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**Research Paper**

# Sustainability of farm and farmers through integrated farming system approach

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## ABSTRACT

An experiment of integrated farming system (IFS) model comprising of 1.0 ha area was conducted during the rainy (*kharif*) seasons of 2010–11 to 2016–17 at the Centre for Research on Integrated Farming Systems, Sardarkrushinagar, Dantiwada Agricultural University, Sardarkrushinagar of Gujarat for validation of an IFS model. The system is 4 cropping system on 0.70 ha of 1.00 ha farm, viz. castor (*Ricinus communis* L.) + greengram (*Vigna radiate* (L.) R. Wilczek] (0.32 ha); groundnut (*Arachis hypogaea* L.)–wheat (*Triticum aestivum* L.)-multicut fodder pearl millet [*Pennisetum glaucum* (L.) R. Br.] (0.08 ha); greengram Indian mustard [*Brassica juncea* (L.) Czernj.]–pearlmillet (0.24 ha); and hybrid napier [*Pennisetum purpureum* (Schumach)] + fodder cowpea [*Vigna unguiculata* (L.) Walp.]–Lucerne (*Medicago sativa* L.) + fodder chicory (*Cichorium intybus* L.) (0.06 ha), to ensure annual calorie and nutritional requirement of the family. Both income and health were made more sustainable by growing fruits and vegetable in 2 tiers on 0.25 ha. The soil health was taken care of by including pulses in cropping system, making microbes-enriched vermin-compost from the waste and dung of the 2 buffaloes (*Bubalus bubalis*) reared on 0.04 ha. Farm wastes were recycled within the system which obliterated the need to purchase off-farm inputs. The internal bunds were used for growing fodder while on boundaries quick-growing timber tree like *Ailanthus excelsa* Roxb. were planted to brace up income. The model had a provision of farm pond (0.01 ha) for water harvesting and well recharging on low-lying depression of the farm. The system has been functional for the last 7 years and the cursory analysis of the investment indicated that system is good enough to provide daily average income of ₹617/day with engagement of 0.93 unit of labour/day.

***Key words :*** Farming system, Livelihood improvement, Multi-storey horticulture crops, Productivity, Recycling, Relay cropping

Indian economy is predominantly rural and agriculture oriented where the declining trend in the average size of the farm holding poses a serious problem. In agriculture, 84% of the holding is less than 2 acres (0.81 ha). Majority of them are drylands and even irrigated areas depend on the vagaries of monsoon. In this context, if farmers concentrated on crop production they will be subjected to a high degree of uncertainty in income and employment. Hence, it is imperative to evolve suitable strategy for augmenting the income of the small and marginal farmers to increase the productivity and supplement the income. In an agricultural country like India, the average land holding is very small. The population is steadily increasing without any possibility of increase in land area. The income from cropping for an average farmer is hardly sufficient to sustain his family. The farmer has to be assured of a regular income for a reasonable standard of living by including other enterprizes. In view of the above facts, there is strong need to commercialize agriculture and in order to ensure an all-round development of farming families farming should be considered as a system in which crop and other enterprizes that are compatible and complimentary are combined together. The study of farming systems and application of farming systems approaches can bring a ray of hope for the betterment of farmers. Keeping all these factors in mind, the present study was conducted to suggest which particular mixture of crop, dairy and other farming enterprizes can provide maximum benefit.

Looking back on the necessity of IFS in North Gujarat which having capricious low rainfall (average 625 mm), overarching small (62%) and marginal farmers (18%), insecure farm income and flagrant malnutrition, a study of integrated farming system (IFS) model comprising 0.1 ha

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area was conducted for 7 years, to validate an IFS model with collaboration of the ICAR-Indian Institute of Farming Systems Research, Modipuram, Uttar Pradesh.

## MATERIALS AND METHODS

The present study was carried out at the Centre for Research on Integrated farming Systems, Sardarkrushinagar, Dantiwada Agricultural University, Sardarkrushinagar of Gujarat. Farming system which integrates natural resources and regulation into farming activities to achieve maximum replacement of off-farm inputs, secures sustainable production of high quality food and other products through ecologically preferred technologies, sustained farm income, reduction of sources of present environment pollution generated by agriculture and sustains the multiple function of agriculture. When different enterprizes are dependent, complementary and supplementary to each other, they interact among themselves and affect the others. Such a mixed farming system is termed an integrated farming system (IFS). The IFS experiment comprised with 4 cropping systems, viz. (castor + greengram cropping system (0.32 ha), groundnut–wheat-multicut fodder pearl millet cropping system (0.08 ha), greengram–mustard–pearlmillet cropping system (0.24 ha), fodder crops (0.06 ha), multi-storeyed horticultural fruits and vegetable crops (0.25 ha), boundary plantation, livestock unit with 2 Mehsani breed buffaloes (0.025 ha), vermicompost and nursery unit (0.01 ha) and water-recharging unit (0.015 ha). The different components mention are in (Table 1).

