International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 166-175

Received: 12-05-2018
Accepted: 17-06-2018

Manohar Lal
PhD Research Scholar, Dept. of Agronomy, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Jitendra Patidar
PhD Research Scholar, Dept. of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, M.P., India

Shilendra Kumar
PhD Research Scholar, Dept. of Agronomy, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Abhishek Patidar
Scholar, Dept. of Agronomy, Punjab Agricultural University, Ludhiana, Punjab, India

Correspondence
Manohar Lal
PhD Research Scholar, Dept. of Agronomy, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Different integrated farming system model for irrigated condition of India on basis of economic assessment: A case study: A review

Manohar Lal, Jitendra Patidar, Shilendra Kumar and Abhishek Patidar

Abstract
The growth rate of agriculture in the recent past is very slow inspite of the rapid economic growth in India. Integrated Farming System model for livelihood security in crop (Rs. 58,488 with animals (Rs. 57,598) were better net returns got it. Second case study in model -7 cash crop + vegetables + flower + fruits with retail marketing was highest net returns 4.38 lac. In southern Rajasthan that condition suitable model is crop + livestock farming system. In rice + Azolla + fish model was net income Rs. 31,788 compared to other enterprises and all India best model in Tamilnadu is cropping + fish + goat model to highest net returns (Rs.13, 1118) for marginal and small farmers.

Keywords: Integrated farming system, crop, livestock, economies

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 (Gill et al., 2005) [7].

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 (Singh, 2004) [8]. 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 at least for the partial substitution of the fertilizer nutrients for individual crops and in the cropping systems (Manjunatha et al 2014) [12].

Concept: The FSR concept was developed in 1970s in response to the observation that groups of small-scale farm families operating in harsh environment were not benefiting from the conventional agricultural research and extension strategies.

The farming system, as a concept, takes into account the components of soil, water, crops, livestock, labour, capital, energy and other resources with the farm family at the center managing agricultural and related activities. The farm family functions within the limitations of its capability and resources, socio-cultural setting and interaction of these components with physical, biological and economic factors. The term FSR in its broadest sense is any research that views the farm in a holistic manner and considers interactions (between components and of components with environment) in the system.

Integrated farming is defined as biologically integrated system, which integrates natural resources in a regulation mechanisms into farming activities to achieve maximum replacement of off-farm inputs, secures sustainable production of high quality food and other products through ecologically preferred technologies, sustain farm income, eliminates or reduces sources of present environment pollutions generated by agriculture and sustains the multiple function of agriculture. It emphasizes a holistic approach. Such an approach is essential because agriculture has a vital role to play that is much wider than the production of crops, including providing diverse, attractive landscapes and encouraging bio-diversity and conserving wild life. Sustainable development in agriculture must include integrated farming system with efficient soil, water crop and pest management practices, which are environmentally friendly and cost effective. The future agricultural system should be reoriented from the single commodity system to food diversification approach for sustaining food production and income. Integrated farming systems, therefore, assume greater importance for sound management of farm resources to enhance farm productivity, which will reduce environment degradation and improve the quality of life of resource poor farmers and to maintain agricultural sustainability. The aims of the integrated farming system can be achieved by:

- Efficient recycling of farm and animal wastes
- Minimizing the nutrient losses and maximizing the nutrient use efficiency
- Following efficient cropping systems and crop rotations and
- Complementary combination of farm enterprises

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 at higher levels
- Rejuvenation/amelioration of system's productivity and achieve agro-ecological equilibrium.
- Control the 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 chemical fertilizers and other harmful agro-chemicals and pesticides to provide pollution free, healthy produce and environment to the society at large.

Components in IFS

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

Elements of integrated farming system

Watershed	Farm ponds	Bio-pesticides	Bio-fertilizers
Plant products as pesticides	Bio-gas	Solar energy	Compost making
Green manuring	Rain water harvesting	-	-

Case Study 1: Integrated farming system module for livelihood security (Raichur, Karnataka, India) (Desai. 2015)

Teak planting was all along the borders. Bunds between the segments are planted with drumstick, curry leaf and fodder grasses like NB-21, Guinea grass & stylo.

Segment 1: Bullock pair: 1
Cow: 2
Poultry birds: 60
Kitchen garden

Construction of farm pond (Fishery), farm house, Poultry cage, Cattle shed and Vermicompost unit as per the specification

Segment 2: Horticulture crops like Mango & Fig/Guava inter-cropped with vegetables like Bhendi, Ridge gourd and Leafy vegetables
Segment 3: Maize followed by Bengal gram
Segment 4: Bt-cotton
Segment 5: Part 1: Jasmine
Part 2: Marigold
Part 3: Watermelon

For human need, the livestock provides food, fiber, skin, traction, fertilizer and fuel. Livestock also constitutes "living bank" providing flexible financial reserve in times of emergency and serve as "insurance" against crop failure for survival. In this system, animals are raised on agricultural waste. The animal power is for agricultural operation and the dung is used as manure and fuel.

