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RESEARCH ARTICLE :

Promising integrated farming system crops + Horticulture + Dairy + Poultry developed and demonstrated at farmer's for doubling tribal farmers income in high altitude tribal area of Andhra Pradesh

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SUMMARY : Farming systems approach introduces a change in farming techniques for attaining food and nutritional security and for maximizing farm income through optimal utilization of resources by a judicious mix of allied enterprises like dairy, small ruminants like goat and sheep, poultry, piggery, fishery, sericulture etc., with crops suitable for the existing agro-climatic conditions and socio-economic status of the farmers. On farm research was conducted in 36 small tribal farmers fields o in high altitude and tribal area of Srikakulam district of Andhra Pradesh state in East Coast Plain and Hills Agro-climatic zone East coast plains, hot, sub humid to semi arid eco region (S7 Cd 2-5). Agro-ecological region with 915 mm rainfall distribution in 55 rainy days. By diversification in all enterprises farmers realized Rs. 83,630, 96,830, 1,04,720 and 1,12,960 gross returns and Rs.57435, 68600, 65080 and 81240 net returns was than the bench mark Rs. 53110 and Rs. 35430 at the additional cost of interventions of Rs. 8515 than the bench mark cost of cultivation Rs. 17680 in 2012-13, 2013-14, 2014-15 and 2015-16, respectively. Net returns are getting doubled from the third year of interventions onwards. The increase income is attributed to increase in income from intervention in paddy crop and cashew crop, introduction of YMV tolerant green gram variety, feeding of supplement feed to the cattle and also the introduction of Vanaraja and Rajshri back yard poultry birds. In addition to this not only due to diversification of existing enterprises, but also introduction of Azolla and nutritional kithen garden, helped the farmer nutritional food, besides reduction in cost of maintenance helped in increase in net returns recorded. By introduction of interventions the cost of cultivation is increased by 63.73 per cent with increase of gross returns by 87.42 per cent and net returns of 99.23 per cent with 13.33 per cent increase in B:C ratio was observed. The area share was allocated 44 per cent to crops, 43 per cent horticultural crops, 1-2 per cent area for other components, these various components the net income was maximum in livestock (44.93%), closely followed by horticulture (37.93 %) and crops (16.14%). Additionally 54 man days were created on an average during four years of introduction of IFS approach due to diversification of enterprises and introduction of few enterprise.

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BACKGROUND AND OBJECTIVES

In the present scenario, it is hardly difficult to meet out the ever increasing requirement for the ever rising population in India. Unfortunately, In India the food producing enterprises like agriculture and its allied activities namely livestock farming, horticulture, floriculture, aquaculture etc. have been dominated by the small and marginal farmers. Hence, they are unable to invest more capital for doing intensive farming activities to produce more and meet the requirement. In this situation, Integrated Farming System (IFS) plays an imperial role for maximizing their profit and production to meet the nutritional requirement with food security with less investment. Further in IFS it is more advantageous that the farmers can able to produce more by using optimal resource utilization and recycling of waste materials and family labour employment. Panke *et al*. (2010) stated that the integration is made in such a way that the product *i.e.* output of one enterprise / component should be the input for the other enterprises with high degree of complementarily effects. The rationale of IFS is to minimize the wastes from the various sub systems on the farm and thus it improves employment opportunities, nutritional security and income of the rural people. Tripathi and Rathi (2011) stated that various prevailing farming system models in Uttarkhand namely., crop + dairy, crop + dairy + goats + horticulture, crop + horticulture +goats, crop +dairy + vegetables, horticulture + dairy + vegetables, vegetables + dairy and crop + dairy + companion animals are the major components in IFS.

Farming systems main objective is introduction in farming techniques and diversification of enterprises with latest interventions for attaining food and nutritional security and for maximizing farm income through optimal utilization of resources by a judicious mix of allied enterprises like dairy, small ruminants like goat and sheep, poultry, piggery, fishery, sericulture etc., with crops suitable for the existing agro-climatic conditions and socioeconomic status of the farmers.

