (reared separately)	62, 977	Chnnabasavanna *et al*., 2007 [18]
			Rice-fish (pit at one side of the field) - poultry(shed on fish pit)	49, 303	
Goa	Cashew	36,330	Coconut+forage +dairy	32,335	Manjunath *et al*., 2003 [19]
			Rice-brinjal (0.5 ha) + Rice-Cowpea (0.5ha)+mushroom +poultry	75,360	
Madhya Pradesh	Arable farming	24,093	Mixed farming + 2 cow	37,668	Tiwari *et al*., 1999 [20]
			Dairy (2cows) +15 goats+10 poultry + 10 duck + fish	44,913	
Tamilnadu	Rice-rice-blackgram	8,312	Rice-rice-cotton +maize	15,009	Shanmugasundaram *et al*.,1993 [21]
			Rice-rice-cotton +maize+poultry/fish	17,209	Shanmugasundaram *et al*.,1995 [22]
	Rice-rice	15,299	Rice-rice-Azolla/Calotropis+Fish	17,488	
	rice-rice-rice-fallow-pulses	13,790	Rice-rice-rice-fallow-cotton+maize+duck cum fish	24,117	Ganesan *et al*., 1990 [23]
	Cropping alone	36,190	Cropping+fish+poultry	97,731	Jayanthi *et al*., 2001 [24]
			Cropping+fish+pigeon	98,778	
			Cropping+fish+goat	13,1118	
	Rice	22,971	Rice+fish	28,569	Balusamy *et al*., 2003 [25]
			Rice+Azolla+fish	31,788	
Uttar Pradesh	Crops (Sugarcane-wheat)	41,017	Crops (Sugarcane+wheat)+dairy	47,737	Singh, 2004 [26]
Maharashtra	Cotton (K) + Groundnut (S)	(-) 92	Blackgram(K) - Onion (R)-Maize+cowpea	1,304	Shelke *et al*., 2001 [27]
			Crop+dairy+sericulture	3,524	
			Crop + dairy	5,121	

Conclusion

The above discussion revealed that 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 immense need of proper documentation and dissemination for the betterment of poor and prosperity of our country both in rural and urban sector. Therefore it is high time for the promotion of IFS concept and knowledge in different agro-climatic pockets of our country to contribute towards national agenda-doubling the income of the farmers as well as addresses the issue of malnutrition.

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