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RESEARCH ARTICLE :

On-farm evaluation of farming system modules for improving profitability and livelihood of small and marginal tribal farmers in high altitudes tribal zone of Andhra Pradesh

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SUMMARY : Small and fragmented land holdings do not allow a farmer to keep independent farm resources like draught animals, tractors, bore wells/ tube wells and other sophisticated machineries for various cultural operations. Further, most of the inputs have become costly and out of reach of these resource poor farmers which has resulted farming as an uneconomic and unsustainable enterprise. To fulfil the basic needs of household including food (cereal, pulses, oilseeds, milk, fruit, honey, fish meat, etc.) for human, feed and fodder for animals and fuel and fibre for general use warrant an attention about integrated farming system. 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. Integrated farming system is a commonly and broadly used word to explain a more integrated approach to farming as compared to monoculture approaches. AICRP-IFS, Seethampeta, ANGRAU centre implemented on farm research on "on-farm evaluation of farming system modules for improving profitability and livelihood of small and marginal farmers" with financial and technical assistance from Indian Institute of Farming System Research, Modipuram in 12 small and marginal tribal farmers' households in Seetampeta mandal of Srikkakulam district of Andhra Pradesh objectives of to address critical constraints of small and marginal farm holders for overall improvement of productivity and to increase the profitability of small and marginal households and ensure livelihood. By diversification in all enterprises farmers realized Rs. 62755, 65387, 82235 and 88967 gross returns and Rs.32125, 34117, 47075and 49747 net returns was more than the bench mark Rs.46720, 47856, 58240 and Rs. 62376 with the additional interventions costs of Rs.3770 in 2012-13, 2013-14, 2014-15 and 2015-16, respectively. Further, with integration of enterprises *viz.,* Crops+Poultry, Crops+Dairy and Crops+Poultry+Dairy farmers realized Rs. 65387, 82235and 88967 gross returns and Rs.34117, 47075 and 49747 net returns when compared to crops only *i.e.*, Rs. 62755 and Rs.32125, respectively. The increase income is attributed to increase in income from intervention in paddy crop and ragi crop, 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 addition of enterprises in farming system modules. Gross income in all farming systems increased when compared to cropping system only. Gross income increased in crop – poultry farming system due to different modules from Rs. 47856/house hold to Rs. 65387/house hold with B: C ratio 2.09 and Gross income increased in crop – dairy farming system due to different modules from Rs. 58240/house hold

to Rs. 85235/house hold with B: C ratio 2.23. Gross income increased in crop – dairy -poultry farming system due to different modules from Rs. 62376/house hold to Rs. 88967 /house hold with B: C ratio 2.26.

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BACKGROUND AND OBJECTIVES

Weakening of the traditional joint family concept combined with unchecked linear growth in human population lead indiscriminate fragmentation of land holdings. More than 85 per cent farm families have been converted in to marginal and small categories of farmers having land less than one hectare. Small and fragmented land holdings do not allow a farmer to keep independent farm resources like draught animals, tractors, bore wells/ tube wells and other sophisticated machineries for various cultural operations. Further, most of the inputs have become costly and out of reach of these resource poor farmers which has resulted farming as an uneconomic and unsustainable enterprise. Large scale urbanization, industrial and infrastructural growth - a need of the day has necessitated looking for vertical growth rather than horizontal expansion as far as Indian agriculture is concerned. In past, the focus had been on maximization of crop yields and that too for well endowed resource rich farm families. Marginal and small farmers in general are literally illiterate, financially handicapped, their holdings are small and scattered not suited for high-tech agricultural machinery, work in resource poor and risk prone diverse conditions. Lot of efforts have been made aiming at increasing the productivity of different components of farming system but lacking in their integration by following farming system approach. To fulfil the basic needs of household including food (cereal, pulses, oilseeds, milk, fruit, honey, fish meat, etc.) for human, feed and fodder for animals and fuel and fibre for general use warrant an attention about integrated farming system.

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. Integrated farming system is a commonly and broadly used word to explain a more integrated approach to farming as compared to monoculture approaches. The prosperity of any country depends upon the prosperity of farmers. This in turn depends upon the adoption of improved technology and judicious allocation of resources. Human race depends more on farm products for their existence than anything else since food and clothing – the prime necessaries are products of farming. Even for industrial prosperity, farming forms the basic raw material. To sustain and satisfy as many as his needs, the farmers include crop production, livestock, poultry, fisheries, beekeeping etc. in their farms. Presently, the farming objective is the sustainable economic yields for the present generations without dislocating the natural resource base for the future generations.

With this back ground AICRP-IFS, Seethampeta, ANGRAU centre implemented on farm research on "on-farm evaluation of farming system modules for improving profitability and livelihood of small and marginal farmers" with financial and technical assistance from Indian Institute of Farming System Research, Modipuram in 12 small and marginal tribal farmers' households (Table A) in Seetampeta mandal of Srikkakulam district of Andhra Pradesh with following objectives and modules.

