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Integrated Farming System: An ideal approach for developing more economically and environmentally sustainable farming systems for the Eastern Himalayan Region

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ABSTRACT

The present work was carried out at Chandel Khullen village of Chandel hill district of Manipur during 2010-11 to 2012-13. The average holding size of the farmer was 1.33 ha in 2010-11, 1.96 ha in 2011-12 and 2.21 ha in 2012-13. The tribal farmer adopted seven components, i e crop production, vegetables, fruits, piggery, backyard poultry, fishery and water management as suggested by ICAR Manipur Centre. In 2010-11, the paddy yield was 3.5 tonnes/ha as compared to 4.79 tonnes/ha in 2012-13. It was mainly due to adoption of improved package and practices. The cabbage and onion yield increased by 103 and 54 per cent, respectively after adoption of improved cultivation methods under integrated farming system. Similarly, the papaya and banana production was increased by 275 and 270 per cent. There was marked increase in pork, chicken, egg and fish production. In 2012-13, this system also provided significantly higher Rs per Re invested than that of the other 2010-11. In Manipur, women's participation is more in farming system rather than men. In the same way, this farming system also gives more opportunity to women to engage in agriculture farming. Thus integrated farming system provides new venture for employment and sustainable development of livelihood for North Eastern people. The overall result revealed that the improved practices with different crop and animal components are an excellent approach for sustainable production, income generation and employment opportunity for the small and marginal rural households of Manipur.

Key words: Economics, Employment generation, Farm productivity, Integrated farming system, Interlinkage of components

Farming system approach requires involvement of agriculture, horticulture, soil conservation, forestry, fisheries, animal husbandry (piggery and poultry) and allied enterprises (apiculture etc). The soil and water conservation practices are encouraged through contour bunds in low rainfall areas and graded bunds or bench terraces in high rainfall areas. Half moon terraces are practiced in hill slopes for planting horticulture plants. Water harvesting structures in the form of small farm ponds or community large ponds are constructed and integrated with fishery, duckery, piggery etc. Gulley plugging is resorted to wherever needed. Topo-sequential cropping involving agro forestry in top portion, horti-pastoral crops in the middle and agricultural crops like rice, maize/popcorn, soybean, groundnut etc. are to be grown in lower portion of the hills for effective management of land and water resources. This integration of components of ecosystem (land, water, plant species etc.) to give sustained production from rainfed and degraded lands which inturn to check natural calamities like floods, drought and soil erosion.

In North Eastern Region, farmers work hard but do not make profit, because there is very little left after they pay for all inputs (seeds, livestock breeds, fertilizers, pesticides, energy, feed, labour, etc.). The emergence of Integrated Farming Systems (IFS) has enabled us to develop a framework for an alternative development model to improve the feasibility of small sized farming operations in relation to larger ones (Ravisankar *et al.* 2006). Integrated farming system is a commonly and broadly used word to explain a more integrated approach to farming as compared to monoculture approaches. It refers to agricultural systems that integrate livestock and crop production or integrate fish and livestock and may sometimes be known as Integrated Bio systems. In this system, an inter-related set of enterprises is used so that the "waste" from one component becomes an input for another part of the system, which reduces cost and improves production and/or income. IFS

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works as a system of systems (Chan 2006). IFS ensure that wastes from one form of agriculture become a resource for another form. Since it utilizes wastes as resources, we not only eliminate wastes but we also ensure overall increase in productivity for the whole agricultural systems. We avoid the environmental impacts caused by wastes from intensive activities such as pig farming. We selected farmers from Chandel Khullen village, Chandel District, Manipur for the comparative study of integrated farming system development in Manipur with the following objectives: 1. To study the change in the farming techniques for maximum production in the cropping system. 2. To evaluate the suitable integration of enterprises in a given agro-climatic conditions.3. To study the socio-economic status of the farmers. 4. Recycling of farm waste in the IFS.