Results/outcomes: The results of the study have indicated that integration of various enterprises on 1 ha of land holding were viable.

The productivity of the farming systems was based on the quantity of marketable produce obtained during all three years. The profitability of different components of IFS in the first year was comparatively less than second year and third year. During the first year net income generated from crop component was 30,570 with a B: C ratio of 2.30 while, from allied activities it was about 46,398 with B: C ratio 2.81 respectively. In second year, benefit cost ratio is in increasing trend when compared to the first year. The net income generated during the second year from the crop component is Rs. 70319 with B:C ratio of 3.69 while, Rs. 57243 with B:C ratio is 3.02 obtained from the allied sector.

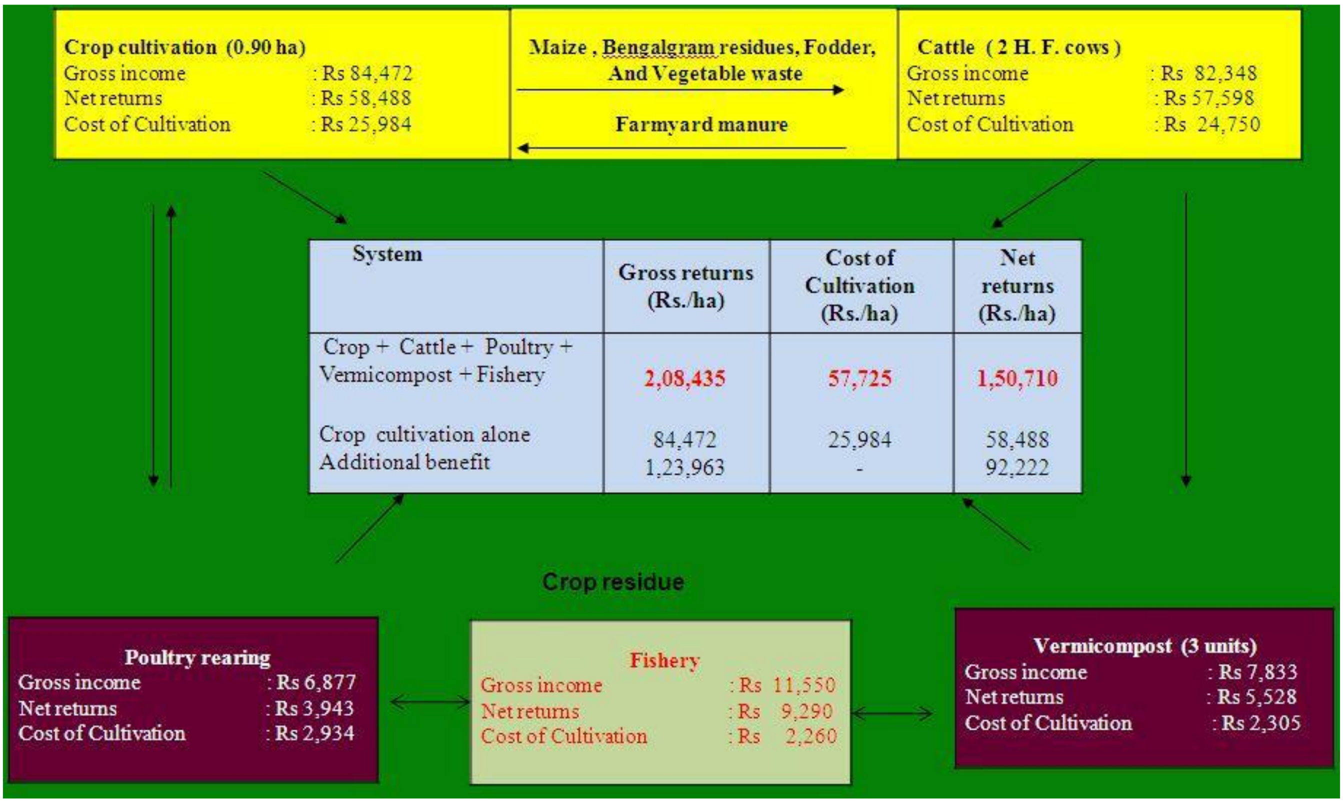


Fig 1: Productivity and profitability in integrated farming system model for average (3 years)

Integrated Farming System method records higher net returns and benefit cost ratio in all the three years because this method comprising the components like cropping, vegetables, vermi compost, goat rearing, poultry and cattle (bullocks, cow and calves) rearing. At the end of third successive year IFS method contributed a net return Rs. 2,27,398 with 4.63 benefit cost ratio, which gives 26.5 per cent higher net returns compared to conventional method (cotton). The net income generated during third year from the crop components is Rs. 74577 with B: C ratio of 3.64 while Rs. 152821 with B:C ratio is 5.34 obtained from the allied sector. Higher net income generated during third year compared to first and second year due to proper recycling of farm resources each other through use of vermicompost, FYM and also from yielding of horticulture components like drumstick, curry leaf, adoption of floriculture and good planning of vegetables according to good seasonal demand might be contributed to good returns. Among components studied, cotton + vegetable cultivation + diary + vermicomposting unit + fodder cultivation on bunds was more profitable and recorded average net returns of Rs. 108212 with 5.41 B: C ratio than growing of single crop cotton.

