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Farming System Approach to Improve IUE, Employment and Income in Eastern India

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Integration of different farming systems (FS) results in better utilization of all the resources at the command of the farmers. In India, small and marginal farmers are in the majority, more so in some eastern states particularly West Bengal where more than 95 percent farmers belong to these categories. Farm size is too small to employ the family labour force year around if they grow mono crop. Therefore, they resort to integration of various types of farming systems namely cropping, livestock, fishery, piggary,goatary,horticulture (fruit, vegetables, flower, apiculture, plantation) etc. This results in higher use efficiency of inputs (IUE) including fertilisers, reduction of risks, generation of employment opportunities in culminating higher farm income.

For the survival, the small and marginal farmers over the years have evolved techniques which have benefited them immensely. Without knowing the scientific basis of such integration they have been practising the system for long. Of late, ICAR institutes, agricultural universities, and others organizations have come forward to provide scientific basis for such integrated farming systems. In 1983, FAO-FAI International Seminar on the theme of System Approach (SA) to agriculture was organized in New Delhi.

A few years ago, ICAR initiated a coordinated research project on Farming System and the Project Directorate of Cropping System Research located at Modipuram, U P, India, was designated as the nodal agency. The project might have generated valuable information on the different facets of the subject. But the consolidated publication on the subject is yet to come. Therefore, in this paper, an attempt has been made, to provide some practical information through case studies as well as published information generated by various research and other agencies involved in Farming System Research (FSR) and development. It is imperative to make a mention here that the name of the Project Directorate of Cropping System Research has been changed to Project Directorate of Farming System Research (PDFSR).

Eastern India in general is dominated by small and marginal farmers. It is imperative to make a mention here that certain parts of the eastern India is rich in natural resources, but the farmers are poor because they have very poor resource base. It is planned to treat the subject into four parts taking the examples of Orissa, Bihar, West Bengal and Assam in North East.

Orissa

It is paradoxical that the state of Orissa, with rich natural resources, is one of the poorest states of the country because of poor resource base of the farming community in general and that of ST and SC farmers constituting 44 percent of the population in particular who live in the undulating rainfed drought prone fragile environment for undertaking agricultural activities, the only mode of their livelihood (1). Orissa has been attracting a large number of NGOs, International agencies etc. to work in the state. Hundred of reports on the their poor conditions, have been written and, consultants were duly paid , but their condition remains where they were. New costly techniques totally unsuitable to their socio-economic conditions suggested by the learned experts have been lost to posterity.

Of late, a man with local rural base and a big heart braved to analyze the situation which finds a place herein.

Farming System Research (FSR)

The pond based FSR and extension programme was taken up in A Block of the Central Research Station,OUAT, Bhubaneshar, with the objective to (1) to generate maximum income and employment by combining different enterprises namely field crop, multistoried cropping, pomology, olericulture, floriculture, fishery, duckery, poultry, mushrooms, apiary, biogas, agro-forestry and commercial nursery by recycling product and by products.

This farm pond based model is intended for farmers of the coastal districts having two ha of land with a pond. Shade loving crop plants such as ginger, turmeric and pine apple were planted under the coconut trees. One poultry unit had been installed at one of the corners of the pond with the idea that the droppings of the birds would directly fall into the water to help the growth of the planktons. The model also had a duckery unit. A biogas plant was installed to meet the energy need of the family. Slurry generated at the plant was used as manure for crops and a part of it was diverted to fish pond to encourage the growth of the plankton

Every early morning raw dung collected from the bullock shed of the central farm was fed to the biogas plant. Brinjal, okra, cowpea and maize were grown in *Kharif* while tomato,

watermelon, cucumber, bitter gourd, and bottle gourd etc , were grown in the *Rabi* season. Fodder crop was grown to supply greens to the dairy. Banana, mango, ber, lemon and yam had been planted around the pond to utilize all the available space. An ornamental unit was developed in front of the farm house to provide the mental food. The area allotted to different components of the farm is mentioned in **Table 1**.

The income generated has been indicated in the **Table 2**.