MATERIALS AND METHODS

The study was conducted on the field of H B Starson (tribal farmers) in Chandel Khullen village, Chandel district of Manipur during 2010–11 to 2012–13. A model of integrated farming system was developed on farmer's field. Household survey on socio-economic status and agriculture farming has been done in 2010-11. In 2012-13, survey was done to know the socio economic status of the farmers. The holding size of the farmer increased from 1.33 ha in 2010-11 to 1.96 ha in 2011-12 and 2.21 ha in 2012-13 due to technological interventions like terracing and the fallow land has been put for cultivation of crops. We kept the same enterprises which the farmer had earlier (rice, groundnut, maize in *kharif* season, pea and mustard in *rabi* season, fishery, poultry, piggery, vegetable production, fruit cultivation, apiary and water management). Training and inputs were given to the farmers for adoption of scientific management practices in the integrated farming system.

Table 1 Area under different components in integrated farming system in different years

Enterprises	Area under different enterprises (ha)		
	2010-11	2011-12	2012-13
Cropping system			
Rice	0.80	1.00	1.00
Pea	0.20	0.25	0.25
Rapeseed mustard	0.20	0.25	0.25
Animal Husbandry			
Piggery	0.01	0.02	0.03
Backyard poultry	0.001	0.005	0.01
Horticulture			
Fruit production	0.02	0.03	0.05
Vegetable production	0.10	0.25	0.35
Fishery	0.00	0.15	0.25
Water harvesting	0.00	0.01	0.02
Apiary	Integrated with crops	Integrated with crops	Integrated with crops
Total	1.33	1.96	2.21

Table 2 Price of different enterprises and average labour requirement (Based on MSP-2012-13 and local market price)

Particulars	Price (₹)	Parti-culars	Price (₹)	Parti-culars	Price (₹)
Paddy	12.5/kg	Guava	15/kg	Fish finger-lings	2/finger-lings
Rapeseed mustard	25/kg	Banana	10/kg	Water	10 paise/ litre
Cabbage	10/kg	Pork	200/kg	Paddy straw	1/kg
Onion	15/kg	Piglets	2000/ piglet	Poultry manure	6/kg
Pea	40/kg	Chicken	100/kg	Pig manure	6/kg
Papaya	20/kg	Egg	8/egg	Compost	1/kg
Lemon	120/kg	Fish	100/kg	Banana flower	8/piece
Enterprises	*Labour engaged (days)*	*Enter-prises*	*Labour engaged (days)*	*Enter-prises*	*Labour engaged (days)*
Paddy	40/ha	Pea	32/ha	Banana	45/ha
Rapeseed mustard	30/ha	Papaya	45/ha	Piggery	120
Cabbage	45/ha	Lemon	45/ha	Fishery	100
Onion	45/ha	Guava	45/ha	Water manage-ment	30

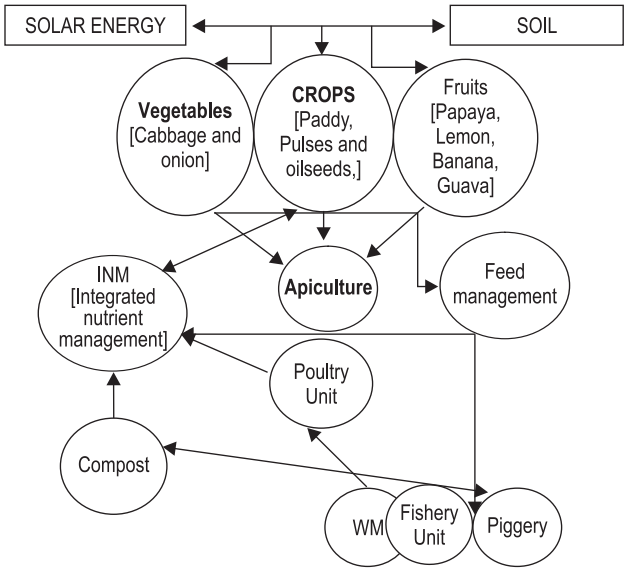

Fig 1 Model of Integrated farming system developed by ICAR RC for NEH Region, Manipur Centre, Imphal and implemented at Chandel (Chandel Khullen)

RESULTS AND DISCUSSION

Crop production

Rice is an integral component of farming system among cereals in *kharif* season. After harvesting of rice farmers grow pulses and oilseeds with the harvested rain water in