Case Study 2: Development of Region Specific Horticulture based Integrated Farming System Models of Sirohi District of Rajasthan (Bhardwaj and Vyas 2015) [4]

On the basis of available resources, incorporate following horticulture based farming system models for emerged as economically viable system for small and marginal farmers. To increase farm profitability by refinement in existing technologies and farmers advised to adopt developed "Region specific integrated farming system models" based on horticultural crops, popularization of fruit (papaya, lime, pomegranate), flowers (marigold, roses) and vegetables (tomato, chilli, okra, cucurbits etc.) cultivation, primary processing (proper harvesting, grading and packing of produce) for increasing shelflife and retail marketing of produce for maximizing net profit. By the help of agriculture scientists, progressive farmers and fruit-vegetables merchants develops a suitable IFS model consisting of three layers (lime + papaya + marigold or pomegranate + papaya + marigold) orchard, vegetables and off-season vegetables for regular and sustainable income generation from the farm. A bouquet of 7-10 modern agro-technologies were provided to farm households with horticulture based IFS models options. Horticulture based farming system emerged as economically viable system for small and marginal farmers and income of farm families doubled within a short span of 4 years (2008-09 to 2012-13). Papaya + lime based nutrition garden also improved nutritional status of the tribal families. Vegetable cultivation not only improved economy of the families but also empowered women as they were also engaged in retail marketing of vegetables themselves in nearby vegetable markets and in urban areas. Today (2012-13) the tribal farmers adopted maximum technologies and producing good quality vegetables, papaya, flowers, lime, pomegranate with highest productivity (Table 1). This IFS model secured farmers from the unseen losses by weather vagaries also enhancing farm income manifold and farmers earned `5.30 lakh from 2.0 hectare land by adopting crop production + cash crop + vegetable + fruit + flower production with improved technologies in contrast to only Rs 1.22 lakh from same piece of land by crop production (Table 2).

Introducing crop diversification in prevailing farming system as the district has vast potential for cash crops, vegetables, flowers and fruit crops. The agroecological conditions of the areas are suitable for diversification of traditional agriculture to more remunerative farming. The date presented in Table 2 those farmers adopt model 7 (Crop + cash crop + vegetable + flower + fruit production with retail marketing of fruit and vegetables) were earn Rs 5.30 lakh year-1 with maximum B: C ratio (4.38) and generate 1800 mandays year-1 employment opportunities at farmers field from 2 hectare cultivable land, whereas under model-1 (crop production) the farmers earn annually Rs 1.22 lakh with lowest benefit cost ratio (2.03). Bhardwaj et al., (2015) [4] reported that the horticulture based integrated farming system is more remunerative and maximum utilization of available resource for generate on farm employment opportunity. Bhardwaj, (2011) [5]; Bhardwaj and Kumar (2012) [3] also observed similar results. For promoting adoption of new technologies in operational area organized different activities like awareness camps, on and off farm trainings on vegetable production and exposure visits in different vegetable growing areas.

Case Study 3: Farming systems in southern Rajasthan (Singh et al. 2013) [13].
Rajasthan is the largest state in the country and is at 6th position with respect to agricultural production. The basic aim of integrated farming system is to derive a set of resource development, management and utilization practices that lead to a substantial and sustained increase in agriculture production. Since farming systems differ in different situations such studies should be location specific (Singh, 1998).

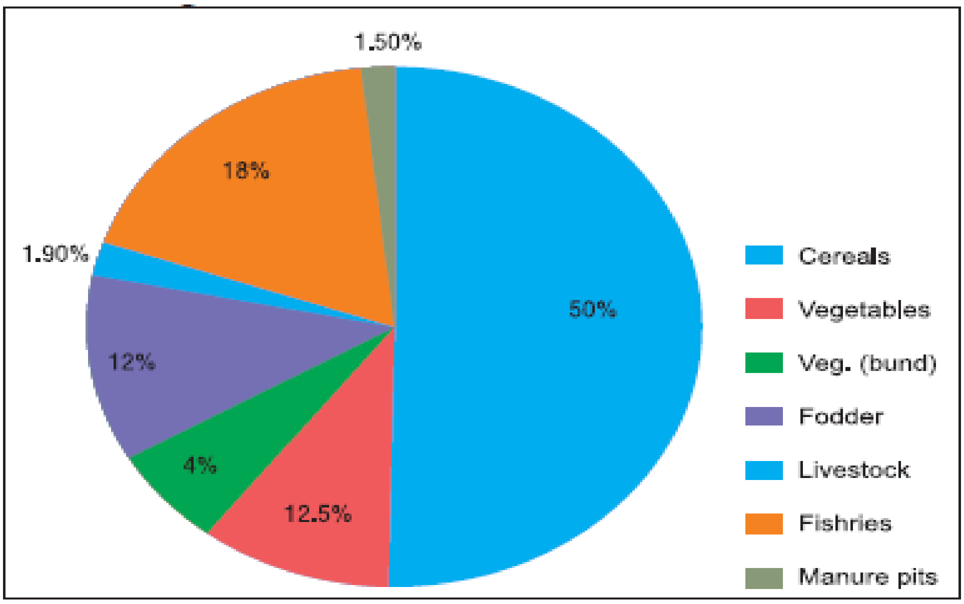
Model 1: Crop-livestock farming system
Kharif: Maize, soybean and cotton, *Rabi:* wheat, barley and mustard
Livestock: Cow and buffalo