The data mentioned in **Table 2** indicate that a net profit of Rs 58367.00 could be generated from Farming System Approach in a Research Farm (RF) (1). It would be worth while to examine if the FSA is employed in farmer's field. A study was, therefore, conducted in the farm of a marginal farmer, Minati Behera, in Banshipatna village of Bhadrak district of Orissa (2).Area allocation to different component in farming system has been mentioned in **Table 3**.

The Economies of the (IFS) Integrated Farming System has been mentioned in **Table 4**.

The data on the economics of IFS indicated that agroforestry and pomology unit yielded the maximum return of Rs 5.60 and Rs 4.90/Re invested, respectively followed by vegetables farming (Rs3.79/ Re) Rice (low land rice) yield being the lowest. Return from fishery was also low. It might be due to local fish culture, not the composite culture (2).

It is interesting to note that the overall success with respect to economics and employment generation from the system was quite high. About an acre area generated a net return of Rs 47,825 with an investment of Rs 18,515 and also employment generation of 248 mandays. Manure generated from dairy unit better ulitised by vegetables. Likewise rice generated straw which was used by the dairy unit Thus, the synergy among

Table 1 – Area allocation to different components in FSR unit at CRS, OUAT, Bhubaneshwar

Particular	Area (sq. m)	Percentage
Farm house	100	
Threshing floor	300	2.30
Cattle shed &apiary	36	
Biogas plant	12	
Pisciculture (duckery, poultry)	3128	15.6
Floriculture	500	2.5
Multistoried croppings	2080	10.4
Low land crop	3200	16.0
Upland crop	2550	12.80
Mushroom, agroforestry, Forage unit, compost pit, Irrigation, drainage etc.	7674	38.4
Total	20,000	100

Table 2 – Income generated by the different components

S.No	Component	Total labour (Mandays)	Total cost (Rs.)	Gross returns (Rs.)	Net returns (Rs.)	Return/Rs. invested (Rs.)
1	Field crop (rice, maize, rice bean)	98.2	3315	8954	5638	2.70
2	Multistoried cropping (Coconut, ginger, turmeric, pine apple)	87.0	3831	12920	9089	3.37
3	Banana, papaya	18.4	900	2366	1466	2.63
4	Vegetables (brinjal, okra, potato, tomato etc)	96.4	3812	12114	8310	3.18
5	Floriculture	4.0	125	225	100	1.8
6	Fishery (multi layer)	31.0	3722	20326	16603	5.46
7	Poultry	23.0	9240	10221	981	1.11
8	Duckery	23.0	5387	6100	713	1.13
9	Mushroom	180.0	18184	31040	12856	1.70
10	Apiary	1.0	170	1350	1180	7.91
11	Biogas	11	600	2031	1431	3.33
	Total	573	49286	107645	58367	2.18

Source : (1)

Table 3 – Area allocation to different component in Farming System

Component	Particulars	Number of units/plants	Area (Squ m)
Field crops	Low land rice (Sarala/Kanchan)		1600
Vegetables	Brinjal, tomato, okra, pumkin, bitter gourd, cucumber, etc		1420
Fruits	lemon	2	30
	Guava	5	50
	Mango (Baiganpalli, Sinduri)	3	40
	Coconut	12	220
	Papaya	20	80
	Litchi	2	20
	Banana	40	100
Floriculture	Marigold, Jasmine	50,12	60
Agroforestry	Teak	4	40
	Drumstick	1	16
	Bamboo	25	90
	Tamarind	1	20
	Karanja	4	32
	Sahada	3	12
Fishery	Pond system	1	120
Dairy unit	Cowshed(4cows& 4calves)	1	50
General areas	For Children to play and other needs	1	120
Farm house	Including threshing floor	1	240
Total			4360

Table 4 – Economics of Integrated Farming System

Component	Area (Sq.m)	Gross return (Rs)	Investment (Rs)	Net return (Rs)	RUE (Rs)	Labour needed (Mandays)
Crops						
Rice	1600	2100	1100	1000	1.91	14
Vegetables	1420	35180	9260	25920	3.79	96
Fruits	540	9960	2030	7980	4.90	39
Floriculture	60		50			1
Agroforestry	210	2100	375	1725	5.60	7
Fishery	120	2300	700	1600	3.28	8
Dairy	50	14600	500	9600	2.92	83
Grand total	4000	66,240	18515	47825	3.73	248
Previous year (2003-04)	2760	37800	12200	25600	3.09	136

components within the FS was better utilized for improving the input use efficiency at the farm level (2).