Table 3 Technological interventions under IFS at farmer's field

Components	Changes on	2010-11 (practices followed before intervention)	12/13/2011 (Technological interventions)
Paddy cultivation	1. Variety	1. Local or improved cultivars	1. Improved varieties
	2. Seed quality	2. Old cultivars	2. Good in quality
	3. Techniques	3. Conventional package and practices	3. Improved package and practices
	4. Weed management	4. Hand weeding	4. Cono/rotatory weeder
Vegetable cultivation	1. Cultivars	1. Local cultivars	1. Improved cultivars
	2. Seed	2. Uncertified seed	2. Certified seed
	3. Method of cultivation	3. Conventional methods	3. Improved methods
	4. Manure & fertilizers	4. Less than recommended dose	4. Balance nutrition
Fruits cultivation	1. Training and pruning	1. Not timely and regularly	1. Timely and regularly
	2. Fertilization	2. Below recommended dose	2. Optimum dose
	3. Irrigation	3. Not properly	3. Proper at certain interval
Piggery	1. Breed	1. Local	1. Cross breed and improved
	2. Feed	2. Based on house hold wastage	2. Quality feed
	3. Health management	3. Rarely	3. Proper deworming and vaccination
Backyard poultry	1. Breed	1. Local	1. Improved birds
	2. Feed	2. Scavenging	2. Quality and concentrated feed
	3. Health management	3. Rarely	3. Proper vaccination
Fishery	1. Fingerlings	1. Local	1. Improved
	2. Pond liming	2. Rarely	2. Proper at certain interval
	3. Stocking density	3. Below stocking density	3. Optimum stocking density
	4. Feed	4. Natural feed	4. Natural + Concentrated
	5. Fertilization	5. Raw cow dung	5. Fertilization with well rotted organic and inorganic fertilizers
Water management	1. Water harvesting unit	1. No water harvesting structure	1. Jalkund/Farm pond

Table 4 Crop varieties and animal breeds under different enterprises

Components	2010-11	2012-13
Paddy cultivation	Local	RCM-10
Vegetable cultivation	Local varieties	Cabbage: Rareball, Wonderball, Green hero
		Onion:
Fruits cultivation	Local cultivars	Banana: Jaint Cavendis
		Kachai lemon
		Papaya: Coorg Honey Dew
Piggery	Local Breed	Cross breeds
Backyard poultry	Local birds	Vanraja
Fishery		Common carp (Lower layers)
		Grass carp (Upper layers)
Water management	Not practiced	Construction of Jalkund/Farm pond

farmer pond. In Chandel, farmer was growing rice simce a decade. But, he was not fully trained about the scientific cultivation practices. The lower yield of rice in 2010-11 was mainly due to use of poor quality seeds, that he had procured from neighboring farmers and use of conventional methods in rice cultivation with very poor nutrient and weed management. In 2010-11, rice productivity was 3.5 tonnes/ha as compared to 4.79 tonnes/ha in 2012-13 due to adoption of improved package of practices (Fig 2 A). However, the yield of rice, pea and rapeseed mustard increased by 36.85, 106 and 90 per cent respectively in 2012-13 as compared to 2010-11 (Fig 2 A). Our results are in close agreement with Yadav *et al.* (2013), who found that adoption of improved package and practices on farmer's field in Tripura can increase the yield of crops as compared to conventional system.

Vegetable production

In Manipur, farmers are growing vegetables in the form of kitchen gardening for self consumption and commercial cultivation for economic returns. The vegetable yield was poor in 2010-11 due to local cultivars, imbalanced fertilization and other management practices. But, in 2012-13 farmers got 103 and 54 per cent more cabbage and onion yield due to adoption of improved cultivation methods and use of quality seeds and better management practices under integrated farming system (Fig 2 B). The increase in yield of vegetables with improved practices could be attributed to improved vegetative growth, better availability of nutrients at vital growth period and greater synthesis of carbohydrates and their translocation to the storage organs (Yadav *et al*. 2013). The observations of the present study