Model 2: Crop-livestock-horticulture farming system
Kharif: Maize, soybean and cotton, *Rabi:* wheat, barley and mustard
Livestock: Cow and buffalo
Horticulture: Fruit, Vegetable and flowers

In crop-livestock farming system, a total expenditure incurred by the small farmers (Rs. 28292 ha^{-1}), gross return (Rs 61677 ha^{-1}) and Net return (Rs33385 ha^{-1}). The crop-livestock-horticulture farming system model for small farmers was economic like that total cost of cultivation (Rs. 28647 ha^{-1}), gross return (Rs 80808 ha^{-1}) and Net return (Rs 5216 ha^{-1}) in Crop-livestock-horticulture model more economical for small farmers compared to crops- livestock system, which indicates that there is a lot of scope of improvement in total income of farmers through adoption of improved livestock technologies (Table 3).

Case Study 4: Developed two Integrated Farming Systems Modules for small and marginal farmers of Eastern region for lowland and midland irrigated ecosystems of Bihar (Kumar et al. 2012) [9].
The details of the module are given as:

A) Two acre IFS module (for lowland situation)
Components:
Crop + Livestock + Fishery
Allied: Duckery / Vermicomposting / Bee keeping/ FYM



1) Cereal crops (50% area)
Kharif: Rice
Rabi: Wheat/Maize/Lentil/Mustard

2) Horticultural crops (Fruits +Vegetables): 12.5 % area Vegetables
Kharif: Cucurbits/Brinjal/Okra
Summer: Brinjal/Boro/ Okra/ Bitter gourd / Cucumber etc.
Fruits: Papaya (On pond's dike and field bunds)
Banana (On pond's dike)
Lemon (On pond's dike and Horticultural block)
Guava (On pond's dike and Horticultural block)

3) All around the field bunds cucurbits or seasonal vegetables having lesser water requirement may be raised by making wire fences.

4) Fish + Duck integration (17.8% area)
i) Mix carp culture: Rohu (20% as column feeder), Catla (30% as surface feeder), Mrigal/common carp (50% as bottom feeder)
ii) Duck: For 1000 m2 water area 40 numbers of ducks are sufficient Khakhi Campbell breed of duck is right choice for this area (Dual purpose) A thatched hut of 10 x 15' size is optimum for 40 ducks above the water or on the pond's dike.

5) Livestock (1.80% area)
A size of 3 adult cows + 3 calves is optimum for two acre land in respect of FYM requirement for the fields and fodder requirement for the livestock. A thatched hut of 20' x 30' with sufficient paddock space is sufficient for above no. of animals. The Cow shed should be connected with the pond with a drainage channel so that urine and water can move into

the pond. A storage hut for storing of animal feed should be also made near the animal shed.

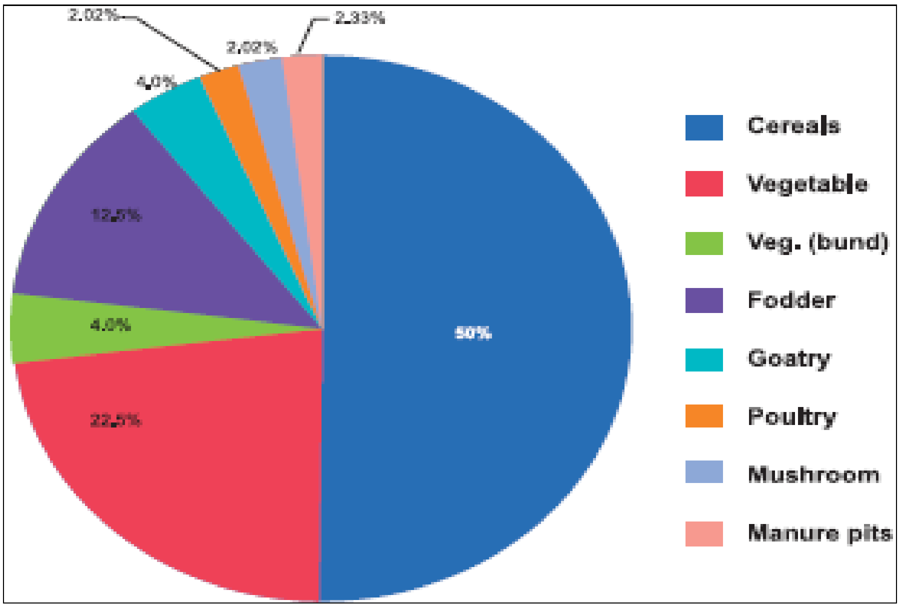
6. Fodder production (12.5% area): For feeding of 3 cows and 3 calves 1000 m² land is sufficient if year round fodder production is carried out. In addition to green fodder, straw, leaves, stems of different cereals and vegetables can be also used as animal feed.
***Kharif*:** M.P. Chari/Sudan grass/ Napier/Maize
***Summer*:** Boro/Lobia/Maize/Sudan grass
***Rabi*:** Berseem/Oat/Maize etc.

