Sustainability of Farm and Farmers through Eco-friendly Integrated Farming System Approach

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ABSTRACT

The field experiment has been conducted to study the performance of integrated farming system (IFS) approach over conventional method of farming. The 1.0 ha IFS is based on in vogue cropping system on 0.70 ha viz.; (i) green gram - castor relay (0.32 ha), (ii) groundnut - wheat - fodder pearl millet (0.08 ha), (iii) green gram - mustard - summer pearl millet (0.24 ha) and (iv) fodder cowpea - lucerne + chicory (0.06 ha) to ensure annual calories and nutritional requirements of a family. The income and health were made more sustainable by growing fruits and vegetables in two tiers on 0.25 ha. The soil health was taken care by including pulses in cropping systems, making microbial enriched vermicompost from the waste and dung of the two buffaloes reared on 0.035 ha. Farm wastes were recycled within the system which obliterated the need to purchase off-farm inputs. The internal bunds were planted with fodder crops (Dhaman and Napier grass) and timber trees (Teak, drum stick, subabul etc.), while on boundaries quick growing timber trees like Ailanthus, bamboo, drum stick and Eucalyptus were planted to brace up income. The model has a provision of farm pond (0.015 ha) for water harvesting and water recharging on low lying depression of the farm. The system has been functional for the last seven years and the cursory analysis of the investment indicated that the system is good enough to provide average income of ₹ 617/day with average engagement of 0.93 labour-day/day. The continuous sustainable income and livelihood security throughout the year can be fruitful to check urban migration.

INTRODUCTION

Farming system integrates natural resources and regulates into farming activities to achieve maximum replacement of off-farm inputs and to secure sustainable production of high quality food and other products through ecologically preferred technologies and therefore sustains farm income, reduces sources of environment pollution generated by agriculture and stabilizes the multiple function of agriculture. In IFS, different enterprises are dependent, complementary and supplementary to each other; they interact among themselves and affect the others. Sustainable development in agriculture must include IFS with efficient soil, water, crop and pest management practices which are environmental friendly and cost effective. In IFS, the waste of one enterprise becomes the input of another for making better use of resources. For eg, in integrated crop livestock farming system, crop residues can be used for animal feed, while manure from livestock can enhance the agricultural productivity. IFS also play an important role in improving soil health by increasing the nitrogen, phosphorous, organic carbon and microbial count of soil and thus, reduce the use of chemical fertilizers. Moreover, the components of IFS are known to control the weeds and regarded as an important element of integrated pest management and thus minimizes the use of herbicides as well as other pesticides and thus protects the environment.

Looking back on the necessity of IFS in North Gujarat which is having capricious low rainfall (average 625 mm), overarching small (62%) and marginal farmers (18%), insecure farm income and flagrant malnutrition, an experiment of IFS model comprised of 1.0 ha area has been conducted for seven years at Centre for Research on Integrated Farming Systems, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar of Gujarat during *Kharif* season of the year 2010-11 to 2016-17 for validation of an IFS model.

METHODOLOGY

The present study has been conducted at Centre for Research on IFS, SDAU, Sardarkrushinagar of Gujarat State.

Geographically, Sardarkrushinagar is situated at 24°19' North latitude and 72°19' East longitude at an elevation of 154.52 meter above mean sea level and is situated in North Gujarat Agro-climatic region (Zone-IV of Gujarat). The climate of this region is sub-tropical monsoon type and falls under semi-arid region. The experimental field has even topography with a gentle slope having good drainage. Data on different aspects of various IFS components were recorded as per the standard procedures.

The IFS experiment comprised with four cropping systems [(Castor + Greengram cropping system (0.32 ha), Groundnut - Wheat - Multicut fodder pearl millet cropping system (0.08 ha), Greengram-Mustard-Pearl millet cropping system (0.24 ha)], fodder crops [0.06 ha], multistoried horticultural fruits and vegetable crops [0.25 ha], boundary plantation, livestock unit with two Mahesani breed buffaloes [0.025 ha], vermicompost and nursery unit [0.01 ha] and water recharging unit [0.015 ha]. The view of IFS model is shown in Fig. 1.

