e-ISSN: 2319-9857
p-ISSN: 2347-226X

Research and Reviews: Journal of Agriculture and Allied Sciences

Integrated Farming System - An Holistic Approach: A Review.

Manjunatha SB[1]*, Shivmurthy D[1], Sunil A Satyareddi[1], Nagaraj MV[2], and Basavesha KN[1].

[1]Department of Agronomy, University of Agricultural Sciences, Dharwad , Karnataka – 580 005, India.
[2]ARS Hanumanamatti, Ranebennur, Karnataka, India.

Review Article

Received: 07/05/2014
Revised : 23/05/2014
Accepted: 16/06/2014

*For Correspondence

Department of Agronomy, University of Agricultural Sciences, Dharwad , Karnataka – 580 005, India.

Keywords: Integrated, Farming system, Employment.

ABSTRACT

There are 115 million operational holdings in the country and about 80 % are marginal and small farmers. To fulfill the basic needs of house hold including food (cereal, pulses, oilseeds, milk, fruit, honey, meat, etc.), feed, fodder, fiber, etc. warrant an attention about Integrated Farming System (IFS). Undoubtedly, majority of the farmers are doing farming since long back but their main focus was individual components but not in a integrated manner. At the ICAR and State Agricultural Universities level, lot of efforts have been made aiming at increasing the productivity of different components of farming system like crop, dairy, livestock, poultry, piggery, goat keeping, duckery, apiculture, sericulture, horticulture, mushroom cultivation etc. individually but lacking in their integration by following farming system approach. The integration is made in such a way that product of one component should be the input for other enterprises with high degree of complimentary effects on each other. The preliminary research investigations advocated the benefits of productivity improvement by 30-50% depending upon the number and kind of enterprises and their management. The information on farming system in a systematic way is presented here. The methodology is explained keeping in mind the work done so far to realize better productivity, profitability and sustainable production systems that would help to solve the fuel, feed and energy crisis, create more employment avenues, ensure regular income and encourage agricultural oriented industry.

INTRODUCTION

The growth rate of agriculture in the recent past is very slow inspite of the rapid economic growth in India. According to the Economic Survey of India, 2008, the growth rate of food grain production decelerated to 1.2% during 1990-2007, lower than the population growth of 1.9%. It is projected that in our country population will touch 1370 million by 2030 and to 1600 million by 2050. To meet the demand, we have to produce 289 and 349 mt of food grains during the respective periods. The current scenario in the country indicates that area under cultivation may further dwindle and more than 20% of current cultivable area will be converted for non-agricultural purposes by 2030 [6].

The operational farm holding in India is declining and over 85 million out of 105 million are below the size of 1 ha. Due to ever increasing population and decline in per capita availability of land in the country, practically there is no scope for horizontal expansion of land for agriculture. Only vertical expansion is possible by integrating farming components requiring lesser space and time and ensuring reasonable returns to farm families. The Integrated Farming Systems (IFS) therefore assumes greater importance for sound management of farm resources to enhance the farm productivity and reduce the

environmental degradation, improve the quality of life of resource poor farmers and maintain sustainability. In order to sustain a positive growth rate in agriculture, a holistic approach is the need of the hour. Farming system is a mix of farm enterprises in which farm families allocate resources for efficient utilization of the existing enterprises for enhancing productivity and profitability of the farm. These farm enterprises are crop, livestock, aquaculture, agro-forestry, agri-horticulture and sericulture [19].

In such diversified farming, though crop and other enterprises coexist, the thrust is mainly to minimize the risk, while in IFS a judicious mix of one or more enterprises along with cropping there exist a complimentary effect through effective recycling of wastes and crop residues which encompasses additional source of income to farmer. IFS activity is focused around a few selected interdependent, inter-related and interlinking production system based on crops, animals and related subsidiary professions.