7. Spices: In the sheds or where light intensity is less like orchards, spaces between the huts etc. turmeric, ginger or guinea grass can be taken.

8. FYM/ vermi-composting pits: (1.4 % area)
Optimal sizes pits for preparation of FYM and vermin-compost should be made depending upon land available near the cowshed so that required raw materials for making manures should be made available nearby for convenience and to avoid transportation charges (Fig. 3).

Note: Cattle shed should be always constructed away from birds to avoid attack of any transmissible or contagious diseases to animals or vice-versa.
Details of nutrient recycling in the model are given in Fig 3, economics of IFS models are presented in Table 4-6.
Out of above mentioned income, we get about 27.8 t Cow dung and 1.2 t vermin-compost which is equivalent to 482 kg Urea, 400 kg of SSP and 396 kg of MOP. In other words we can curtail the cost of cultivation up to Rs 8,000-9,000/year by recycling these organic wastes into the system.

B. One acre IFS module (midland situation)
Components:
Crop + Goat + Poultry
Allied: Mushroom/Goat manure/Vermi-composting
Land allocation: Details of land allocation or different components in 1 acre model has been given in Fig 4.



1. Cereal crops (50% area)
***Kharif*:** Rice
***Rabi*:** Wheat/Maize/ Lentil/Mustard

2. Horticultural crops (Fruits + vegetables): 22.5 % area
Vegetables
***Kharif*:** Cucurbits/Brinjal/Okra
***Summer*:** Brinjal/Boro/ Okra/ Bitter gourd/Cucumber etc.
Fruits: Papaya (On field bunds)
Banana (On field bund)
Lemon (In Horticultural block)
Guava (In Horticultural block)

3. All around the field bunds cucurbits or seasonal vegetables having lesser water requirement may be raised by making wire fences (about 4 % of total area)

4. Livestock (Goat): 2.5% area
A size of 20 female goat + 1 buck is optimum for one acre land in respect of manure requirement for the fields and fodder requirement for the livestock. A thatched hut of 20' x 30' with sufficient fenced paddock space (to move the goats freely as goats have to kept on stall feeding) is sufficient for above no. of animals. The goat shed should be airy and sunny. A storage hut for storing of animal feed should be also made near the animal shed. Black Bengal breed of goat is suitable for this region.

5) Poultry (100 birds)
100-200 birds (broiler) can be reared in an area of 225 sq. ft. by making a thatched hut. All around wire meshing should be done at the inner walls to protect the birds from predators and hunting animals. The hut should be airy and proper arrangement of bulb or other lighting should be done before rearing the chicks.

6) Mushroom: Year round mushroom production can be done in an area of 25 X 20' by making a thatched hut for optimum return. In this shed about 200 mushroom bags can be kept at a time by making bamboo shelves. Selection of the mushroom strains should be done on the basis of climate and humidity in the atmosphere as March-September: straw/paddy/milky mushroom.
October-February: Oyster/ Button mushroom

7) Fodder production: (12.5% area)
For feeding of 20 + 1 unit of goat an area of 600 m2 is sufficient if year round fodder production is carried out. In

addition to green fodder, dry husks, leaves, stems of different cereals and vegetables can be also used as feed.
***Kharif*:** M.P. Chari/Sudan grass/Maize
***Summer*:** Boro/Lobia/Maize/Gunea grass
***Rabi*:** Berseem/Oat/Maize etc.

8) Spices: In the sheds or where light intensity is less like orchards, spaces between the huts etc. turmeric, ginger or guinea grass can be taken.

9) FYM/ vermicomposting pits: (1.4% area)
Optimal sizes pits for preparation of goat manure and Vermicompost should be made depending upon land available near goat shed so that required raw materials for making manures should be made available nearby field and livestock (Fig. 5) (Table 7-8).
Details of nutrient recycling in the model are given in Fig 5, economics of IFS models are presented in Table 7-8.
In addition to above mentioned income about 5.6 t of goat manure and 0.6 t of vermin compost is also prepared within the system which were recycled within the system. The above mentioned organic manures are equivalent to 100 kg Urea, 170 kg SSP and 40 kg MOP in addition which costs about Rs 4000/-. The straw available from the crops was recycled into the system in form of mushroom, feed to animals and vermin-composting.

Case Study 5: Integrated Farming System Research models developed in different states of the country (Manjunath, 2002).
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 government 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 (Gill et al 2005) [7].
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 (Lasson and Dolberg, 1995) [10]. 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 (Table 9).