## RESULT AND DISCUSSION

Research studies have demonstrated the technical feasibility and economic viability of integrated farming systems. Besides facilitating cash income, integrated farming system generates additional employment for family labour and minimizes the risk associated with conventional cropping system. It also sustains soil productivity through the recycling of organic nutrient sources from the enterprizes involved. The advantage of using low-cost or no-cost material at farm level for recycling is reduced production costs, with improved farm income.

### *Profitability of Integrated Farming System model*

There are different 4 types of cropping systems (Table 1). Among the 4 types of cropping systems; $C_1$, castor + greengram cropping system in 0.32 ha area; $C_2$, groundnut–wheat–multicut fodder pearl millet cropping system in 0.08 ha area. $C_3$, Greengram–Indian mustard–pearl millet cropping system in 0.24 hectare area and the fourth cropping system in 0.06 ha area for fodder purpose due to animal unit in IFS model. Average of 7 years net returns received from the cropping system component was ₹98,483/0.70 ha which was 49.17% of total net returns (Table 2). In Horticulture unit, growing different types of *kharif*, *rabi* and summer season vegetables and average of

**Table 1.** Components of 1.0 hectare integrated farming system model

| Component | | Area (ha) | Treatment |
|---|---|---|---|
| I. | Cropping systems | 0.70 | $C_1$, Castor + greengram (0.32 ha)<br>$C_2$, Groundnut–wheat–multicut fodder pearlmillet (0.08 ha)<br>$C_3$, Greengram–Indian mustard–pearl millet (0.24 ha)<br>$C_4$, Hybrid napier + fodder cowpea–lucerne + fodder chicory (0.06 ha) |
| II. | Multi-storeyed horticultural fruits and vegetables | 0.25 | 1. Mango (*Mangifera indica)*: [8 m × 8 m (40 plants)]<br>2. Lemon (*Citrus limonum)*: [In between 2 rows of mango at 4 m distance (80 plants)]<br>3. Custard apple (*Annona reticulata*):[In between 2 plants of mango (36 plants)]<br>4. Seasonal vegetables in between fruit trees |
| III. | Boundary | | I. Timber wood/Fruit/ Medicinal plants<br>1. Tree of heaven, Ardusa (*Ailanthus excelsa*) : 10<br>2. Eucalyptus (*Eucalyptus globulus*) : 10<br>3. Subabul (*Leucaena leucocephala*) : 10<br>4. Custard apple (*Annona squamosa*) : 10<br>5. Black plum (*Syzygium cumini*) : 4<br>6. Mulberry (*Morus rubra*) : 3<br>7. Drum stick (*Moringa oleifera*) : 15<br>8. Aonla (*Phyllanthus emblica*) : 3<br>9. Bamboo (*Bambusa vulgaris*) : 1<br>10. Teak (*Tectona grandis*) : 35<br>II. Fodder crops: *Dhaman* (*Cenchrus ciliaris*) and hybrid napier on bunds around 1,000 plants |
| 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) × 10 m (H) × 15 m (W) sized farm pond was opened for water harvesting and recharging unit |
| | Total | 1.000 | |

7 years received ₹26,264.2/0.25 ha horticulture unit area which was 12.11% of total net returns. As per the boundary plantation unit, growing *dhaman* grasses and hybrid napier, drumstick, teak and *subabul* on bund. Total average net return from boundary plantation was ₹61,999 being 21.79% of total net returns. Dairy unit and vermicompost which had 2 Mehsani buffaloes showed average gross returns of ₹128,613 (Table 3). Total average net profit from dairy and vermicompost unit was ₹38,411/ 0.035 hectare area which contributed 16.93% to total net returns. (Gill *et al.,* 2009; and Kumar *et al.,* 2018) Integration of different farming systems were also found beneficial by Ramrao *et al.* (2005), Sharma *et al.* (2008) and Channabasavanna *et al.* (2009) in their research of different states.

### *Employment generation*

Integrated farming system has created more number of working hours in the system owing to more enterprizes than cropping system alone. Model generated average of 7 years 340 man-days/ year (Fig. 1), this has provided employment opportunity throughout the year due to involvement of more than one enterprise in the system.

Integrated farming systems has created as live ATM through system profitability which generated ₹617/day (Fig. 1).

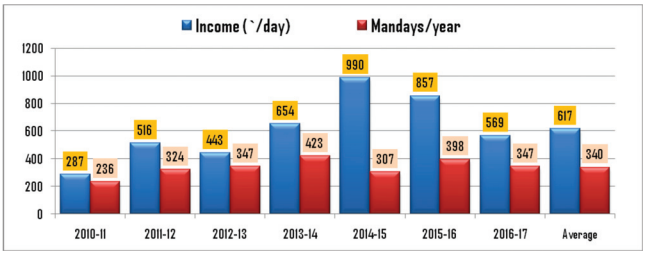


**Fig. 1.** Employment generation and per day income from 1.0 ha integrated farming system

### *Soil studies through integrated farming system model*

Different 4 cropping systems and multistoried horticulture with vegetables crops, after harvesting its residue incorporated into soil. Soil fertility can be further improved by incorporating crops that add organic matter to the soil, which leads to improved soil structure and promotes a healthy, fertile soil by growing legumes to fix nitrogen from the air through the process of biological nitrogen fixation; by micro-dose fertilizer applications, to replenish losses through plant uptake and other processes; and by minimizing losses through leaching below the crop root-