RESOURCES AND METHODS

On-farm research evaluation of Integrated Farming Systems programme was taken up by OFR centre, Seethampeta under AICRP-IFS of ANGRAU, Guntur, Andhra Pradesh. The study area, Srikakulam is situated in East Coast Plain and Hills Agro-climatic zone East coast plains, hot, sub humid to semi arid eco region (S7 Cd 2-5) Agro-ecological region with 915 mm rainfall distribution in 55 rainy days per annum (Table A). The net sown area of the district is 2,71,000 ha with cropping intensity of 129 per cent. The major soil is shallow red chalka soils which contribute 50 per cent of the area followed by black soils (25%) and deep red chalks soils (20%). The major sources of irrigations are bore wells and open wells (69%) followed by tanks (17%). The major crops are rice, cashew, maize, greengram, redgram and groundnut. Mango is the major fruit crop of the district followed by banana and Guava. The district has local low yielding cattle population of 5,85,000. The non-descriptive buffaloes comprises of 4,48,800 and cross bred cattle population are 12,400. Sheep comprises of 9,60,000 goats are 2,46,200. Back yard poultry comprises 13,83,927 and commercial birds are 7,74,547 (Hand book of statistics of Srikakulam district, 2015). The scientists of AICRP-IFS centre identified the farmer and continuously worked for about four years during 2012-2016 and identified the suitable farming system model implemented in the 36 farmer's field (Table B) in said period. Made diversification for existing system by identifying the technological gaps and intervened with latest interventions. Simultaneously introduced the back yard poultry birds, nutritional kitchen garden for nutritional security and vermicomposting for nutrient recycling in farmers field itself. Documented the crop yields in agricultural crops, horticultural crops, vegetables production and also recorded milk production from cattle, production of eggs, meat from poultry. Assessed the

Table A: Agro-ecological region details

District	Srikakulam	State	Andhra Pradesh
Agro-climatic zone: 11 (East Coast Plain and Hills)			
Agro-ecological region: 18(East coast plains, hot, sub humid to semi arid eco region (S7 Cd 2-5)			
NARP Zone (Zone Code)	52 (AZ 119)	Rainfall (mm)	915
Net sown Area (ha)	2,71,000	Distribution (rainy days)	55