Assam

Rice- fish farming can be conveniently practised in about 10 mha of rainfed low land with the depth of water varying from 5-100 cm in India. Assam has 10 % of such area under rice (7). Rice grown in such area yields 1.0 to 1.5 tonnes/ha. Unfortunately rice is only suitable in such a situation which is plaqued by various constraints like excess water, flood, drought, insect-pects, weeds, poor socio-economic condition of farmers.The Famous Brahmaputra valley of Assam has great scope for rice–fish farming system because of high rainfall resulting waterlogging in the low lying areas for 3-8 months. CRRI, Cuttack, has developed a suitable eco-friendly rice – fish farming echnology for rainfed lowland areas. This farming system is said to ensure higher and stable farm productivity, employment and income. The technology developed a CRRI,Cuttack, has been revalidated and fine tuned for adoption in the Brahmaput valley of lower Assam with aim of enhancing farm income for small holding farm.

The components of IFS were (1) rice in the field and (2) fish in the refuge pond, trenches and also in the rice fields, (3) vegetables(radish, brinjal, okra, pumpkin, tomato, poi, spinach, coriander etc), (4) pomology (lemon, papaya, banana, guava, coconut, etc) (5) agroforestry (teak was grown on dyke). Climbing vegetables like ash gourd, ridge gourd, country beans, bottle gourd, etc were grown on the platform hanging over the trenches. Field design and production technology were the two main components of technologies employed.

A low lying rice field measuring 125m X 40m having water depth ranging from 20-60 cm in rainy season but free from flood was selected for construction of rice –fish pond.

The field design consisted of (1) wide dykes all around a pond refuge connected to two sides trenches (micro-water shed cum-fish refuge) with a guarded outlet.

Rice was the main component occupying 60 % area. Horticultural crops were lemon, orange, guava, papaya, coconut, arecanut, marigold, tuberose, and seasonal vegetables. Teak was the agro-forestry component.

Pond refuge with a size of 30 X 12X 2m was constructed at the lower (down slope)end of the field occupying 7 % area. The trenches with 2.5 m width occupying 10 % area were constructed adjacent to dykes along the longituditional side of the field which were connected to pond refuge at one end. The trench bottom had a gentle slope of 0.75 towards the pond refuge (7).

Production Technology

Rice

Rice-rice-rice cropping system was followed. All the locally suitable recommended package of practices were adopted

Fish

Fingerlings, totaling 6250 in number, of catla, rohu, mrigal, bata, silver carp etc. were released in the pond in the first week of July. Locally suited recommended practices were employed.

Horticulture

All major branches of horticulture namely pomology (banana, lemon, orange, papaya, coconut, arecanut etc.), olericulture (vegetables like brinjal, radish, tomato, pumkin, poi, spinach, climbing and creeper vegetables like country bean, bottle gourd, ash gourd etc.), floriculture (marigold, tuberose etc.) were included. Teak was the main component of agroforestry.

10% of construction cost+interest on total cost is taken as the deprecation cost.

The data presented in **Table 5** indicates that the incomes generated in rice and fish components were almost equal.

Table 5 – Economics of rice-fish farming system in the Ist year

Components	Operational cost (Rs)	Gross return (Rs)	Net return (Rs)
Farm construction*	6000.00		
Rice	17106.00	25387.00	8281.00
Fish	8650.00	17180.00	8530.00
Horticulture	1400.00	1825.00	425.00
Total	33156.00	44382.00	11226.00

Bihar

A case study of a farm of about 9600squre m owned by Shri Rajendra Kumar of village Priyanagar, district Saharsa, about 95 km away (North –East) of Patna, the capital city of Bihar has been taken up to find out the impact of IFSA on the IUE, employment generation, and income over the existing system. The District HQ is only about 10 Km away but very difficult to reach. The local market Sonbarsa Raj is only one km away from the village. The village houses about 500 families (about 2500 population). Brain drain is a rule in this area rather than an exception. The intelligent, educated people are mostly away to the different cities of the country/ world and are in very good positions.