Case Study 6: Rice-Azolla fish integrated farming system: (Balusamy *et al*. 2003) [1]
Explained that rice + Azolla-cum-fish culture is one of the economical option in such type of area. Monoculture systems 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 10) 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.

Table 1: Horticulture based farming system model

S. No	Models	Types of Models
1.	Models-1	Crop production
2.	Models-2	Cash crop production
3.	Models-3	Vegetable production
4.	Models-4	Crop + cash crop+ vegetable production
5.	Models-5	Crop + cash crop+ vegetable + fruit production
6.	Models-6	Crop + cash crop+ vegetable + flower + fruit production
7.	Models-7	Crop + cash crop+ vegetable + flower + fruit production with retail marketing

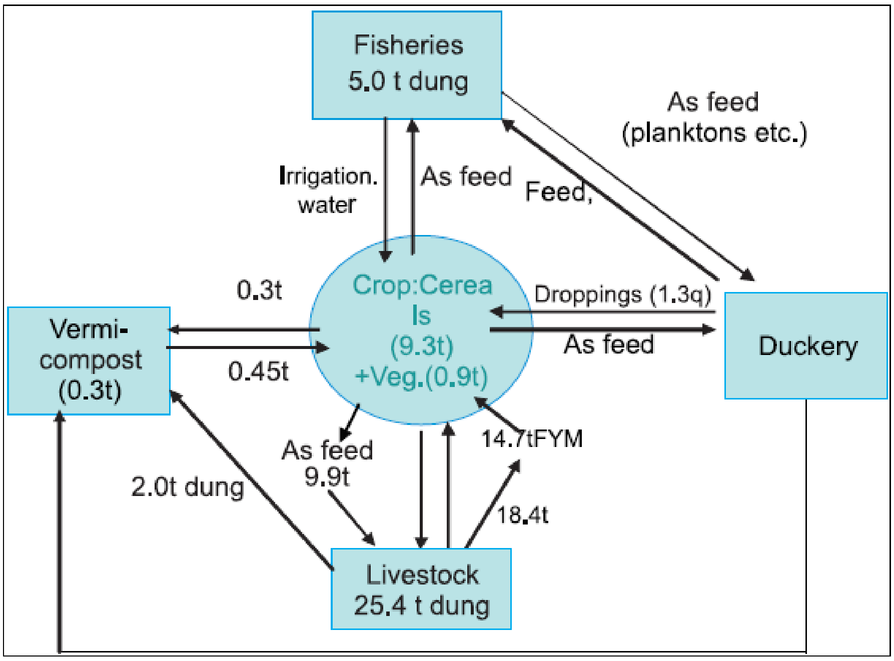


Fig 3: Details of nutrient recycling in the model for two acre area.

Table 2: Region specific integrated farming system models for partially irrigated arid condition in 2.0 hectare

Models	Major component	Cost of cultivation (in lakh)	Gross return (in lakh)	Net return (in lakh)	Benefit-cost ratio
Models-1	***Rabi***-wheat, mustard, barley, gram etc. ***Kharif***-Maize, bajra, green gram, cluster bean etc.	0.60	1.82	1.22	2.03
Models-2	Fennel- 0.5 ha Castor -0.5 ha Cotton- 0.5 ha Other crop- 0.5 ha	0.78	2.84	2.06	2.64
Models-3	***Rabi***-Tomato, brinjal, colecrop, pea ***Kharif***- Okra, cucurbits ***Zaid***- Okra, chilli, cucurbits	1.68	6.80	4.12	3.04
Models-4	Crop-0.6 ha Cash crop-0.7 ha Vegetable -0.7 ha	1.02	2.85	2.91	2.86
Models-5	Crop-0.5 ha Cash crop-0.5 ha Vegetable -0.5 ha Fruit plants-0.5ha	0.90	4.32	3.33	3.75
Models-6	Crop-0.4 ha Cash crop-0.4 ha Vegetable -0.4 ha Fruit plants-0.4ha Flower -0.4 ha	1.05	5.07	4.01	3.80
Models-7	Crop-0.4 ha Cash crop-0.4 ha Vegetable -0.4 ha Fruit production-0.4ha Flower -0.4 ha with retail marketing	1.20	6.50	5.29	4.38
P<0.05	-	0.224	0.111	0.079	1.010

Table 3: Economics of integrated farming system for small farmers.