Objectives:

– To address critical constraints of small and marginal farm holders for overall improvement of productivity

– To increase the profitability of small and marginal households and ensure livelihood

Modules : 5 :

M_0 = Characterization details of the house hold (Existing practice)

M_1 = M_0 + Interventions in crops module

M_2 = M_0 + Interventions in Animals module

M_3 = M_0 + Kitchen garden module

M_4 = M_0 + Vermi copmosting module (Optional) .

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 B).

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 nondescriptive 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 12 farmer's field (Table A) in said period.

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

Sr. No.	Name of farmers	Village	Block	Area (ha)	Latitude	Longitude	Altitude (m)
1.	Sri Majji Prakash	Mahadavavalasa	Veeraghattam	0.8	N 18° 39' 58,6"	E 083° 37' 29.1"	85
2.	Sri S Neelamdora	Mahadavavalasa	Veeraghattam	0.2	N 18° 39' 58,8"	E 083° 37' 28.3"	85
3.	Sri S.Sumbaramma	Mahadavavalasa	Veeraghattam	0.2	N 18° 42' 58,6"	E 083° 37' 47.1"	100
4.	Sri S Ramarao	Mahadavavalasa	Veeraghattam	1.2	N 18° 42' 58,6"	E 083° 36' 47.7"	94
5.	Sri K Pakeeru	CSR Peta	Veeraghattam	0.8	N 18° 42' 58,6"	E 083° 36' 44,0"	83
6.	Sri K Trinadha	CSR Peta	Veeraghattam	1.2	N 18° 42' 58,6"	E 083° 45' 46.1"	86
7.	Sri S Anapayya	CSR Peta	Veeraghattam	0.8	N 18° 41' 58,6"	E 083° 46' 29.1"	300
8.	Sri S Sambayya	CSR Peta	Veeraghattam	0.8	N 18° 43' 58,6"	E 083° 46' 28.1"	309
9.	Sri J Parvithamma	Naidu Guda	Seethampeta	0.8	N 18° 39' 58,6"	E 083° 48' 29.1"	86
10.	Sri K Tavitamma	Naidu Guda	Seethampeta	0.8	N 18° 39' 58,6"	E 083° 48' 39.1"	100
11.	Sri Kchandrayya	Naidu Guda	Seethampeta	0.8	N 18° 42' 58,6"	E 083° 48' 30.1"	297
12.	Sri V Apparao	Naidu Guda	Seethampeta	0.8	N 18° 42' 58,6"	E 083° 48' 39.1"	259

Table B: 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 C: M_0-Characterization details of farmers bench mark (Existing practice)

Type of farming system (s)	No. of HH	Mean holding size (ha)	Mean family size (no's)	Mean Net Income (Rs.)			Mean total cost of production (Rs.)
				On Farm	Off Farm	Total	
Crops	12	0.96	6	46720	25450	72170	28320
Crops+ Poultry	6	0.94	6	47856	24870	72726	28460
Crops+ Diary	3	0.98	6	58240	22650	80890	33550
Crops+ Diary + Poultry	3	1.02	6	62376	22460	84836	34510

Made on-farm evaluation of farming system modules for improving profitability and livelihood of small and marginal farmers with comparison with 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 economics for all the enterprises in integrated farming system.

OBSERVATIONS AND ANALYSIS

The on Farm Research Centre of AICRP-IFS identified 12 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 0.96ha of Srikakulam district of Andhra Pradesh state. Average family consists of four members. Average age men surviving with 58 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 murrah buffalos.

In cropping system made diversification with interventions like, introduction of medium-short duration high yielding varieties MTU 1001 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.1350. During *Rabi* also made intervention by introducing high yielding Ragi variety with VR-847 with intervention cost of Rs.120 (Table 1). Due to diversification farmers realized the on an average in four years recorded mean yield advantage of 1728kg/ha in paddy and 241kg/ha in Ragi and same was reflected in net monetary advantage of

Table 1: $M_1 = M_0$ + Interventions in crops for four years period from 2012-13, 2013-14, 2014-15 and 2015-16

Existing system	Interventions in diversified system	Average yield of existing (kg/ha)	Average yield of diversified (kg/ha)	Cost of intervention (Rs.)	Mean yield advantage (kg/ha)	Net monetary advantage (Rs./ ha)
Kharif-Paddy with traditional long duration variety Isakaravvalu	Short duration HYV MTU-1001	1424	3152	1350 seed fertilizers herbicide	1728	17280
Rabi-Ragi with traditional variety	Introduced HYV of Ragi (VR-847- Sri chaitanya)	524	765	120 seed	241	1205
Total				1470		18,485

Table 2 : $M_2 = M_0$+ Interventions in Animals module Buffalo for four years period from 2012-13, 2013-14, 2014-15 and 2015-16

Existing system	Diversified system	Average milk yield of existing (lt/year)	Average milk yield of diversified (lt/year)	Cost of intervention (Rs.)	Mean yield advantage	Net monetary advantage
Grazing on open land Low milk yield	Fodder strips and mineral mixture supplied	324	646	1200	322	6440

Table 3 : $M_2 = M_0$+ Interventions in Animals module-Poultry for four years period from 2012-13, 2013-14, 2014-15 and 2015-16

Existing system	Diversified system	Average eggs/ year of existing (eggs/ year)	Average eggs/ year of diversified (eggs/ year)	Cost of intervention (Rs.)	Mean eggs advantage (Eggs/ household)	Net Monetary advantage (Rs./ ha)
Desi birds Low egg laying and Chicken production	Vanaraj and Rajasri backyard poultry birds with high egg laying capacity	184	1058 (10 hens 2 cock)	600	874	2622

Rs. 18,485 additional over bench mark.