The important crops grown are rice (autumn, winter and summer rice), autumn moong, maize (autumn, winter and summer maize, wheat(has less area than maize) barley, ragi, summer moong lentil, gram, khesari, pea, mustard sunflower, all kinds of vegetables (brinjal, tomato, potato, chilli being more important), mango, banana, guava, citrus, coconut etc. Fishery, agroforestry goatary, etc are common. Important constraints are flood, transport, marketing, availability of good quality seeds, fertilisers, plant protection materials etc. Last year (2009) the area interestingly had floods without rain. The Kosi tributary called "Kamal"runs through the area.

Table 6 indicates area allocation to different components in FS.

Table 6 – Area allocation to various components

Component	Particulars	Number of units/plant	Area (squ.m)
Field crops System	Rice-moong-maize/wheat		4800
Mustard			489
Vegetables	Brinjal, tomato, okra, pumpkins, bitter gourd, chilli etc.		1100
Fruits	Mango	48	480
	Banana	500	1250
	Guava	100	100
	Jackfruit	5	100
Flower	Marigold	50	50
Agroforestry	Mohua	5	50
	Jamun	5	100
	Sesum	30	120
	Bamboo	30	120
Fishery	Pond	1	500
Goatary		10	50
Farm house with threshing floor, store etc.			300
Total		9600	

It is observed that less than one hectare (ha) area (9600 sq. m) generated an income of Rs.40295.00 per annum and employment generation of 485 mandays through farming system approach (FSA).

Table 7 indicates income and employment generation from various components of FS.

West Bengal

West Bengal is one of those a few states which experienced severe pressure of population on land since the partition of the country. It constitutes 8.07 per cent of India's population with highest density of 904 persons/sq km. Bulk of the farm holdings are under small and marginal category. Besides this, a number of these holdings are scattered and fragmented. The cropping intensity has reached upto 174 per cent. Agriculture in West Bengal is characterized by rice based systems. Rice is grown throughout the year in three specific seasons, namely Aus (autumn), Aman (winter) and Boro (summer). It is grown in about 6.07 m ha. Mustard, potato, sesame, greengram, potato and jute are the other component crops. The state produces 72 percent country's jute, 34 per cent potato, 22 percent tea and 15 percent of total rice. It ranks first in rice, vegetables, jute and fish production.

The income from seasonal field crops in small and marginal farms is hardly sufficient to sustain the farmer's family. However, through proper farming system approach, good income and higher standard of living can be achieved even from small holdings. A farming system represent appropriate combination of farm enterprises viz. cropping system, livestock, poultry, fishery, forestry etc. and the means available to farmer to raise them for increasing profitability.

A good farming system should ensure

- Self sufficiency in farmers' requirement of food and cash.
- Increased income and employment opportunities,
- Recycling of farm wastes and byproducts and,
- Increased operational efficiency by efficient use of resources.

The farmer has to undertake some land based enterprises which will complement their cropping activity and will get more income and employment, thus leading to higher social and economic upliftment. Keeping above facts in view, a case study of a farmer in West Bengal was undertaken.

Table 7 – Income and employment generation from various components of FS

Component	Area (squm)	Gross income (Rs)	Investment (Rs)	Net return (Rs)	RUE (Rs)	Labour needs (Mandays)
Agronomy	4800	26070.00	8395.00	13675.00	1.82	138
rice	4800	3468.00	3100.00	368.00	0.11	45
moong	4800	9600.00	2000.00	7600.00	3.80	25
maize	2880	9547.00	2013.00	7534.00	3.70	42
wheat	1920	3070.00	1094.00	1976.00	1.80	21
mustard	480	389.00	192.00	197.00	1.02	5
Olericulture Brinjal tomato, okra,	1100	12000.00	6930.00	5070.00	0.73	85
Pomology	1930	14950.00	7450.00	7500.00	1.00	155
Mango	480	4800.00	2500.00	2300.00	0.92	
Banana	1250	8750.00	4500.00	4250.00	0.94	
Guava	100	400.00	200.00	200.00	1.00	
Jackfruit	100	1000.00	250.00	750.00	3.00	
Dairy	40	15000.00	12000.00	3000.00	0.25	70
Agroforestry		3400.00	750.00	2650.00	3.5	5
Fishery	500	6000.00	2000.00	4000.00	2.00	20
Duckery	10	2000.00	500.00	1500.00	3.00	12
Total	9600	79324.00	39029.00	40295.00	1.08	485

Method Employed

A personal interview at the farmstead of a representative farmer who follows the farming system approach was undertaken **(Table 8)**. The detailed economics of the cultivation was calculated based on the information provided by the farmer verbally.