RESULTS AND DISCUSSION

IFS of crops with allied enterprises, implemented in on-station situations facilitated a favorable average cash income (₹ 617/day) besides generating mean employment (0.93 labour/day) of seven years for family labor and also minimizes the risk associated with conventional cropping system. It also sustains soil productivity through the recycling of organic nutrient sources from the enterprises involved. The advantage of using low-cost or no-cost materials at farm level for recycling is reduced production costs with improved farm income.

The IFS model was analyzed for seven years. The four types of cropping systems were tested in this model. The total net return from four cropping systems (0.70 ha) were ₹ 87,280 (2010-11), ₹ 1,13,074 (2011-12), ₹ 96,539 (2012-13), ₹ 93,367 (2013-14), ₹ 1,15,952 (2014-15), ₹ 1,11,517 (2015-16) and ₹ 71,650 (2016-17) with mean net return of ₹ 98483/0.70 hectare of seven years, which was 49.17 % of total net returns of 1.0 ha IFS model.

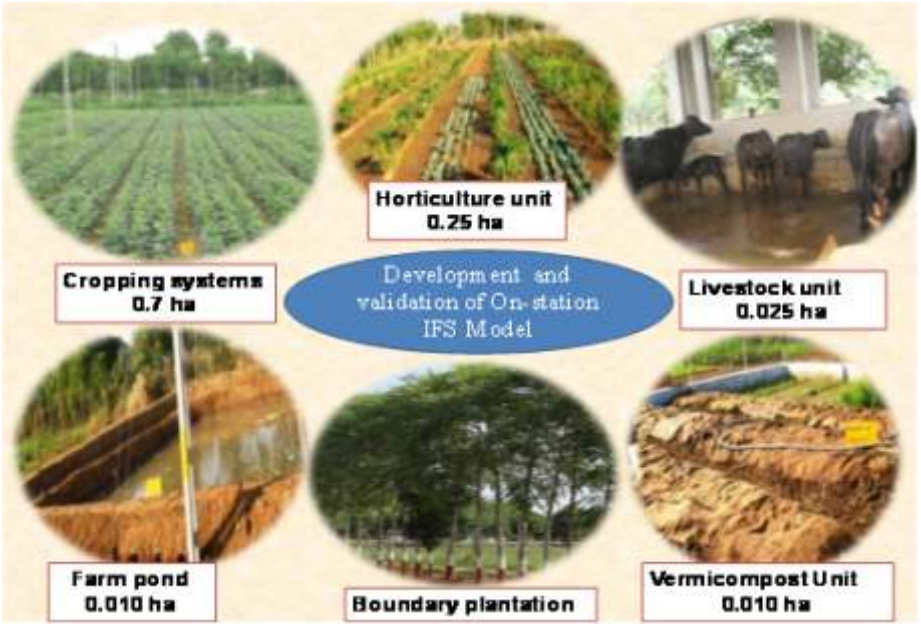

Fig. 1 Irrigated based IFS model (1.0 ha)

