

Integrated farming system models

for arid and semiarid rainfed regions

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Rainfed agriculture accounts to about 52% net sown area in diverse agro-ecologies contributes over 40% to our food basket, supports 40% of human and 60% of livestock populations. Due to ever increasing population and decline in per capita availability of land in the country, practically there is no scope for horizontal expansion of land for agriculture. Only vertical expansion is possible by increasing cropping intensity or by integrating farming components requiring lesser space and time and ensuring reasonable returns to farm families. Integrated Farming Systems (IFS) approach is described as 'A judicious mix of two or more components using cardinal principles of minimum competition and maximum complementarities with advanced agronomic management tools aiming for sustainable and environment friendly improvement of farm income, family nutrition and ecosystem services. IFS is an economically and environmentally sound diversified production system which may have great potential in doubling farmers' income with careful planning and scientific intervention under Indian context. Integration of field crops, horticultural crops, dairy, fishery, goatry, poultry, duckery and piggery with existing farming systems enhances farm income by many folds. Recycling and intermittent use of products and by-products within the system could save cost to the extent of 45% and even more by reducing the dependency on external inputs.

Keywords: Agroforestry, Arid region, Integrated farming systems, Poultry rearing system, Semi-arid region

IN general, in regions with rainfall of 500 to 700 mm, the farming systems should be based on livestock with promotion of low water requiring grasses, trees and bushes to meet fodder, fuel and timber requirements. In areas of 700 to 1100 mm rainfall, crop, horticulture and livestock based farming systems can be adopted depending on the soil type and the marketability factors. Runoff harvesting is a major component in this region in the watershed-based farming system.

IFS Model for Arid Regions

Arid regions of Rajasthan endowed with some of the most drought hardy crops, multi-purpose trees [e.g. *Prosopis cineraria* (L.) Druce (khejri) and *Ziziphus mauritiana* Lam. (ber)], grasses (e.g.

Cenchrus ciliaris L., *Lasiurus scindicus* (Henrard), and breeds of cattle (e.g. 'Tharparkar', 'Kankrej') and small ruminants (Marwari sheep and goat). Owing to risky crop production, land is put to alternate uses with perennial components like agroforestry, agri-horticulture, agri-pasture, horti-pasture, farm forestry etc. At ICAR-CAZRI, Jodhpur with 250–400 mm rainfall an IFS model for 5–7 ha farm holding arable cropping (20%), agroforestry (30%), agri-horticulture (20%), silvi-pasture (10%) horti-pasture (10%) and boundary plantation (10%) has been recommended. In the livestock component, 'Tharparkar' cattle [0.75 adult cattle unit (ACU)/ha] and 'Marwari' sheep and goat (3 animals/ha) found rational to fully utilize family labour and available fodder.

Moisture conservation practices are indispensable component of the model. The expected net returns calculated from this IFS model are 70,000/ha with a payback period of 5 years at an (IRR) of 33%. This IFS model is expected to generate employment to the tune of 130 mandays/ha. This diversification is also equally effective to provide ecosystem services, viz. enhanced biodiversity, carbon-sequestration, fuel-wood production and greenery in the desert.

IFS model for semi-arid regions

In Ananthapuramu district of Andhra Pradesh with the mean annual rainfall is 553 mm, it was found that farmers with cropping activity alone incurred losses due to poor yield of pigeonpea and



Fig. 1. Kadaknath poultry in two tier integrated farming system.



Fig. 2. Duplex system of housing poultry.

groundnut, sometimes even failure of crops, as a result of drought/prolonged dry spells during crop growing season. However, integration of sheep rearing with crop production gave higher economic returns compared to crop production alone for both marginal and small farmers. On farm studies indicated that ram lamb rearing farmers were benefited by getting additional income of ₹ 300-400 per sheep per month after harvest of groundnut. By investing ₹ 3,000 per ram lamb and rearing for about five months, net profit of ₹ 500-2,000 could be realized. Depending upon the financial capacity of the farmers can rear 20 to 50 ram lambs for more profitability. Rearing black Bengal goat is also profitable due to highly prolific (twinning character), resistant to common diseases, thrive on meagre feeding conditions (browsers like sheep), and can produce excellent-quality meat within a short span (6-8 months). By rearing one female and a male goat costing about ₹ 6,000, a net profit of ₹ 9,000 could be realized in a span of one year. Due to high labour cost in grazing, stall feeding of ten ram lambs with harvested groundnut haulms and horsegram bhusa for five months was remunerative and profitable farming system compared to that of growing groundnut alone.