The farmer under study followed Jute – Rice –Mustard system last year. He also practised other enterprises like horticulture, animal husbandry, fisheries etc.

Results

The detailed analysis of each component practised by the farmer is given as under:

Cropping System

Jute : Before partition of the country, Jute was unknown to the local people of this

area. Farmers in this part used to grow only one rice crop. After partition, farmers who migrated from Bangladesh settled in this area. As they knew the technique of Jute extraction they started growing jute .This has become a very important cash crop in this area having facilities of retting in ponds and other water bodies. Jute is a very labour intensive crop which provides employment to large number of poor people. Its leaves are used as vegetables, fibers provides cash while stem is used as fuel and fencing materials etc. Jute cultivation is profitable provided the fiber price is reasonably high i.e. Rs. 800-1000/ quintal. It is observed that the farmers got a net profit of Rs. 1020 per bigha **(Table 9)**.

Rice: West Bengal ranks first in rice production in the country. With irrigation, two to three rice crops can be grown from the same land. The farmer under discussion took rice after the harvest of Jute. It is seen that he used both organic manures (oil cakes) and fertilisers mainly N (urea) and P (SSP). He did not use K fertiliser.

Rice yield recorded was 8q/bigha (60q//ha) and net profit was only Rs. 647/ bigha (Rs.4853 /ha) which is not high **(Table 10)**. But as the rice is staple food of the people of the area, it always finds a place in the cropping system practised.

Mustard : Since mustard oil is used as main cooking medium by the local people it also finds a place in the cropping system. The farmer took mustard after rice. It is interesting to note here that the local farmers have been practicing zero tillage for many years to save time and money. The profit per bigha was Rs. 380 **(Table 11)**.

Income From the Cropping System

It is observed that the cropping system gave an income of Rs. 16888 only and out of the three crops jute gave the highest amount of profit (49.8 %).

Small and marginal farmers who dominate in West Bengal (90%) are not able to survive if they have to depend on field crops only and which are very often destroyed by floods and other weather aberrations. This is why they practise other systems like horticulture, animal husbandry, fishery etc.

Horticulture

It is observed that in the home stead, the farmer grows coconut, mango, jackfruit, guava, areca nut, lemon, banana, date palm, palmyra palm etc. The farmer under discussion makes an earning of about Rs.7825 /annum from horticultural system **(Table 12)**.

Animal System

Animal system is a very important component of farming system associated with the farmers of this area. This provides employment, milk and dung which is used for generating energy and manure .The farmer in question owns 3 animal (2 adult cows). He has also installed a biogas plant, rears 10 ducks (9+1). The reported income is about Rs. 24950 per annum which seems to be at higher side **(Table 13)**.

Fishery System

Rice and fish go well in Bengal. The farmer has a small pond (¼th bigha) which had provided income of Rs. 1000/- in the first year itself in addition to family consumption **(Table 14)**.

Total Income

Total income of the farmer amounts to be Rs. 50663 per annum which seems to be reasonably adequate to run a small family of 3 adult and 2 minor **(Table 15)**.

CONCLUSION

THE ENTIRE PHILOSOPHY OF FARMING system revolves around better utilization of time, money, resources and family labour. The farm family gets scope for gainful employment round the year thereby ensuring good income and higher standard of living even from small holdings. From the above study it is clear that the small size farms can earn a living provided the farmer does all the field operations as well as marketing himself. The income can be further increased if the farming system is managed so as to harvest the crop during festivals. Early harvest can also help to get high price.