Table 1
Components of 1.0 hectare IFS model

Components		Area (ha)	Treatment
I.	Cropping Systems	0.70	C_1: Castor (*Ricinus communis*) + Greengram (*Vigna radiata*) [0.32 ha] C_2: Groundnut (*Arachis hypogaea*) - Wheat (*Triticum aestivum*) - Multicut fodder pearl millet (*Pennisetum glaucum*) [0.08 ha] C_3: Greengram (*Vigna radiata*) - Mustard (*Brassica juncea*) – Pearl millet (*Pennisetum glaucum*) [0.24 ha] C_4: Hybrid Napier (*Pennisetum purpureum*) + Fodder Cowpea (*Vigna unguiculata*) - Lucerne (*Medicago sativa*) + Fodder Chicory (*Cichorium intybus*) [0.06 ha]
II.	Multi-storeyed horticultural fruits and vegetables	0.25	1. Mango (*Mangifera indica)*: [8m x 8m (40 plants)] 2. Lemon (*Citrus limonum)*: [In between two rows of mango at 4 m distance (80 plants)] 3. Custard apple (*Annona reticulata*):[In between two plants of mango (36 plants)] 4. Seasonal vegetables in between fruit trees
III.	Boundary plantation		I. Timber wood/Fruit/ Medicinal plants 1. Ardusa (*Ailanthus excelsa*) :10 | 6. Mulberry (*Morus rubra*) :03 2. Eucalyptus (*Eucalyptus globulus*) :10 | 7. Drum stick (*Moringa oleifera*) :15 3. Subabul (*Leucaena leucocephala*) :10 | 8. Aonla (*Phyllanthus emblica*) :03 4. Custard apple (*Annona reticulata*) :10 | 9. Bamboo (*Bambusa vulgaris*) :01 5. Jambun (*Syzygium cumini*) :04 | 10. Teak (*Tectona grandis*) :35 II. Fodder crops: Dhaman (*Cenchrus ciliaris*) and Hybrid Napier (*Pennisetum purpureum*) on bunds
IV.	Livestock	0.025	Mehsani breed Buffaloes (*Bubalus bubalis*) (2)
V.	Vermicompost and nursery unit	0.010	To be filled with FYM, farm wastes and cattle feed wastage. Raising nursery for fennel, brinjal, tomato, onion, chilli *etc.*
VI.	Farm pond	0.015	10 m (L) x 10 m (H) x 15 m (W) sized farm pond was opened for water harvesting and recharging unit.
Total		1.000	

Table 2
Net return (₹) of different farm enterprises and their per cent share to total gross return of 1.0 ha IFS model

Year	Net return (₹)					Income (₹/day)	Man days/ year	Average labour utilization (Man days/ day)
	From crop (0.7 ha)	From horti. (0.25 ha)	From livestock (0.035 ha)	From boundary	Total (1.0 ha)*			
2010-11	87280	15480	0.00	2135	104895	287	236	0.65
2011-12	113074	23888	44653	6784	188399	516	324	0.89
2012-13	96539	23370	32695	9181	161785	443	347	0.95
2013-14	93367	24190	110791	10480	238828	654	423	1.16
2014-15	115952	35733	16645	193086	361416	990	307	0.84
2015-16	111517	40740	44763	115888	312908	857	398	1.09
#2016-17	71650	20447	19332	96438	207867	569	347	0.95
Average	**98483**	**26264**	**38411**	**61999**	**225157**	**617**	**340**	**0.93**

*Remained 0.015 ha was allotted to farm pond. # During 2016-17, the labour cost was raised to ₹ 260/day as compared to earlier years (₹ 150/day). Hence, the net return from each enterprise was lowered as compared to earlier years.

Economics of IFS model

On an average of seven years, growing of different types of seasonal vegetables and perennial fruit trees in horticulture unit (0.25 ha) provided ₹ 26264/0.25 hectare per year, which was 12.11 % of total net returns of 1.0 ha IFS model.

Growing of dhaman grass, hybrid Napier, drumstick, teak, subabul and ardusa at bunds as well as boundaries added an average net return of ₹ 61,999 per year (of seven years), which was 21.79 % of total net return.

Dairy and vermicompost unit comprised with two Mehsani breed buffaloes provided seven year's mean net returns of ₹ 38,411/0.035 hectare area per year which was 16.93% of total net return of the whole IFS model. These results are in conformity with the Ramrao *et al.* (2005), Sharma *et al.* (2008) and Channabasavanna *et al.* (2009) who found integration of different enterprises as beneficial in their research in different states.

Employment generation in IFS

IFS has created more number of working days in the system due to involvement of more enterprises than cropping system alone. IFS model of 1.0 ha has generated 236, 324, 347, 423, 307, 398 and 347 man days/ha per year during 2010-11, 2011-12, 2012-13, 2013-14, 2014-15, 2015-16 and 2016-17, respectively. This has provided employment opportunity almost throughout the year due to involvement of more than one enterprise in the system.

IFS is considered as basket of technologies that can be treated as a live ATM as it has generated per day per hectare income of ₹ 287, 516, 443, 654, 990, 857 and 569 during 2010-11, 2011-12, 2012-13, 2013-14, 2014-15, 2015-16 and 2016-17, respectively.