Types of Model	Components	Area (ha.)	Total cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)
1	Crops- livestock	1.0	28292	61677	33385
	Crops		18952	45870	26918
	Livestock		9340	15807	6467
2	Crop-livestock-horticulture	1.47	28647	80808	52161
	Crops		12534	33958	21424
	Livestock		8506	18558	10052
	Horticulture		7607	28292	20685

Table 4: Economics of two acre IFS module (complete one year)

Components	Gross income (Rs)	Net income (Rs)
Cereals	39,335	19,010
Vegetable	42,180	29,647
Fruits	14,505	10,000
Dairy + Income from calves	1,44,280	96,870
Fishery	19,700	14,172
Duckery (egg)	15,000	10,800
Total (Rs)	2,75,000	1,80,499

Table 5: Establishment, income and expenditure statement of two acre IFS module

Components	Establishment cost	Gross income (Rs)	Net income (Rs)
Crop (0.4 ha)	-	20325	19010
Horticulture Crops (0.15 ha)	2500	17785	39647
Fodder Crop (0.1 ha)	-	6224	Used within the system
Fishery (0.1 ha)	70000	5528	14172
Duckery (pond's bund)	18000	4200	10800
Dairy (0.016 ha)	70000	62500	81870
Vermicompost & FYM pits	15000	3300	Used within the system
Total (Rs)	175500	119862	180499

Table 6: Economic analysis of different components and system under two acre IFS module

Farming system	Rice-Wheat	Vegetable	Fishery	Duckery	Cattle	Net income (Rs)
Rice - Wheat system	46122	-	-	-	42290	46122
Rice - Wheat + Dairy	43815	-	-	-	42290	86105
Rice - Wheat + Dairy + Fishery	38050	-	22500	-	42290	102840
Rice - Wheat + Dairy + Fishery + Duckery	38050	-	22500	18000	-	144165
Rice - Wheat + Dairy + Fishery + Duckery	38050	-	22500	18000	42290	134130
Rice - Wheat + Vegetable + Dairy	32285	53790	-	-	42290	128365
Rice – Wheat + Vegetable + Dairy + Fishery	32285	53790	22500	-	42290	150865

Table 7: Economics of the system (complete one year cycle)

Components	Gross income (Rs)	Net income (Rs)
Rice crop	13893	8398
Vegetable / Fruits	30240	21015
Goatry	50000	39180
Poultry	52500	32500
Beekeeping	16500	10800
Mushroom Production	22000	16800
Total (Rs)	185133	128693

Table 8: Establishment and expenditure statement of one acre IFS

Components	Establishment cost	Gross income (Rs)	Net income (Rs)
Rice crop (0.2 ha)	-	5495	8398
Vegetable / Fruits (0.09 ha)	1080	9225	21015
Fodder (0.06 ha)	-	4206	Used within the system
Goatry (20+1) (0.018 ha)	45000	10820	39180
Mushroom Production (0.018 ha)	10000	5200	16800
Poultry (200) (0.0015 ha)	12000	20000	32500
Vermicompost & Goatry FYM pits	8000	2660	Used within the system
Beekeeping	8000	5700	10800
Total (Rs)	84080	63306	128693

Table 9: 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
Tamilnadu	Rice-rice-blackgram	8,312	Rice-rice-cotton +maize	15,009
			Rice-rice-cotton +maize+poultry/fish	17,209
	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
	Cropping alone	36,190	Cropping+fish+poultry Cropping+fish+pigeon Cropping+fish+goat	97,731 98,778 13,1118
	Rice	22,971	Rice+fish Rice+Azolla+fish	28,569 31,788
Goa	Cashew	36,330	Coconut+forage +dairy Rice-brinjal (0.5 ha) + Rice-cowpea (0.5 ha)+mushroom +poultry	32,335 75,360
Madhya Pradesh	Arable farming	24,093	Mixed farming + 2 cow Dairy (2cows) +15 goats+10 poultry+10 duck+fish	37,668 44,913
Maharashtra	Cotton (K) + Groundnut (S)	(-) 92	Blackgram(K) - Onion (R)-Maize +cowpea Crop+dairy+sericulture Crop + dairy	1,304 3,524 5,121
Uttar Pradesh	Crops (Sugarcane-wheat)	41,017	Crops (Sugarcane+wheat)+dairy	47,737
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