Table 8 – Particulars of farmer under study

Name (Changed)	:	Sunil Kumar Mandal	
Village	:	Bikehat	
P.O.	:	Bera	
District	:	Burdwan	
Land Holding	:	Irrigated	5.5 Bigha
		Unirrigated	2.75 Bigha
		Total	8.25 Bigha
Number of Family Members	:	3 adults & 2 minors	

Table 9 – Economics of Jute cultivation by the farmer

S.No.	Particulars	Amount (Rs.)
A	Cost of Cultivation (per Bigha)	
1.	Ploughings (@ Rs. 80 /ploughing) -3	240
2	Irrigation -1	150
3	Seed – 1 kg	30
4	Weeding (6+6+4 labour @ Rs. 40) -3	640
5	Thinning (6 labour)	240
6	Harvesting (5 labour)	200
7	Transporting water	200
8	Retting (2 labour)	80
9	Transporting (5 labour)	160
10	Drying	80
	Total	1780
B	Yield 3.5 q/Bigha (@ Rs. 800/q)	2800
C	Profit (per Bigha)	1020
D	Profit (per hectare)	7650

Table 10 – Economics of rice cultivation by the farmer

S.No.	Particulars	Amount (Rs.)
A	Cost of cultivation (per Bigha)	
1	Ploughings (@ Rs. 150/ ploughing)	450
2	Seed bed preparation	
	Seed – 10 kg	120
	Watering	50
	Ploughing	80
3	Manuring	
	Oilcake (@ Rs 8/kg) – 50 kg	400
	SSP – 50 kg	150
	Urea(21 DAT) -15 kg	77
	Urea (20 days later)- 30 kg	154
	Urea (10 -15 days later)	102
4	Irrigation	
	Contract with shallow tubewell	800
	Labour	200
5	Weeding -2	
	1st Weeding (4 labour @ Rs. 40)	160
	2nd Weeding (6 labour)	240
6	Harvesting (4 labour @ Rs.45)	180
7	Bundle making (3 labour @ Rs 45)	135
8	Transporting (3 labour @Rs. 45)	135
9	Threshing (4 labour @ Rs. 45)	180
10	Drying	40
	Total	3653
B.	Income	
	Grain yield 8 q/Bigha (@ Rs. 500/q)	4000
	Straw	300
	Total	4300
C	Profit (per Bigha)	647
D	Profit (per hectare)	4853

Table 11 – Economics of mustard cultivation by the farmer

S.No.	Particulars	With land preparation (Rs.)	Without land preparation (Rs.)
A	Cost of cultivation (per Bigha)		
1	Land preparation	240	30
2	Seed	30	30
3	Weeding	80	80
4	Fertiliser	500	500
5	Harvesting	200	200
6	Threshing	180	180
	Total	1230	1020
B	Yield (@1400/q)	1400	1400
C	Profit (per Bigha)	170	380
D	Profit (per hectare)	1275	2850

Table 12 – Income from horticultural system adopted by the farmer

S.No.	Particulars	Amount (Rs.)
1	Coconut (10 plants) – 800 nuts	2000
2	Mango (7 plants) – 560 kg	1120
3	Jackfruit (@ Rs. 25 /fruit) -25	625
4	Guava (8 plants) – 120 kg	1200
5	Arecanut	200
6	Lemon (2 plants) -20	200
7	Banana	2000
8	Date palm	80
9	Palmyra Palm (5 plants) – 5 X40 nuts	400
	Total	7825

Table 13 – Income from animal system adopted by the farmer

S.No.	Particulars	Amount (Rs.)
1	3 Cows (2 adult) 10X30 X10	15000
2	Gobar Gas plant	
	Gas	3700
	Manures (@ 5 tonnes/animal)	4000
	Total	22700
3	Ducks	2250
	Total	24950

Table 14 – Income from fishery system adopted by the farmer

S.No.	Particulars	Amount (Rs.)
A	Cost of digging 0.25 Bigha pond	2000
B	Income	
	Fish Sale	1500
	Fish consumed	1500
C	Profit	1000

Table 15 – Total income of the farmer from all system adopted

S. No.	System	Amount (Rs.)
1	Jute- Rice-Mustard	16888
2	Horticulture	7825
3	Animals	24950
4	Fisheries	1000
	Total	50663

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