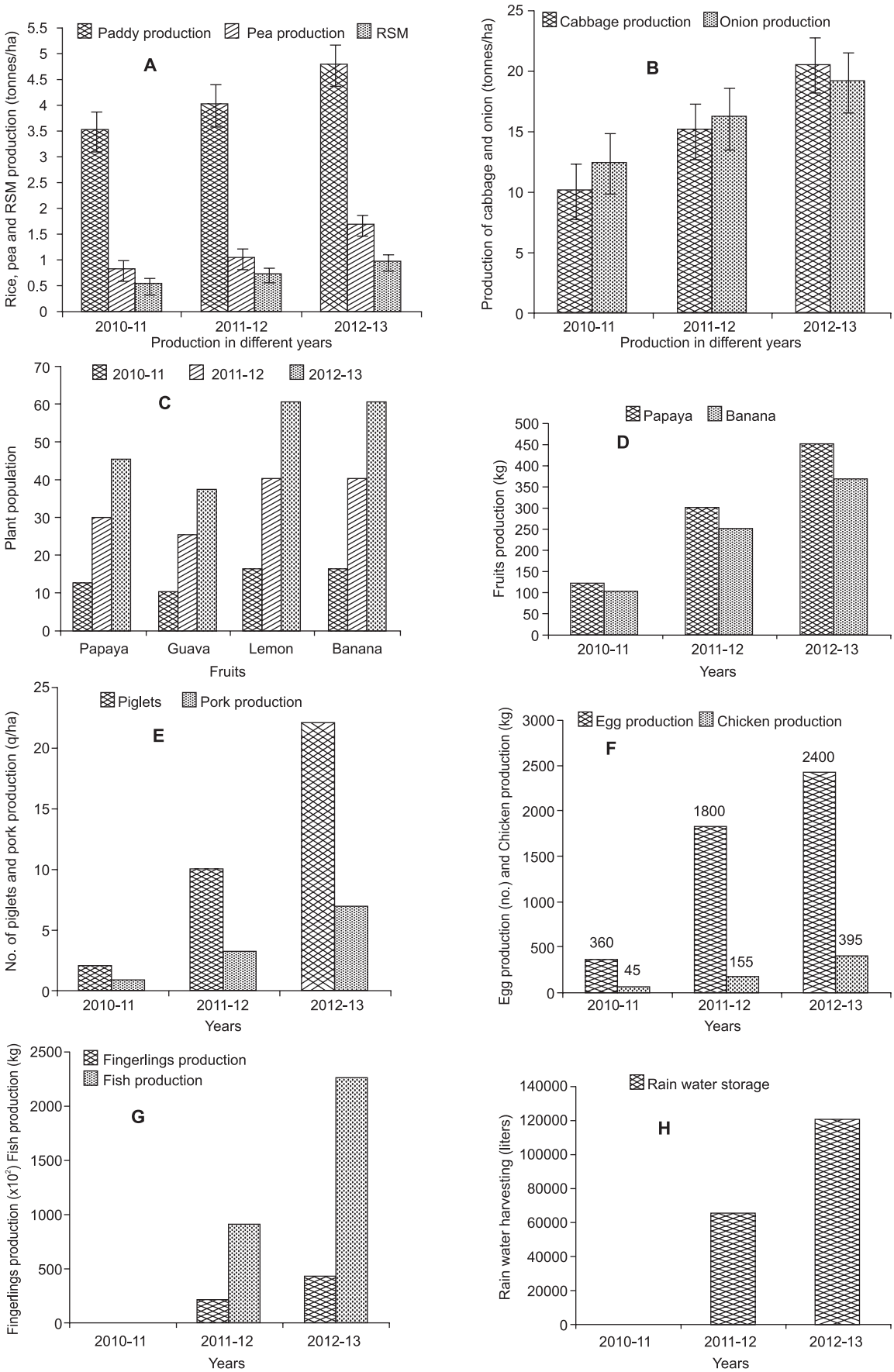

Fig 2 Production of paddy, pea and RSM (A), vegetables (B), fruit plant population and production (C and D), piggery (E), poultry (F), fishery (G) and rain water harvesting (H) in Chandel.

are in line with the findings of Brahma *et al.* (2010) and Patel and Rajput (2003).