Table B: List of farmers involved in refinements of farming systems

Sr. No.	Name of farmers	Village	Block	Area (ha)	Latitude	Longitude	Altitude (m)
1.	Samanga Sivdu dora	Mahadavavalasa	Veeraghattam	0.8	N 18° 43' 22"	E 083° 48' 39.9"	90
2.	S Bodemdora	Mahadavavalasa	Veeraghattam	0.2	N 18° 43' 22"	E 083° 48' 36.9"	78
3.	Samingi Ramu	Mahadavavalasa	Veeraghattam	0.2	N 18° 43' 22"	E 083° 48' 39.9"	81
4.	Ankalapu Appapparaidu	Mahadavavalasa	Veeraghattam	1.2	N 18° 43' 22"	E 083° 48' 39.9"	79
5.	Majji Chandra Mouliswara rao	CSR Peta	Veeraghattam	0.8	N 18° 40' 0,4"	E 083° 37' 39.9"	100
6.	majji Chinna Parusuram	CSR Peta	Veeraghattam	1.2	N 18° 43' 22"	E 083° 37' 32,5"	101
7.	Malam Rathanalu	CSR Peta	Veeraghattam	0.8	N 18° 39' 33,0"	E 083° 37' 22,2"	107
8.	Majji Venkata Balaram Krishna	CSR Peta	Veeraghattam	0.8	N 18° 39' 23,6"	E 083° 37' 39.9"	108
9.	Savara Addayya	Naidu Guda	Seethampeta	0.8	N 18° 43' 22"	E 083° 46' 55,6"	272
10.	Savara Balaraju	Naidu Guda	Seethampeta	0.8	N 18° 43' 29"	E 083° 46' 39.9"	273
11.	Savara Buganna	Naidu Guda	Seethampeta	0.8	N 18° 43' 22"	E 083° 46' 50,2"	288
12.	Savara Dibbayya	Naidu Guda	Seethampeta	0.8	N 18° 43' 32,8"	E 083° 46' 39.9"	269
13.	Vadaki Krishna	J Gopalpuram	Veeraghattam	0.3	N 18° 43' 35,2"	E 083° 46' 25,6"	85
14.	Vuyyaka Ramarao	J Gopalpuram	Veeraghattam	0.2	N 18° 43' 34,9"	E 083° 46' 39.9"	84
15.	Kolaka Durga Rao	J Gopalpuram	Veeraghattam	0.2	N 18° 42' 34,6"	E 083° 46' 42,5"	82
16.	Bodanaki Ramaraidu	J Gopalpuram	Veeraghattam	0.7	N 18° 42' 34,8"	E 083° 38' 47,5"	85
17.	Savara Mangayya	Nadmi Billa Guda	Seethampeta	0.4	N 18° 42' 0,4"	E 083° 48' 47,4"	101
18.	Savara Bapadu	Nadmi Billa Guda	Seethampeta	0.8	N 18° 42' 20,2"	E 083° 38' 47,8"	92
19.	Savara Malayya	Nadmi Billa Guda	Seethampeta	0.8	N 18° 42'0,4"	E 083° 48' 47,3"	95
20.	Savara Kangadu	Nadmi Billa Guda	Seethampeta	0.8	N 18° 42' 11,1"	E 083° 38' 39.9"	97
21.	Biddiki Dandasi	Chinnarama	Seethampeta	0.8	N 18° 42' 22"	E 083° 48' 35,3"	107
22.	Biddiki Appalaswamy	Chinnarama	Seethampeta	0.2	N 18° 42' 35,3"	E 083° 48' 32.0"	108
23.	kumbrika Ganapathi rao	Chinnarama	Seethampeta	1	N 18° 42'35,8"	E 083° 48' 39.9"	138
24.	Biddika Simachalam	Chinnarama	Seethampeta	0.2	N 18° 42' 25,3"	E 083° 48' 33.0"	145
25.	Majji Prakash	Mahadavavalasa	Veeraghattam	0.8	N 18° 39' 58,6"	E 083° 37' 29.1"	85
26.	S Neelamdora	Mahadavavalasa	Veeraghattam	0.2	N 18° 39' 58,8"	E 083° 37' 28.3"	85
27.	S.Sumbaramma	Mahadavavalasa	Veeraghattam	0.2	N 18° 42' 58,6"	E 083° 37' 47.1"	100
28.	S Ramarao	Mahadavavalasa	Veeraghattam	1.2	N 18° 42' 58,6"	E 083° 36' 47.7"	94
29.	K Pakeeru	CSR Peta	Veeraghattam	0.8	N 18° 42' 58,6"	E 083° 36' 44,0"	83
30.	K Trinadha	CSR Peta	Veeraghattam	1.2	N 18° 42' 58,6"	E 083° 45' 46.1"	86
31.	S Anapayya	CSR Peta	Veeraghattam	0.8	N 18° 41' 58,6"	E 083° 46' 29.1"	300
32.	S Sambayya	CSR Peta	Veeraghattam	0.8	N 18° 43' 58,6"	E 083° 46' 28.1"	309
33.	J Parvithamma	Naidu Guda	Seethampeta	0.8	N 18° 39' 58,6"	E 083° 48' 29.1"	86
34.	K Tavitamma	Naidu Guda	Seethampeta	0.8	N 18° 39' 58,6"	E 083° 48' 39.1"	100
35.	Kchandrayya	Naidu Guda	Seethampeta	0.8	N 18° 42' 58,6"	E 083° 48' 30.1"	297
36.	V Apparao	Naidu Guda	Seethampeta	0.8	N 18° 42' 58,6"	E 083° 48' 39.1"	259
			Average	0.68			

economics for all the enterprises in integrated farming system.

OBSERVATIONS AND ANALYSIS

The on Farm Research Centre of AICRP-IFS identified 36 farmers for conducting the On-farm evaluation of farming system modules for improving profitability and livelihood of small and marginal farmers. The mean average small farmer having land holding size of 0.68 ha of Srikakulam district of Andhra Pradesh state. Average family consists of four members. Average age men surviving with 55 years old and their education levels are primary school standard. Major source of irrigation for his farm is water used from seepage channels form hill streams. The average livestock of farmer was having 2 local cows.