Integrated farming system approach is not only a reliable way of obtaining fairly high productivity with considerable scope for resource recycling, but also concept of ecological soundness leading to sustainable agriculture. With increasing energy crisis due to shrinking of non-renewable fossil-fuel based sources, the fertilizer nutrient cost have increased steeply and with gradual withdrawal of fertilizer subsidy. It is expected to have further hike in the cost of fertilizers. This will leave the farmers with no option but to fully explore the potential alternate sources of plant nutrients atleast for the partial substitution of the fertilizer nutrients for individual crops and in the cropping systems.

Definition of Farming System

'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 functional entity, *i.e.* an arrangement of components or parts that interact according to some process and transforms inputs into outputs [3].

Goals of Integrated Farming System

The four primary goals of IFS are-

- Maximization of 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 low level of intensity.
- Reducing the use of chemicals (fertilizers and pesticides) to provide chemical free healthy produce and environment to the society.

Advantages of Integrated Farming System

- Increased productivity through increased economic yield per unit area per time by virtue of intensification of crop and allied enterprises.
- Improved profitability achieved mainly by way of reduced costs due to recycling of wastes of one enterprise as energy inputs for other systems.
- Greater sustainability in production on farm due to integration of diverse enterprises of different economic importance. Recycling of wastes being in built in the system, this helps to reduce dependence on external high-energy inputs thus conserving natural and scarce resources.
- Integration of different production systems provides an opportunity to solve malnutrition problem due to production of variety of food products.
- The recycling of wastes for production helps to avoid piling of wastes and consequent pollution.
- The farming system provides flow of money to the farmer round the year by way of disposal of eggs, milk, edible mushroom, honey, silkworm cocoons etc. This will help resource poor farmer to get out from the clutches of moneylenders/agencies.
- Because of the linkage of dairy/mushrooms/sericulture fruit crops/vegetable crops/flower cultivation etc. cash available round the year could induce small and marginal farmers adopt new technologies such as fertilizer, pesticides etc.
- Recycling of organic wastes reduces requirement of chemical fertilizer. Further, biogas production can meet household energy requirement. Thus, IFS, goes a long way in solving energy crises.
- Fodder/pasture/tree species included in the system help to get more fodder and thus solve fodder crises to some extent.

e-ISSN: 2319-9857
p-ISSN: 2347-226X

- Silvi component used in the system provides fuel and timber wood.
- Inclusion of timber component in the farming system reduces pressure on forests.
- Diverse components integrated can provide enough scope to employ farm labour round the year.
- Integrated farming system forces the entrepreneur to know more things and hence improves the literacy level.
- IFS provide opportunity for the growth of agri-oriented industries.
- There is also advantage of increased input use efficiency.
- Overall benefit of IFS is improved standard of living of the farmer because of the products like edible mushroom, fruits, eggs, milk, honey, vegetables etc.

Components in IFS

* Agriculture	* Fish farming
* Horticulture	* Duck rearing
* Forestry	* Pigeon rearing
* Apiary	* Mushroom cultivation
* Sericulture	* Azolla farming
* Dairy	* Kitchen gardening
* Poultry	* Fodder production
* Goat rearing	* Nursery
* Sheep rearing	* Seed Production
* Piggery	* Vermiculture
* Rabbitory	* Value addition

Elements Of Integrated Farming System

Following elements may be included in IFS demonstrations depending upon the individual farmers resources, interest and opportunities.

- Watershed
- Farm ponds
- Bio-pesticides
- Bio-fertilizers
- Plant products as pesticides
- Bio-gas
- Solar energy
- Compost making (Vermi, Japanese, Improved etc.)
- Green manuring
- Rain water harvesting

Possible output of integrated farming system

Since Integrated Farming System (IFS) is an interrelated complex matrix of soil, water, plant, animal and environment and their interaction with each other enable the system more viable and profitable over the arable farming system. It leads to produce the quality food. To strengthen the food chain, it is essential to eliminate nutritional disorder which has been realized on account of appearing deficiency of mineral nutrients and vitamins in food being consumed. Horticultural and vegetable crops can provide 2-3 times more energy production than cereal crops on the same piece of land and will ensure the nutritional security on their inclusion in the existing system. Similarly inclusion of bee-keeping, fisheries, sericulture, mushroom cultivation on account of space conservative also give additional high energy food without affecting production of food grains. The integration of these enterprises will certainly help the production, consumption and decomposition in a realistic manner in an ecosystem.