Fruit production

In 2010-11, the fruit plants grown by the farmer were not properly maintained. He was also not utilizing the space between the two rows. But in 2011-12, he grew banana in between two rows of lemon. He also grew papaya among guava plants. In 2012-13, he got 275 and 270 per cent more production in papaya and banana as compared to 2010-11 (Fig 2 C&D). The higher fruit production in integrated farming system due to use of quality seed material and better management practices. Yadav *et al.* (2013) also found in his study that the increase in fruit production could be attributed to improved vegetative growth, better availability of nutrients at vital growth period and greater synthesis of carbohydrates and their translocation to the storage organs. Ghosh (2008) also recorded better fruit crops production under improved practices.

Pig rearing and pork production

Pig farming is one of the integral enterprises in farming system in North East Hilly regions. Majority of the people consume pork. The indigenous breed of pigs in Manipur is smaller in size with poor feed conversion abilities and average adult body weight is about 45-55 kg and litter size is 3.5 to 5. The up-gradation of local pigs through cross breeding with the exotic pigs (Hampshire) has given a new dimension to the pig farming among the tribal farmers. In 2012-13, number of piglets increased from 2 to 22. However, it increased the pork production by about 900 per cent as compared to 2010-11. The improved breeds are healthy and their body weight is more than the indigenous pigs (Fig 2 E). Lekule and Kyvsgaard (2003) also reported poor feed conversion, high mortality rates, low productive rates and poor final products in pigs in conventional method of farming.

Backyard poultry

Backyard poultry farming has been adopted by most farmers for household consumption and at commercial scale. Earlier, he was rearing local strains, but under the farming systems approach, he started rearing of Gramapriya and Vanaraja. In the present study, 777 and 566 per cent more egg and chicken production, respectively was recorded as compared to 2010-11 (Fig 2 F). These findings are in line with those of Ershad (2005).

Fish production

Fishery is the highly preferred farming system component along with piggery farming. In 2010-11, the farmer was not having any farm pond. But, after adoption of integrated farming system, he dug two ponds in 2011-12 and one more ponds in 2012-13. In 2012-13, he started fish breeding programme and got very good remunerative returns. In 2011-12, he started fish production and produced 900 kg along with 20 000 numbers of fingerlings and it increased to 2 250 kg fish with 42 000 numbers of fingerlings in 2012-13 (Fig 2G). In composite fish production, he was rearing common carp and grass carp, where grass carp was surviving on middle and upper layers of water and common carp in lower layers of water. In this way, he was able to just double the production with proper management and maintenance. Our results are in accordance with Yadav *et al*. (2013).

Water management

The major water source for cultivating agricultural crops in Manipur is rain water. The rainfall in Manipur varies from 1400 to 2000 mm. In *kharif* season, rain water is sufficient for agricultural crops. But, in *rabi* season water scarcity is prevalent. In 2010-11, the farmer had no water harvesting unit. In 2011-12, he stored 65 000.00 liters of water in the pond and the water stored increased to 120 000.00 liters in 2012-13 due to introduction of more number of rain water harvesting units in 2012-13 (Fig 2 H). This harvested rain water was further utilized for raising of crops.

Economics

On an average, crop production, vegetable production, fruits production, piggery, backyard poultry, fishery and rain water harvesting gave more net returns from given area (Table 1), which was about 51,646, 365, 2285, 1340, 148, 66 per cent higher than 2010-11, respectively; except for fishery and water management, which was adopted in 2011-12 (Table 4). This much net returns difference was due to expansion of area under different components as well as better adoption and management practices. In 2012-13, this system also provided significantly higher Rs per Re invested

Table 5 Economics of different component of farming systems

Components	Gross returns			Net returns			B : C ratio		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
Crop production	51 893	61 203	78 120	39 037	44 823	59 080	4.0	3.7	4.1
Vegetable cultivation	18 300	73 000	128 100	14 850	62 625	110 880	5.3	7.0	7.4
Fruits cultivation	3 400	8 500	12 700	2 000	6 400	9 300	2.4	4.0	3.7
Piggery	13 000	110 000	219 000	7 000	83 000	167 000	2.2	4.1	4.2
Backyard poultry	7 380	39 900	68 700	3 380	25 900	48 700	1.8	2.9	3.4
Fishery		130 000	309 000		100 000	248 000		4.3	5.1
Water management		6 500	12 000		1 500	2 500		1.3	1.3