In cropping system made diversification with interventions like, introduction of medium-short duration high yielding varieties MTU 1001, 1010 and 1121 and balanced fertilizer application, *i.e.,* 80-60-60 NPK per ha in 0.2ha area in three years *i.e.*, *Kharif*, 2013-14, 2014-15, 2015-16, respectively with intervention cost of Rs.1460. During *Rabi* also made intervention by introducing high yielding variety with LGG-460 with tolerance to YMV with intervention cost of Rs.360 (Table 1).

In horticulture component farmers having cashew plantation of 15years old in an average of 0.2ha with 40 plants on hill top, sloppy areas *i.e.,* podu cultivation with poor orchard management without fertilizer application. In this cashew garden also made interventions with clean orchard management by pruning techniques along with balanced fertilizer application 1100 g -Urea,750 g-SSP and 250 MOP per plant during rainy season with two spilts with 60 days interval with of intervention cost Rs.460

Table 1 : Diversifications made in existing IFS practised by farmers and additional cost mean of 36 households

Existing system/Bench mark of the farmer practice				Changes made	Cost of intervention (Rs.)
Module	Details	Cost (Rs.)	Net income (Rs.)		
Cropping systems	Rice local-0.2ha variety (Isaka Ravvalu-Konda dhanyam), Rice -Imbalanced fertilizer use *i.e.,* 56-21-28 kg NPK per ha	5640	3960	*Kharif*- Medium-Short duration high yielding varieties MTU 1001, 1010 and 1121 and balanced fertilizer application, *i.e*, 80-60-60 NPK per ha 0.2 ha in three years *i.e.*, 2013-14, 2014-15, 2015-16 respectively.	1460
	Greengram-Local variety with high incidence YMV	940	1760	*Rabi*-High yielding variety with LGG-460 with tolerance to YMV	360
Horti	Cashew plantation (15years) 0.2 ha 40 plants on hill top areas-Podu cultivation Poor orchard management, No fertilizer application	960	13440	Clean orchard management, balanced fertilizer application 1100g-Urea, 750g-SSP 250MOP per plant-	460
Livestock	Bufallows-2, Grazing on open land : Low milk yield	9280	7920	Fodder strips, feed and mineral mixture supplied	4480
	Desi Birds-12, Desi birds : Low egg laying and low meat production	860	8350	25 Vanaraja backyard poultry birds 6weeks old with all vaccination supplied per year+ Feed	2225
Product diversification	Composting			Vermicomposting cemented rounded structures were supplied to make vermicomposting	900
Optional	No vegetable production purchasing vegetables from market			Kitchen gardening	150
Total		17680	35430		8515

(Table 1).

Farmers were having 2 desi /local cows which are low milk yielders. The milk yield was 640 liters/year excluding home consumption. Fat content in milk was low and was giving less price to milk. Mineral deficiency and improper nutrition were the reasons for low milk fat and production. Further, farmer was maintaining low productive local back yard poultry which are susceptible to diseases and family labour were not getting employment properly throughout the year. Based on above limitations, low cost interventions were proposed and imposed as per farmers willingness and market demand in crop, livestock and product processing and value addition. In livestock module, low milk yield production and low fat content were addressed with supply fodder slips of Co-4 and also supplied nutritious feed with mineral mixture with intervention cost of Rs.4480 (Table 1). In addition to that, introduced to *Azolla* production at farmers fields as supplemental feed to buffalo and back yard poultry throughout the year.

Region specific Vanaraaja birds along with feed supplement were introduced in the back yard alternate to country birds to generate additional income with intervention cost of Rs.2225 (Table 1). These birds survives with kitchen wastes, farm wastes, small insects, grasses available in back yards and other surplus farm products like bhusa, maize flour broken rice were fed to these birds. *Azolla* production and *Ghee* making from surplus milk were the intervention under product processing and value component.

In addition to all this enterprises, introduced nutritional kitchen garden by providing seed material of latest varieties of all vegetables with intervention cost of Rs.150 (Table 1).