Likewise, it is pre-requisite in farming system to ensure the efficient recycling of resources particularly crop residues, because 80-90% of the micronutrients remains in the biomass. In the Indo-Gangetic plains, where rice straw is not recycled in an effective way and even in Punjab where rice cultivation is practised on 2.6 m ha produces about 16 m tonnes of paddy straw which is destroyed by burning. To curtail such precious input loss, the use of second generation machinery for efficient crop residue management to conserve moisture, improve soil micro-organism activities, regulate soil temperature, check soil erosion, suppress weed growth and on decomposition improves soil fertility. Its

beneficial effect can also be accrued by incorporating with the soil. The crop residue can be used as floor thatch for cattle shed, composting, growing mushroom and for dry fodder also. Multiple use of water for raising crops, fruits, vegetables, and fishery may also enhance the water productivity. Likewise, in villages, the sewerage water can be purified through Hydrilla biomass before its release to fish pond. Besides, the community land in the villages, which are accessible to better use, must be used for productive purpose. Therefore, adoption of concept like social forestry, water harvesting and recycling fishery, and stall feeding to the animals (goatery / piggery) will add to the profit margin with other numerous indirect benefits of employment and improved ecology of the area. Such types of enterprise integration generate additional income varying from Rs 20, 000- 25,000/ha under irrigated and Rs 8,000-12,000 under rainfed ecosystem. The income enhancement due to integration of processing and on-farm value addition by 25-50%, yield improvement on account of improved soil health by 0.5-1.0 tonne/ha, cost reduc tion by Rs.500 - 1,000/ha and employment generation by 50-75 man days/household have also been observed [5].

Present status of farming system research

The preliminary investigations clearly elucidated that integration of agricultural enterprises viz., crop, livestock, fishery, forestry etc. have great potential towards improve ment in the agricultural economy. These enterprises not only supplement the income of the farmer by increasing the per unit productivity but also ensure the rational use of the resources and further create employment avenues. The following of suitable crop choice criteria having deep and shallow root system, inclusion of legume crop as catch , cover and fodder crops and adoption of bio-intensive com plimentary cropping system along with other enterprise will certainly prove as a self sustained production system with least cost of production. The farming system is governed by various forces viz., physical environment, socio economic conditions, political forces under various institutional and operational constraints and above all govern ment favorable policies, which may keep the food security intact and livelihood fully protected.

In traditional Chinese system, the animal houses were constructed over a pond so that animal waste fell directly into the water fueling the pond ecosystem, which the fish could then feast on for food. Not only were the fish harvested but the pond water, now with extra nutrients was used for irrigation in crops. The maximum return (Rs 79,064/ha) was earned from fisheries + piggery + poultry as compared to Rs 5,33,221 from the rice-wheat system and registered 48.6% gain. This also generated additional employment of about 500 man days/ha/annum [6].