Two integrated farming systems, viz. (1) Crop + Dairy and (2) Crop + Dairy + Horticulture (4 and 8 farmers and 0.86 and 1.28 ha mean area, respectively) were identified for

on-farm evaluation of farming system modules for improving profitability and livelihood of small and marginal farmers in Northern transitional tract of Dharwad district, Karnataka. Crop + dairy and crop + dairy + horticulture systems, the average gross returns (₹ 1,61,425 and 2,50,330 per household) were 71 and 74% higher than the respective benchmark values (₹ 94,175 and ₹ 1,43,615) and average net returns were (₹ 78,810 and ₹ 1,46,560 per household respectively) 37% and 67% higher than the respective benchmark values (₹ 57,580 and 88,025). Added to this, newly introduced module of processing and value addition contributed, 13% and 11% to total gross returns in crop + dairy and crop + dairy + horticulture, respectively. In spite of this, significant enhancement in gross and net returns is highly encouraging. Family nutrition was improved because of introduction of soybean (40% protein and 20% oil) and peas, vegetables like lady's finger and cucumber, increased food grains and milk yields, butter and butter milk availability. Livestock nutrition was also improved because of introduction of perennial green fodder, azolla as feed, mineral mixture and salt cake, soybean (grain and haulm) and maize (grain) as cattle feed.

In Western zone of Tamil Nadu on crop - livestock - silvi pastoral farming system revealed that, rotational grazing of 39 numbers of sheep per ha is optimum stocking

density to graze in the silvipasture land with *Cenchrus setigerus*, *Stylosanthes hamata*, fodder sorghum and fodder system with sheep (5+1) and buffalo (2 Nos.) and this was the best promising IFS, which generated the highest system productivity, employment generation and net returns.

Organic Farming System model for improving productivity and livelihood of tribal areas:

Promotion of organic farming in niche locations especially low nutrient consuming tribal areas have great scope to enhance soil and crop productivity along with livelihood for the people. A 0.43 ha organic farming system model comprising of cereals, viz. rice and maize, pulses and oilseeds, viz. soybean, lentil and pea, vegetable crops, viz. french bean, tomato, carrot, okra, brinjal, cabbage, potato, broccoli, cauliflower, chilli, coriander, fodder, fruits, viz. Assam lemon and papaya, dairy (1 cow + 1 calf) and a farm pond of 0.04 ha with depth of 1.5 m for life saving irrigation and fisheries was developed at Umiam, Meghalaya under Network Project on Organic Farming (NPOF) for improving the productivity and livelihood. FYM (6 t) and vermicompost (2 t) generated within the system could able to meet the nutrient requirement of all the crops. Total net returns of ₹ 58,321/year could be realized which is 5.7 times higher than existing system (Rice-fallow + dairy (1 cow) being practised in the local areas. Crop component contributed 57% towards

net income while dairy and fisheries contributed 22 and 21% respectively.

Agro-forestry based Integrated farming system:

A field demonstration on IFS with watershed approach was conducted on red sandy loam soil at GKVK, Bangalore, Karnataka. One ha land with five block were used for cultivation of food crops (Field bean, Finger millet, Groundnut, Niger, etc.), dryland orchards (sapota, cashewnut and mango), fodder crops (napier grass, alley cropping of sesbania, glyricidia, subabul, calliandra and drumstick), commercial crops including flower crops (rose, jasmine and crosandra) and vegetable crops (radish, lady's finger, brinjal, etc.) and kitchen garden as a part of subsistence farming. Farm pond of 250 m³ was excavated to utilize the runoff water. Forage tree species, viz. *Moringa olifera*, *Glyricidia sepium*, *Sesbania grandiflora*, *Calliandra calothyrsus* and *Leucaena leucocephala* were planted on bunds for getting balanced forage yield during lean and regular season. Dairy consisting of two milch animals along with sheep, fisheries and backyard poultry has been established to overcome short term expenditure and income. After sixth year, there is sustainable increase in net profit of ₹ 87,900 with benefit cost ratio of 3.04 apart from generating employment of 462-man days under rainfed condition. Glyricidia on bunds recorded large quantity of green biomass of 5.5 t/ha resulted in production of required quantity of compost 4.9 t/ha which in turn helped in improving soil health and reduced dependency on external inputs and reducing the cost of cultivation.

On Land capability class (LCC) IV lands, soapnut is the only tree that withstands low rainfall and with slopy (8-15%) topography. Since tamarind comes to fruiting only in well distributed rainfall years, it should be integrated with pasture (*Stylosanthes*) and sheep rearing components as horti pastoral system



Fig. 3. Two tier integrated farming system unit.

on sloppy (8-15%) and LCC IV lands. Amla based agri-horti system i.e. amla + groundnut on LCC IV lands integrated with ram lamb rearing found to be appropriate system for higher system productivity, profitability and resource use efficiency for arid Ananthapuramu region.

Enhanced income through high value poultry race Kadaknath

The Indian poultry breed, 'Kadaknath' is popular for its quality meat (texture, flavour etc.) which also has special medicinal value in homeopathy (Fig. 1). Due to these good qualities, the meat fetches high price and is in high demand. The birds gain body weight in short time and attain saleable weight of 1.10 kg in 105-120 days. On an average, by rearing ten days old chicks one hundred birds, a net income of ₹ 90,000-1,00,000/year can be obtained.

Different types of units for livestock maintenance

1. Duplex Poultry Unit

The Duplex Poultry Unit is an agri-innovation to rear the backyard poultry in a safe and secure condition. This unit is portable, designed and fabricated at Agricultural Research Station, Vizianagaram, Andhra Pradesh, with specifications of 4 × 8 × 4.5 feet size made up of

Zinc material and rust proof (Fig. 2). It is suitable to rear 15-20 backyard poultry birds with security from dogs, jackals, neighbors with less attention. The 4 weeks old Rajasri birds were evaluated for 10 months with 36 farmer's households, 30 birds (20 female and 10 male) each family. The 10 female and 5 male birds reared in control group in Duplex Poultry Unit and provided with feed and water regularly in confinement whereas another 10 female and 5 male birds were reared conventionally in open range and were provided with shelter during night only. The birds were reared in Duplex Poultry Unit were 100% secure from dogs and jackals. Whereas, the birds reared in open range were taken away by these animals. The birds population reared in the open range rearing was reduced 47%. Further, the performance of birds reared in Duplex unit was superior with 54.5%

Table 1. Economics of two tier ram lamb and poultry integrated farming system

Particulars	Unit-I	Unit-II
No. of ram lambs	20	50
No. of poultry	100	200
Total fenced area	900sft (30ftX30ft)	2500sft (50ftX50ft)
Estimated cost @ ₹ 500/sft	₹ 1,00,000	₹ 2,25,000
Cost of ram lambs	₹ 50,000	₹ 1,25,000
cost of concentrate feed, haulms Medicine and miscellaneous for 6 months	₹ 30,800	₹ 72,000
Cost of chicks	₹ 7,500	₹ 15,000
Cost of feed, medicines and miscellaneous for 6 months	₹ 7,000	₹ 14,000
Total Expenditure	₹ 95,300	₹ 2,26,000
From sale of ram lambs (10% mortality)	₹ 1,08,000	₹ 2,70,000
Sale of poultry birds (10% mortality)	₹ 27,000	₹ 54,000
Total income	₹ 1,35,000	₹ 3,24,000
Net income for 6 months	₹ 39,700	₹ 98,000
Net income per month	₹ 6617	₹ 16333

higher egg production and 57.3% higher meat production and 56.5% higher gross returns as compared to that of birds reared in open range.

ii) Two Tier Integrated Farming System:

The profitability of the IFS varies depending on integration of traditional farming practices upon the local factors of demand and supply of livestock products and utilization of the common property resources of the region. Two tier farming system model has been established at Krishi Vigyan Kendra, Yagantipalle, Kurnool district, Andhra Pradesh where 50 Black Bengal Goats and 200 poultry are accommodated in 2500 sq. feet area (Fig. 3).