Table 10: 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

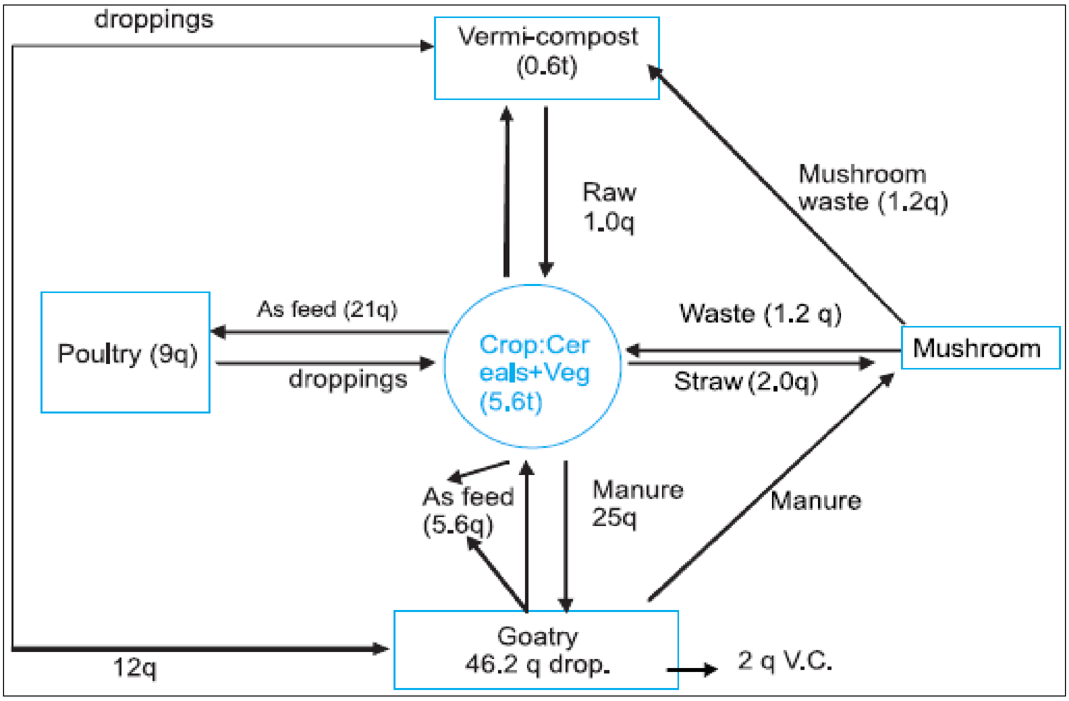


Fig 5: Nutrient recycling among different components of the 1 acre IFS model

Conclusion

Integrated farming systems, therefore, assume greater importance for sound management of farm resources to enhance farm productivity, which will reduce environment degradation and improve the quality of life of resource poor farmers and to maintain agricultural sustainability. Maximization yield were all component enterprises to provide steady and stable income at higher levels by IFS. Efficient recycling of farm and animal wastes and minimizing the nutrient losses and maximizing the nutrient use efficiency following efficient cropping systems and crop rotations and Complementary combination of farm enterprises to maintained sustainable production with increase farmers income.

Acknowledgement
The first author is thankful to Researcher of Agronomy that need of frames according to conducted research and IFS model for sustainable productivity in irrigated condition of India as basis on economic outputs. Author is also thankful to the anonymous reviewer/referee for the valuable suggestions and comments to improve the paper.

References

1. Balusamy M, Shanmugham PM, Baskaran R. Mixed farming an ideal farming. Intensive Agric. 2003; 41(11-12):20-25.
2. Bhardwaj RL, Barhat VS, Bajpai NK, Singh I. Development of region specific integrated farming system models with crop diversification based on horticulture crop for sustainable financial, nutritional and health security of tribal of district Sirohi Rajasthan: A case study. National symposium on modern agro-technologies for nutritional security and health at Dr. YSPUHF, Solan, 2015, 258-259.
3. Bhardwaj RL, Kumar L. Krishi me tikaupan ka rastha: Mixed cropping system. Khad Patrika, New Delhi, 2012, 32-35.
4. Bhardwaj RL, Vyas L. Development of Region Specific Horticulture based Integrated Farming System Models with Crop Diversification for Sustainable Livelihoods and Nutritional Security of Tribal of Sirohi District of Rajasthan: A Case Study. Advances in Social Research. 2015; **1**(1):17-29.
5. Bhardwaj RL. Bench mark survey on effect of integrated farming system model on socioeconomic development of tribals. Krishi Vigyan Kendra, Sirohi, Maharana Pratap University of Agriculture and Technology, Udaipur, 2011, 12-15.
6. Desai BK. Integrated Farming System Module for Livelihood Security (Raichur, Karnataka, India): Success story under RKVY Project Implemented at UAS, Raichur, Karnataka, 2015, 1-14.
7. Gill MS, Samra JS, and Singh G. Integrated farming system for realizing high productivity under shallow water-table conditions. Research bulletins, Department of Agronomy, PAU, Ludhiana, 2005, 1-29.
8. 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.
9. Kumar S, Dey A, Kumar U, Chandra N, Bhatt BP. Integrated farming system for improving agricultural productivity. Status of Agricultural Development in Eastern India. Eds: B.P. Bhatt, A.K. Sikka, Joydeep Mukherjee, Adlul Islam, A. Dey, 2012, 205-230
10. Lasson de A, Dolberg F. The casual effect of landholdings on livestock holdings. Quarterly J Int Agr Germany, Frankfurt. 1995; 24(4):339-354.
11. Manjunath BL. Integrated farming systems for coastal region of Goa. Ph.D. Thesis Department of Agronomy, University of Agricultural Sciences, Dharwad, 2002.
12. Manjunatha SB. Shivmurthy D, Sunil Satyareddi A, Nagaraj MV, Basavesha KN. Integrated Farming System - An Holistic Approach: A Review. Research and Reviews: Journal of Agriculture and Allied Sciences 2014; 3(4):1-9.
13. Singh H, Sharma SK, Dashora LN, Burark SS, Meena GL. Characterization and Economics of Farming Systems in Southern Rajasthan. Annals of Arid Zone 2013; 52(1):67-70.