For poor people, it starts small with ducks and chickens; then a few goats are kept for milk or fattening and to slaughter for a day of sacrifice; next a milch cow; then a bullock for ploughing in cooperation with another one buffalo family; then two bullocks. These can be used to plough the fields of others- a very lucrative business in the planting season. In India, one would add a milch buffalo at the apex of desirable animals on the farm. In the Vietnamese concept, the pigs will be the second step in the ladder. The concept means to start with small livestock and women and then the household will step by step get out of poverty. The poorest households kept only poultry and these households were those most dependent on common property resources for their living (e.g. use and sale of firewood from the forest). A similar stratification has been reported in several studies from Asia [9]. Survey on farming systems in the country as a whole revealed that milch animals; cows and buffaloes irrespective of breed and productivity is the first choice of the farmers as an integral part of their farming system. However, from economic point of view, vegetables and fruits (mango and banana in many parts of the country) followed by bee keeping, sericulture, mushroom and fish cultivation was the most enterprising components of any of the farming systems prevalent in the country. The average yield gaps between 27 pre-dominant and 37 diversified farming systems were examined across the agro-climatic zones through detailed survey on character ization of on-farm farming systems. Diversification of farming system by integration of enterprises in varied farming situations of the country enabled to enhance total production in terms of rice equivalent yield ranging from 9.2% in eastern Himalayan region to as high as 366% in Western-plain and Ghat region when compared to prevailing farming systems of the region. A number of success stories on IFS models including Sukhomajari Watershed of Chandigarh, Fakot Watershed in hilly areas of Uttarakhand. Jayanthi models for almost all the situations of Tamil Nadu, WTCER model for coastal and irrigated alluvial lands of Orissa, Darshan Singh Model for irrigated conditions of Punjab, PDCSR model, for western Uttar Pradesh. and many more in different parts of the country suggest that farmers' income can be increased manifold by way of diversification of enterprises in a farming system mode for sustainability and economic viability of small and marginal category of farmers (Table1).

e-ISSN: 2319-9857
p-ISSN: 2347-226X

Productivity enhancement by IFS

In view of serious limitations of horizontal expansion of land for agriculture, only alternative left is vertical expansion through various farm enterprises requiring less space and time but give high productivity and ensuring periodic income especially for the small and marginal farmers. The highlights about the research investigations carried out in India towards farming system outcome are discussed to conceptualize its significance towards farming community livelihood. In a study conducted at ICAR Research Complex, Goa, it was revealed that rice-brinjal crop rotation is the best in terms of productivity and profitability owing to higher yield of the brinjal. The system yielded a total productivity of 11.22 t/ha rice grain equivalent yield with a net return of Rs.46, 440/ha. Further, with the integration of mushroom and poultry production (based on the resources availability within the system) the system productivity was increased to 21, 487 kg/ha especially with rice-brinjal rotation leading to an additional returns of Rs 30,865/ha with integration. In addition, the system approach was found to sustainable as reflected from the changes in soil organic carbon and indicated by sustainability yield index [8].

In Tamil Nadu, the IFS increased the net return on an average of Rs 31,807/ha/year over the arable farming (Rs 19,505/ha/year). While in Goa, when coconut was inte- grated with crop, vegetables, mushroom, poultry and dairy enabled to enhance Rs 17,518/ha/annum over the cashewnut cultivation alone. In Madhya Pradesh, the integrated farming gave a margin in net return of Rs 17,198/ ha/year over the arable farming. In Uttar Pradesh, the average enhancement in return was Rs 45,736/ha/annum over the existing crop-based farming system.

In Haryana, Singh *et al.* [15] conducted studies of various farming systems on 1 ha of irrigated and 1.5 ha of unirrigated land and found that under irrigated conditions of mixed farming with crossbred cows yielded the highest net profit (Rs 20,581/-) followed by mixed farming with buffaloes (Rs 6,218/-) and lowest in arable farming (Rs 4,615/-). In another study conducted with 240 farmers of Rohtak (wheat-sugarcane), Hisar (wheat-cotton) and Bhiwani (*gram*-bajra) districts in Haryana which represented zones of different crop rotations revealed that maximum returns (Rs/ha) of 12,593, 6,746 and 2,317 were obtained from 1 ha with buffaloes in Rohtak, Hisar and Bhiwani, respectively. The highest net returns from Rohtak was attributed to the existence of a better soil fertility type and of irrigation facilities coupled with better control measures compared to other zones. In terms of total man days, Rohtak had the highest employment potential followed by Hisar and Bhiwani. The employment potential under mixed farming conditions was predominantly from livestock rather than crop production [17].