**Table 2.** Gross returns (× $10^3$ ₹/allotted area) of different farm enterprizes and their per cent share to total gross returns of 1.0 ha integrated farming system model

| Year | Total gross returns | Gross returns from crop | % share | Gross returns from horticulture | % share | Gross returns from livestock | % share | Gross returns from boundary | % share |
|---|---|---|---|---|---|---|---|---|---|
| 2010–11 | 170 | 135 | 79.39 | 31 | 18.23 | 0.00 | 0.00 | 4 | 2.38 |
| 2011–12 | 332 | 162 | 48.83 | 39 | 11.77 | 124 | 37.36 | 7 | 2.04 |
| 2012–13 | 331 | 151 | 45.58 | 41 | 12.24 | 128 | 38.62 | 12 | 3.56 |
| 2013–14 | 431 | 152 | 35.23 | 42 | 9.84 | 224 | 51.84 | 13 | 3.09 |
| 2014–15 | 585 | 180 | 30.79 | 58 | 9.83 | 150 | 25.68 | 197 | 33.70 |
| 2015–16 | 503 | 175 | 34.89 | 62 | 12.40 | 146 | 29.02 | 119 | 23.69 |
| 2016–17 | 440 | 157 | 35.56 | 54 | 12.17 | 129 | 29.18 | 102 | 23.10 |
| Average | 399 | 159 | 44.33 | 47 | 12.35 | 129 | 30.24 | 65 | 13.08 |

**Table 3.** Net returns (× $10^3$₹ /allotted area) of different farm enterprizes and their per cent share to total gross return of 1.0 ha integrated farming system model

| Year | Total Net returns | Net returns for crop | % share | Net returns for horti. | % share | Net returns for livestock | % share | Net returns for boundary | % share |
|---|---|---|---|---|---|---|---|---|---|
| 2010–11 | 105 | 87 | 83.21 | 15 | 14.76 | 0 | 0.00 | 2 | 2.04 |
| 2011–12 | 188 | 113 | 60.02 | 24 | 12.68 | 45 | 23.70 | 7 | 3.60 |
| 2012–13 | 162 | 97 | 59.67 | 23 | 14.45 | 33 | 20.21 | 9 | 5.67 |
| 2013–14 | 239 | 93 | 39.09 | 24 | 10.13 | 111 | 46.39 | 10 | 4.39 |
| 2014–15 | 361 | 116 | 32.08 | 36 | 9.89 | 17 | 4.61 | 193 | 53.42 |
| 2015–16 | 313 | 112 | 35.64 | 41 | 13.02 | 45 | 14.31 | 116 | 37.04 |
| 2016–17 | 208 | 72 | 34.47 | 20 | 9.84 | 19 | 9.30 | 96 | 46.39 |
| Average | 225 | 98 | 49.17 | 26 | 12.11 | 38 | 16.93 | 62 | 21.79 |

**Table 4.** Soil properties (0–15 cm soil layer)

| Parameter | Cropping systems | | | | Horticultural systems | | Initial soil properties (2010–11) |
|---|---|---|---|---|---|---|---|
| | CS 1 | CS 2 | CS 3 | CS 4 | HS 1 | HS 2 | |
| Bulk density ($Mg/m^2$) | 1.469 | 1.465 | 1.474 | 1.474 | 1.448 | 1.464 | 1.48 |
| *p*H | 7.63 | 7.71 | 7.73 | 7.67 | 7.46 | 7.17 | 7.65 |
| Electrical conductivity (dS/m) | 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 | 0.4 | 0.33 |
| Average P (kg/ha) | 19.73 | 19.13 | 18.72 | 18.75 | 19.34 | 20.21 | 18.60 |
| Average K (kg/ha) | 178 | 174 | 176 | 176 | 186 | 184 | 172 |
| Average 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 | 0.79 | 0.78 | 0.75 | 0.75 | 0.74 | 0.68 |
| DTPA-extractable Cu (mg/kg) | 0.85 | 0.87 | 0.87 | 0.85 | 0.87 | 0.78 | 0.78 |

$CS_1$, Caster + greengram; $CS_2$, Groundnut-wheat multicut fodder pearlmillet; $CS_3$, Greengram-Indian mustard-pearlmillet; $CS_4$, Hybrid napter + fodder cowpea–Lucerne + Fodder chicory; $HS_1$, Horticulture based system; $HS_2$, Vegatables system

ing zone by improved water and nutrient application. After 7 years data (Table 4), all soil properties improved than their initial status. Among different cropping systems, green gram–mustard–pearl millet (0.24) cropping systems showed the maximum improvement in organic carbon (0.41 %) and micronutrients than the other cropping systems, but maximum available P and K were found under greengram + castor cropping systems.

## CONCLUSION

The results of 7 year IFS experiment revealed that, yearly average net returns (₹225,157/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 agriculture and has 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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