Features and advantages of two tier farming system unit:

- Total area allotted for the system is 2500 sq. feet which is completely protected (Table 1).
- Elevated wooden floor shed constructed in an area on 350 sq. feet and accommodated 50 black Bengal goats. One woman labour is engaged for caring.

- Scope for intensive rearing of ram lambs/sheep/goat throughout the year.
- The floor remains dry in all seasons and hence the problem of broncho-pneumonia can be prevented. Less chances of ectoparasite infestation to the animals.
- Growth rate can be improved by 30% and mortality can be reduced to below 2%
- Habit of scavenging in the poultry through turning makes the faecal matter dry thus avoiding fowl or ammonia smell from the litter.
- Poultry birds can get natural protein from open area and hence the additional feeding cost can be reduced.

SUMMARY

Strengthening of the traditional farming systems can be done with crop diversification, inclusion and improvement of livestock, horticulture crops, kitchen garden with primary and secondary processing, boundary plantations for improving the farm income of small holders in arid and semiarid regions.

This also paves a way to meet the household balanced diet, improved recycling of nutrients and water besides increasing the on-farm employment for family. A productivity gain of 2 to 3 times and income gain of 3 to 5 times (enhancing the income of household to the level of at least ₹ 400-500/day) is possible with improved integrated farming systems in rainfed regions. Further, resource saving of 40-50% can also be ensured. Additional employment of 70-80% can be generated. Improved diversified systems also ensure household nutritional security. Most importantly, the improved integrated farming systems are better resilient than the single commodity-based production system, thus reduce climate risks in arid and semiarid regions.

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Livestock based Integrated farming systems for semi-arid Bundelkhand farmers

Five resources based and farmer specific IFS models (2 for rainfed and 3 for irrigated farmers) each of one ha size were developed and demonstrated by IGfRI, Jhansi to enhance the livelihood of Bundelkhand farmers. The models are irrigated intensive IFS with balanced enterprise combinations (for resource rich farmers), irrigated dairy based IFS with greater emphasis on milch animals and fodder (for dairy farmers), high value IFS with greater emphasis on high value crops like vegetables and fruits (for peri-urban and farmers near cities/market), rain-fed crop dominated IFS with greater emphasis on rainfed crops and water harvesting (rainfed crop based farmers) and rainfed livestock dominated IFS with focus on livestock, rainfed fodder and crops and water harvesting (for rainfed livestock based farmers). Among the irrigated IFS models, dairy based IFS resulted in the highest net return (₹ 162,593), employment (431 man-days/year) and resource recycling followed by intensive IFS with balanced enterprises (₹ 108,638 and 336 man-days/year, respectively) while the B:C ratio was the highest in intensive IFS with balanced enterprises (1.58) followed by dairy based IFS (1.52). On the other hand, among the rainfed models, highest net return (₹ 37,424) and B:C ratio (2.03) was observed in rainfed crop dominated IFS as compared to rainfed forage dominated IFS. The average annual income of irrigated and rainfed farmers in Bundelkhand region is ₹ 80,000 to 10,000 and ₹ 25,000 to 30,000, respectively, which can be enhanced to ₹ 1,60,000 and ₹ 40,000 by adopting dairy and rainfed IFS models, respectively. IGfRI is also simultaneously promoting above IFS models on fields of representative farmers in the area and planning for further up-scaling on larger scale through other inter-institutional programmes.



View of water harvesting pond and rainfed IFS

(Source: ICAR Annual Report 2020)