Another study involving cropping, poultry, piegon, goat and fishery was conducted under wetland conditions of Tamil Nadu conducted by Jayanthi *et al.* [7]. Three years results revealed that integration of crop with fish (400 reared in 3 ponds of 0.04 ha each), poultry (20 babkok layer bird), pigeon (40 pairs), and goat (Tellichery breed of 20 female and 1 male in 0.03 ha deep litter system) resulted in higher productivity, higher economic return of Rs 1,31,118 (mean of 3 year). Integration of enterprises created the employment opportunities where in comparison to 369 mandays/year generated in cropping alone system, cropping with fish and goat created additional 207 mandays/annum (Table 2). The resources were recycled in such a way that fish were fed with poultry, pigeon and goat dropping. Similarly, extra poultry, pigeon and goat manure and composted crop residue of banana and sugarcane were applied to the crops (fig. 1and 2). The four conventional cropping system tried were rice-rice-blackgram, maize-rice-blackgram, maize-ricesunhemp and rice-rice-sunhemp.

Balusamy *et al.* [1] explained that rice + *Azolla*-cum-fish culture is one of the economical option in such type of area. Monoculture system rely mainly on external inputs while in integrated system, recycling of nutrients takes place that help in reducing the cost of production for economic yield. The fish in rice field utilized the untapped aquatic productivity of rice ecosystem as the rice bottom is highly fertilized on account of the production of zoo and phytoplankton and these resources are fully utilized by the fish. The data (Table 3) clearly advocated the beneficial effect of *Azolla* on rice+fish. The gross income obtained in rice + *Azolla* + fish was 25.7 % more over the rice crop and 6.9 % more over the rice + fish. The net income followed the same trend. Thus rice + *Azolla* + fish on an average gave Rs 8,817/ha more over the rice monoculture and Rs.3,219/ha over the rice + fish. This model was proposed for extensive scale adoption in Tamil Nadu.

Farming system is a resource management strategy to avail maximum efficiency of a particular system. Studies conducted at ICAR Research Complex for Goa revealed the higher energy use efficiency of IFS with rice [10]. The mean total energy input varied considerably among the systems. Integration of poultry and mushroom enterprise with rice-brinjal system required highest energy input (52,030 MJ/ha) and

followed by rice groundnut system integrated with mushroom and poultry (46,077 MJ/ha). However, rice cropping alone without any rice based crops or enterprises recorded the least requirement of energy (Table 4). The energy output was maximum (1,65,334 MJ/ha) under rice-brinjal + mush room + poultry with 3.18 system energy efficiency mainly due to the lesser energy input involved in contrast to energy rich output enterprises. The output of all multi – rice based enterprise was reasonably good varying from 1,00,911 to 1,05,627 MJ/ha excluding brinjal crop based farming system. It is thus evident that efficient utilization of scarce and costly resource is the need of the hour and can be accrued by following the concept of IFS through supplementation of allied agro-enterprises.

Table 1: 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
Tamilnadu	Rice-rice-blackgram	8,312	Rice-rice-cotton +maize	15,009	[12]
			Rice-rice-cotton +maize+poultry/fish	17,209	[13]
	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	[4]
	Cropping alone	36,190	Cropping+fish+poultry Cropping+fish+pigeon Cropping+fish+goat	97,731 98,778 13,1118	[7]
	Rice	22,971	Rice+fish Rice+Azolla+fish	28,569 31,788	[1]
Goa	Cashew	36,330	Coconut+forage +dairy Rice-brinjal (0.5 ha) + Rice-cowpea (0.5 ha)+mushroom +poultry	32,335 75,360	[11]
Madhya Pradesh	Arable farming	24,093	Mixed farming + 2 cow Dairy (2cows) +15 goats+10 poultry+10 duck+fish	37,668 44,913	[18]
Maharashtra	Cotton (K) + Groundnut (S)	(-) 92	Blackgram(K) - Onion (R)-Maize +cowpea Crop+dairy+sericulture Crop + dairy	1,304 3,524 5,121	[14]
Uttar Pradesh	Crops (Sugarcane-wheat)	41,017	Crops (Sugarcane+wheat)+dairy	47,737	[16]
Karnataka	rice – rice system	21599	Rice-fish (pit at the center of the field) – poultry (reared separately) Rice-fish (pit at one side of the field) – poultry (shed on fish pit)	62, 977 49, 303	[2]