Table 2: Economics of low-cost IFS over different years

Parameters	Benchmark (Before intervention)	Low cost based intervention period (years)					Percentage increase of parameters over benchmark year
		2012-13	2013-14	2014-15	2015-16	Mean	
Cost of interventions in all enterprises (Rs./year)	17680	26195	28240	29640	31720	28948	63.73
Gross return (Rs./year)	53110	83630	96840	104720	112960	99537	87.41
Net income (Rs./year)	35430	57435	68600	75080	81240	70588	99.23
B: C ratio	3.00	3.19	3.42	3.53	3.56	3.40	13.33

Table 3 : Employment generation from each enterprise

Treatments	Employment from existing system (Man days)	Employment from diversified system (Man days)	Increased employment diversification (Man
M1-Cropping system diversification	148	172	24
M2-Livestock and poultry diversification	152	164	12
M3-Product diversification	12	24	12
M4-Capacity building	2	8	6
Total	314	368	54

Table 4 : Area and income share

Components	Area share (%)	Net income share (%)
Field crops including vegetables	44	16.14
Horticulture (only fruits, plantations, spices, flowers etc)	43	37.93
Fodder (Please specify name of fodders here)	2	0
Livestock (Cows and poultry)	0	44.93
Fishery	0	0
Kitchen garden	1	0
Other enterprises (Pl specify like vermicompost, mushroom)	0	0

By diversification in all enterprises farmers realized Rs. 83,630, 96,830, 1,04,720 and 1,12,960 gross returns and Rs.57435, 68600, 65080 and 81240 net returns (Table 2) was than the bench mark Rs. 53110 and Rs. 35430 at the additional cost of interventions of Rs. 8515 than the bench mark cost of cultivation Rs. 17680 in 2012-13, 2013-14, 2014-15 and 2015-16 respectively. Net returns are getting doubled from the third year of interventions onwards. The increase income is attributed to increase in income from intervention in paddy crop and cashew crop, introduction of YMV tolerant green gram variety, feeding of supplement feed to the cattle and also the introduction of Vanaraja and Rajshri back yard poultry birds. In addition to this not only due to diversification of existing enterprises, but also introduction of *Azolla* and nutritional kitchen garden, helped the farmer nutritional food, besides reduction in cost of maintenance helped in increase in net returns recorded. By introduction of interventions the cost of cultivation is increased by 63.73 per cent with increase of gross returns by 87.42 per cent and net returns of 99.23 per cent with 13.33 per cent increase in B:C Ratio was observed. Mohanty *et al*. (2010) also reported similar results that, a successful tribal integrated farmer in Orissa who was getting enhanced the productivity as well as the profitability and sustainability after adopting the IFS as compared to the conventional farming system and earned seven times higher Net Monetary Return (NMR) as compared to traditional method of farming.

Additionally 54 man days were created on an average during four years of introduction of IFS approach (Table 3) due to diversification of enterprises and introduction of few enterprise, the man days was created due to diversification are 368 when compared to existing farmers practice 314.

The area share was allocated 44 per cent to crops, 43 per cent horticultural crops, 1-2 per cent area for other components, these various components the net income was maximum in livestock (44.93%), closely followed by horticulture (37.93 %) and crops (16.14%) (Table 4). Biswas (2010) reported that the farming system revolves around better utilization of time, money, resources and family labour and also the farm family gets scope for gainful employment round the year thereby ensuring good income and higher standard of living even from the small holdings. Jagadeeshwara *et al*. (2011) reported that the productivity of IFS was 26.3 per cent higher than the conventional system. Ramasamy *et al*. (2008) reported that the income from integrated crop+ livestock + goat + poultry was Rs. 98,270 than Rs. 28,600 in traditional farming system and similarly income of Rs. 99,209 in IFS with the crop +livestock +goat + poultry than conventional farming system.

Conclusion:

It is concluded that the integrated farming system (IFS) is a promising enterprise for the marginal and small farmers particularly who has less farm holdings. From this study, the IFS provide progressive economic growth, employment opportunities, family nutritional requirements, optimal utilization of resources of the farming enterprises *etc* and also created additional man days as employment to the farmers households. The farming systems research, besides offering the potential scope to solve the technology development problems, will help the optimization of various agricultural components and their integration for multi-enterprise farming systems. This will result in development of sustainable and climate resilient farming practices through farming systems approach for enhanced and stable income on farm holding basis. The major outcome of the project will be the development of climate smart farming systems for diverse farming situations and farm categories.

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