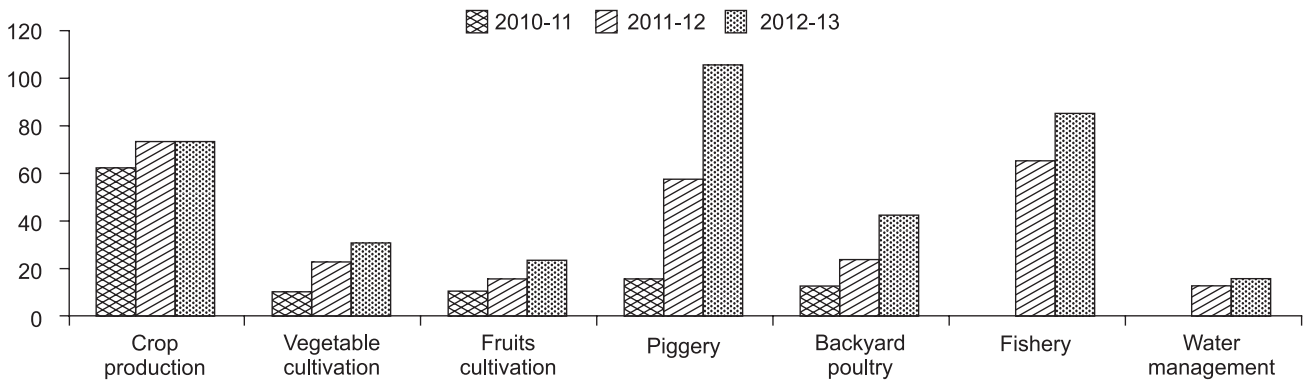

Fig 3 Employment generation under different components of IFS from farms holding size of farmers in different years

than in 2010-11 (Table 4). Higher crop profitability was recorded under integrated farming system in 2012-13 over 2010-11. The most profitable components were vegetable production followed by fishery and piggery. The higher variable cost in all the components during 2012-13 was mainly due to the use of quality seed material of improved varieties/breeds, optimum fertilization, proper weed management and pest management with better package and practices. In 2012-13, the higher gross returns, net returns and B: C ratios were due to more production of economic products, expansion of area in respective components of IFS as compared to 2010-11. The lower cost of production, gross returns, net returns and B: C ratios in 2010-11 due to use of poor quality seed material of local varieties/breeds with poor management practices just for subsistence farming for sustaining the family livelihood. Similar results were also reported by Kumar *et al.* (2011), Alam *et al.* (2009) and Yadav *et al*. (2013).

Employment generation

In this system, family members are gainfully employed due to production and maintenance of several components. A special feature of farming system is value addition due to employment of family members and non farming families. One small farmer absorbs 593 man days, out of which family labour absorption is 470 man days (MSSRF 2009). Family members were employed for 109, 267 and 373 days in 2010-11, 2011-12 and 2012-13, respectively. In Manipur,