Table 2: Productivity and economic analysis of integrated farming system in Tamil Nadu (1998-2000)

Farming systems System	rice- equivalent yield (t/ha)	Net returns (Rs./ha)	B:C ratio	Per day return (Rupees)	Employment generation (mandays)
Cropping alone	13.0	37,153	2.43	178	369
Cropping + fish + poultry	29.6	97,731	3.02	400	515
Cropping + fish + pigeon	29.2	98,778	3.06	400	515
Cropping + fish + goat	37.7	1,31,118	3.36	511	576

Table 3: Economics of rice-*Azolla* fish integrated farming system.

System	Gross income (Rs.)			Total expenditure (Rs.)	Net income (Rs.)
	Crop	Fish	Total		
Rice	43,291	---	43,291	20,320	22,971
Rice + fish	39,447	11,422	50,869	22,300	28,569
Rice + azolla + fish	40,752	13,649	54,401	22,613	31,788

Table 4: Energy budgeting for rice based integrated farming system

Farming system	Pooled mean energy		
	Total input (MJ/ha)	Total output (MJ/ha)	Efficiency
Rice-fallow	11563	78182	6.76
Rice-groundnut + mushroom + poultry	46077	102857	2.24
Rice-cowpea + mushroom + poultry	43792	105627	2.41
Rice-brinjal + mushroom + poultry	52030	165334	3.18
Rice-sunnhemp + mushroom + poultry	41439	100911	2.44

Figure 1: Resource flow in crop + poultry + fish in integrated farming system

e-ISSN: 2319-9857
p-ISSN: 2347-226X

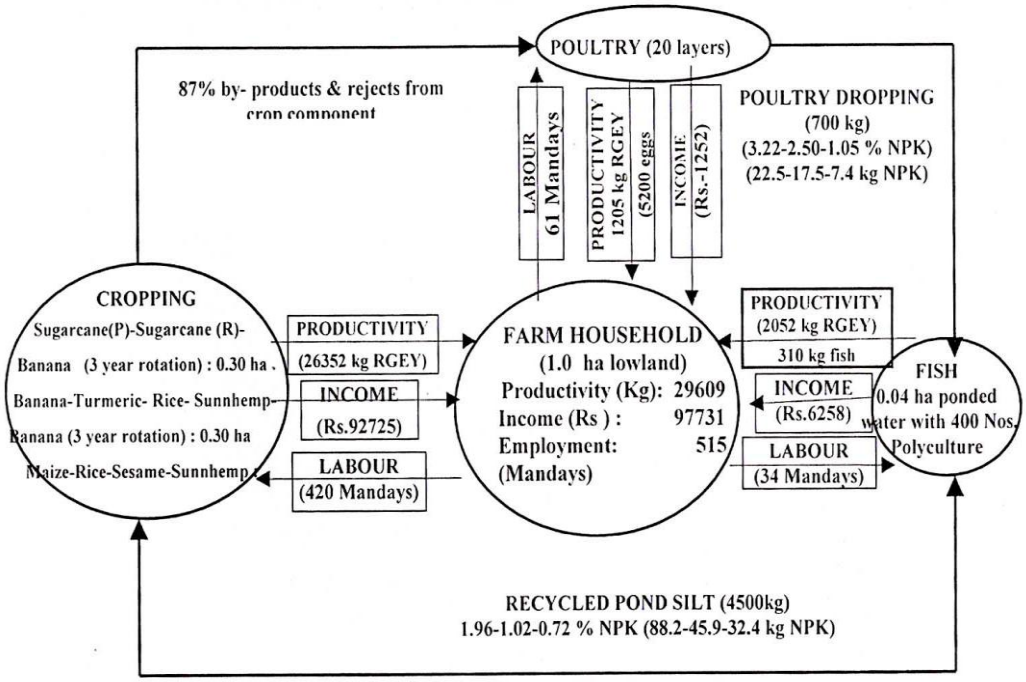
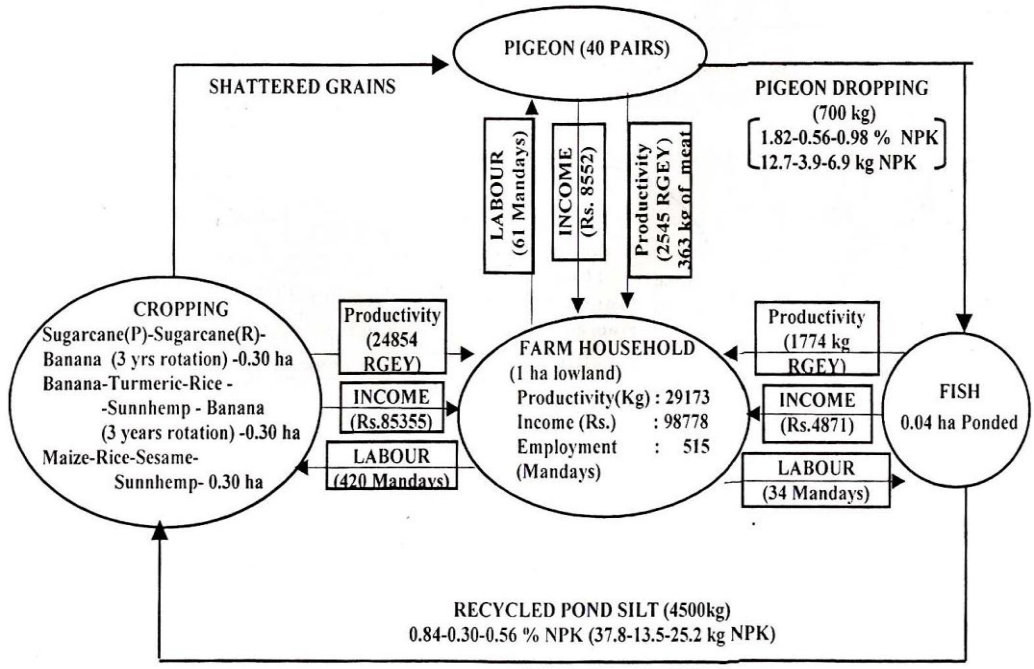