Improvement in soil properties

Pertaining to this experiment, the soil properties are studied after seven years, which are discussed as below.

There was no much difference observed with reference to the bulk density after seven years of experimentation as compared to initial value as the land management practices and manure application were same before and during IFS experiment. The pH was slightly reduced in greengram - mustard - pearl millet cropping system (CS 3) due to the release of organic acids upon decomposition of organic residues as well as N_2 fixation by the legumes. Whereas, the different cropping systems and horticultural systems have not largely varied in EC. The soil organic carbon content and available P, S as well as the DTPA extractable Fe, Mn, Zn and Cu after seven years were increased over initial levels in greengram - mustard - pearl millet cropping system (CS 3) because of addition of organic matter by the green gram and other crop residues apart from N_2 fixation in this system.

Whereas, the available K content was found higher under mango + lemon + custard apple system (HS 1) which might be attributed to lower removal by fruit trees which are harvested once in a year as compared to higher depletion of K under other cropping systems having two to three crops in a year.

Overall, the integrated farming system will be greatly helpful in terms of maintaining soil fertility as compared to practicing usual cropping systems alone. The various soil fertility indicators *viz.,* organic carbon content, available P, S, DTPA extractable Fe, Mn, Zn and Cu have increased after seven years in the IFS system in comparison with the initial levels.

CONCLUSION

The results of seven year's IFS experiment revealed that, yearly average net return (₹ 2,25,157/ha) and employment generation (0.93 man/day) reflects economic benefits and livelihood security for the farm family. Recycling of various farm products improved the soil fertility for the sustainable

Table 3
Soil properties (0-15 cm soil layer) as influenced by IFS model after seven years of experimentation

Parameter	After seven years soil status (2016-17)						Initial soil propertis (2010-11)
	Cropping systems				Horticultural systems		
	CS 1	CS 2	CS 3	CS 4	HS 1	HS 2	
Bulk density (Mg/m^3)	1.469	1.465	1.474	1.474	1.448	1.464	1.48
pH (1:2.5)	7.63	7.71	7.17	7.67	7.46	7.73	7.65
Electrical conductivity (dS/m) (1:2.5)	0.12	0.13	0.12	0.11	0.13	0.14	0.13
Organic carbon (%)	0.38	0.37	0.41	0.39	0.39	0.40	0.33
Available P (kg/ha)	18.72	19.13	19.73	18.75	19.34	20.21	18.60
Available K (kg/ha)	178	174	176	176	186	184	172
Available S (mg/kg)	8.59	8.69	8.68	8.91	8.46	9.19	8.20
DTPA extractable Fe (mg/kg)	9.3	8.8	9.43	9.27	9.24	8.57	8.40
DTPA extractable Mn (mg/kg)	8.71	8.36	8.99	8.45	8.84	8.35	7.80
DTPA extractable Zn (mg/kg)	0.77	0.78	0.79	0.75	0.75	0.74	0.68
DTPA extractable Cu (mg/kg)	0.85	0.86	0.87	0.85	0.88	0.78	0.78

Note: CS: Cropping system, HS: Horticulture system

agriculture and have minimized the environmental pollution. Hence, on station IFS model of 1.0 ha provided a platform to create professional and business oriented skills for farm and farm family and also it has enhanced diversification and effective land utilization of farm as it included boundary plantation.

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REFERENCES

1. Channabasavanna, A. S., Biradar, D. P., Prabhudev, K. N. and Mahabhaleswar Hegde. (2009). Development of profitable integrated farming system model for small and medium farmers of Tungabhadra project area of Karnataka. *Karnataka Journal of Agricultural Sciences*, **22**(1), pp. 25-27.

2. Ramrao, W. Y., Tiwari, S. P. and Singh, P. (2005). Crop-livestock integrated farming system for augmenting socio-economic status of smallholder tribal of Chhattisgarh in central India. *Livestock Research for Rural development,* Volume **17**, Article 90.

3. Sharma, Y. K., Bangarva, G.S. and Sharma, S. K. (2008). Farming System Based Constraints Faced by Farmers. *Indian Research Journal of Extension Education*, **8**(1), pp. 57-59.