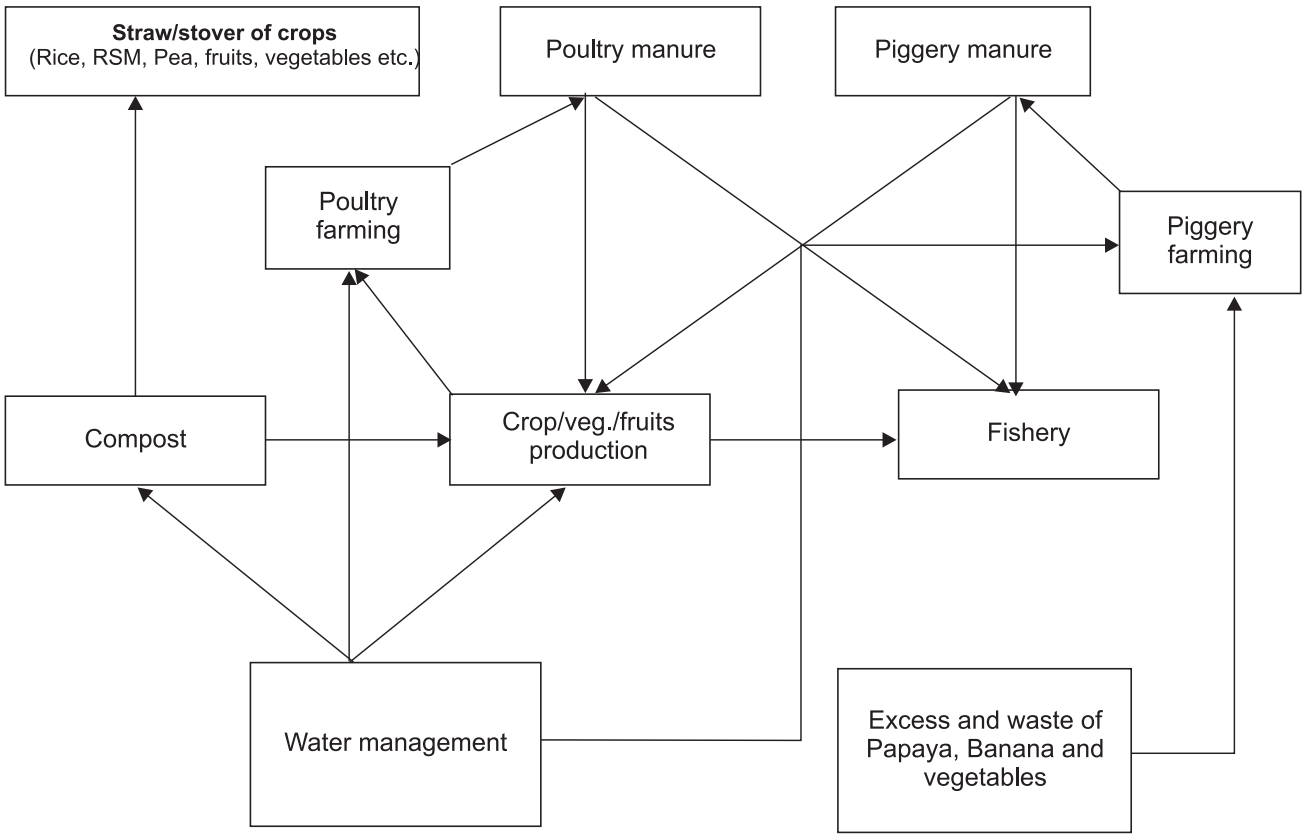

Fig 4 Recycling and linkage of by products, waste materials to one enterprise to another

women's participation is more in farming system rather than that of men. In the same way, this farming system also gave more opportunity to women engaged in agriculture farming. Thus, integrated farming system provides new venture for employment and sustainable development of livelihood for North Eastern people.

Interlinkage of byproducts and their recycling

Integrated farming system works as a set of systems. From crop production, farmers were getting straw and stover which was used for compost preparation. These compost was inturn used for the production of crops, vegetable and fruits and was also used for fish production. In the same way, poultry and piggery manure from poultry and piggery farming was used for the aforesaid components (Fig 4). The excess produce or waste materials from horticulture areused it as feed materials for piggery. In integrated farming system, rain water harvesting is playing a pivotal role for sustainable production especially in rainfed farming system. This water is used as a life saving for different components of integrated farming system. Thus, IFS is best suited for sustainable production and livelihood development in the NEH Region.

CONCLUSION

The study highlighted the impact of IFS on farm income. The farmers in the study area practised partial integration in 2010-11. After adoption of improved cultivars, better performing breeds/strains and good management practices under integrated farming system gave more production, higher income generation and employment opportunities throughout the year. More net farm income realized by farmer who maintained crop-livestock-fish-horticulture integration on their field. It can be concluded that improved farming can play a significant role in increasing production, remunerative returns, and nutrition requirements as well as employment opportunities of tribal populations.

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