Figure 2: Resource flow in crop + pigeon + fish in integrated farming system



CONCLUSION

Results discussed revealed that IFS enables the agricultural production system sustainable, profitable and productive. About 95 % of nutritional requirement of the system is self sustained through resource recycling. As the number of enterprises are increased, the profit margin increases but simultaneously coupled with increase in cost of production and employment generation though the profit increase was marginal. Further, it is evident that profit margin varied with the ecosystem (rainfed/irrigated), management skill, and socio-economic conditions. On an average profit margin on account of IFS varied from Rs 15,000 to Rs 1,50,000/ha/annum. Simultaneously it takes care of the food and nutritional security of the farming family. The study further revealed improvement in the net profit margin varying from 30-50 %. The resource characterization study reveled that/ha improvement in profitability varied from Rs 20,000 to 25,000 under irrigated condition, resource recycling improve fertility

e-ISSN: 2319-9857
p-ISSN: 2347-226X

led to 5 to 10 q/ha crop yield increase, generate 50-75 mandays/ family/ year and reduce the cost of production by Rs.500-1,000/ha. Therefore, there is an urgent need to promote the IFS concept under all agro-climatic conditions of the country.

The further thrust of IFS is:

- There is a need to create the database on farming system in relation to type of farming system, infrastructure, economics, sustainability etc. under different farming situation.
- Need to develop research modules of farming system under different holding size with varying economically viable and socially acceptable systems.
- The assessment and refinement of the technologies developed at research station at cultivators' field.
- Need to prepare a contingent planning to counteract the weather vagaries/ climate threats under different farming situation.
- Need to prepare a policy draft for the consideration of planners for its promotion at large scale with nominal financial assistance either through short/ medium/ long term loans and other promotional advantage