Farmers were having 2 murrah buffalos which are low milk yielders. The milk yield was 740 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. 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.1200 (Table 2). In addition to that, introduced *Azolla* production at farmers fields as supplemental feed to buffalo and back yard poultry throughout the year. The interventions made to livestock improvement resulted in additional 322 liters of milk production with net monetary advantage of Rs.6440 was recorded.

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. 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.600 (Table 3). 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. Due to introduction of Vanaraj and Rajshri birds as back yard poultry recorded additional 874 eggs with net monetary advantage of Rs.2622.

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.200 (Table 4). By introduction of nutritional kitchen garden farmers saved the purchase of vegetables worth of Rs.3045 to their farm family consumption.

For nutrient recycling in the farm and to enrich the soil, introduced vermicomposting with intervention cost of Rs.300 (Table 5). With the introduction of vermicomposting farmers saved the purchase of fertilizer worth of Rs.1160

By diversification in all enterprises farmers realized

Table 4: M_3 = M_0+ Kitchen garden module for four years period from 2012-13, 2013-14, 2014-15 and 2015-16

Existing system	Diversified system	Average yield of existing (kg/ha)	Average yield of diversified (kg/ha)	Cost of intervention (Rs.)	Mean yield advantage (kg/ household)	Net monetary advantage (Rs./ ha)
Few kitchen gardening plants like veins	Total kitchen gardening	45	248	200	203	3045

Table 5: M_4 = M_0 + Vermicopmosting module for four years period from 2012-13, 2013-14, 2014-15 and 2015-16

Existing system	Diversified system	Average dung production of existing (kg/ house hold)	Average vermi compost production of diversified (kg/ha)	Cost of intervention (Rs.)	Mean yield advantage (kg/ household)	Net monetary advantage
Open composting	Earthworms were supplied for Vermi composting	2480	1080	300	Fertilizer purchase cost reduced	1160

Table 6 : Average economics for four years period from 2012-13, 2013-14, 2014-15 and 2015-16

Farming system	Benchmark	Cost of interventions (Rs.)	Total cost of Production (Rs.)	Gross returns after modular interventions (Rs.)	Net returns due to interventions (Rs.)	BCR
Crops	46720	1470	30630	62755	32125	2.04
Crops+ Poultry	47856	2070	31270	65387	34117	2.09
Crops+ Diary	58240	2670	38160	85235	47075	2.23
Crops+ Diary + Poultry	62376	3270	39220	88967	49747	2.26

Rs.62755, 65387, 82235and 88967 gross returns and Rs.32125, 34117, 47075and 49747 net returns (Table 6) was more than the bench mark Rs.46720, 47856, 58240 and Rs. 62376 with the additional interventions costs of Rs.3770 in 2012-13, 2013-14, 2014-15 and 2015-16 respectively. Further, with integration of enterprises *viz.,* Crops+Poultry, Crops+Dairy and Crops+Poultry+Dairy farmers realized Rs. 65387, 82235and 88967 gross returns and Rs.34117, 47075and 49747 net returns (Table 6) when compared to crops only *i.e.*, Rs. 62755 and Rs.32125 respectively. The increase income is attributed to increase in income from intervention in paddy crop and ragi crop, 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 addition of enterprises in farming system modules.

Salient findings of this on farm research:

– Gross income in all farming systems increased when compared to cropping system only.

– Gross income increased in crop – poultry farming system due to different modules from Rs. 47856/house hold to Rs. 65387/house hold with B: C ratio 2.09 and

– Gross income increased in crop – dairy farming system due to different modules from Rs. 58240/house hold to Rs. 85235/house hold with B: C ratio 2.23

– Gross income increased in crop – dairy -poultry farming system due to different modules from Rs. 62376/ house hold to Rs. 88967 /house hold with B: C ratio 2.26.

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.

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:

Due to fragmentation of land holdings with increasing population, small and marginal farmers as well as about 15 to 18 per cent landless families living in the rural areas are unable to generate remunerative employment and income. Eventually, with the lack of food and income security the poor families are compelled to migrate to cities in distress keeping their agricultural lands fallow. This phenomenon may become a major national challenge in the years to come. 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. Advantages include food and nutritional security, enhanced and stable farm income and cash flow through allied components at regular intervals, maintain soil fertility and soil health, environmental protection through effective recycling of waste from animal based enterprises like dairy, poultry, etc. and employment generation. Factors which influences the selection of crops and other components in IFS includes food and other needs and resource base of the farmers, soil type, rainfall, irrigation facilities and length of growing season and market facilities.

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