REFERENCES

1. Balusamy M, Shanmugham PM, Baskaran R. Mixed farming an ideal farming. Intensive Agric. 2003;41 (11–12):20–25.
2. Chnnabasavanna AS, Biradar DP. Relative performance of different rice-fish-poultry integrated farming system models with respect to system productivity and economics. Karnataka J Agric Sci. 2007, 20(4) : 706-709.
3. Frescolo, Westphale. A hierarchical classification of farm systems. Exptl Agric. 1988;24:399-419.
4. Ganesan G, Chinnasamy KN, Bala Subramanian A, Manickasundram P. Studies on rice based farming system with duck cum fish culture in deltaic region of Thanjavur district, Tamilnadu. Farming Systems Newsletter. 1990;1(2):14.
5. Gill MS, Singh JP, Gangwar KS. Integrated farming system and agriculture sustainability. Indian J Agron. 2009;54(2):128-139.
6. Gill MS, Samra JS, Singh Gurbachan. 2005. Integrated farming system for realizing high productivity under shallow water-table conditions. Research bulletins, Department of Agronomy, PAU, Ludhiana, pp. 1-29.
7. Jayanthi C, Rangasamy A, Mythili S, Balusamy M, Chinnusamy C, Sankaran N. 2001. Sustainable productivity and profitability to integrated farming systems in low land farms. In: Extended summaries, pp. 79-81. (Eds: A.K. Singh, B. Gangwar, Pankaj and P.S. Pandey), National Symposium on Farming System Research on New Millennium, PDCSR, Modipuram.
8. Korikanthimath VS, Manjunath BL. Integrated farming systems for sustainability in agricultural production. Indian J Agron. 2009;54(2):140-148.
9. Lasson de A, Dolberg F. The casual effect of landholdings on livestock holdings. Quarterly J Int Agr Germany, Frankfurt. 1995;24(4):339-354.
10. Manjunath BL. 2002. Integrated farming systems for coastal region of Goa. Ph.D. Thesis Department of Agronomy, University of Agricultural Sciences, Dharwad.
11. Manjunath BL, Itnal CJ. Farming system options for small and marginal holdings in different topographies of Goa. Indian J Agron. 2003;48(1): 4-8.
12. Shanmugasundaram VS, Baluswamy M. Rice-fish- *Azolla* - An Integrated Farming System in Low Land Wetlands. Farming Syst. 1993;9 : 105-107.
13. Shanmugasundaram VS, Baluswamy M, Rangaswamy A. Integrated Farming System Research in Tamilnadu. J Farming Syst Res Develop. 1995;1 (1 and 2):1-9.
14. Shelke VB, Kulkarni SN, Waghmore DB, Chavan, A. 2001. Study on Integrated Farming System in Marathwada. Extended Summaries: 1st National Symposium on Farming System Research in New Millennium held at PDCSR, Modipuram, 15-17 October, 2001, pp. 99-100.
15. Singh CB, Renkema JA, Dhaka JP, Singh, Keran, Schiere, J.B. 1993. Income and employment on small farmers. In : Proceeding An International workshop on Feeding of Ruminants on fibrous crop residues: Aspects of treatment, feeding, nutrient evaluation, research and extension. Karnal, Haryana, 4-8 February, 1991, pp. 67–76.
16. Singh Gurbachan. 2004. 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, pp. 80-94.

e-ISSN: 2319-9857
p-ISSN: 2347-226X

17. Singh Rajender, Singh Narinder, Phogat SB, Sharma UK, Singh R, Singh N. Income and employment potential of different farming system. Haryana Agr Univ J Res 1999;29 (3-4): 143–145.
18. Tiwari SP, Ravi R, Nandeha KL, Vardia HK, Sharma RB, and Rajgopal S. Augmentation of economic status of Bastar tribals through integrated (crop, livestock, poultry, duck, fish) farming system. Indian J Animal Sci. 1999;69(6): 448–52.
19. Varughese K, Mathew T. Integrated farming systems for sustainability in coastal ecosystem. Indian J Agron. 2009, 54(2): 120-127.