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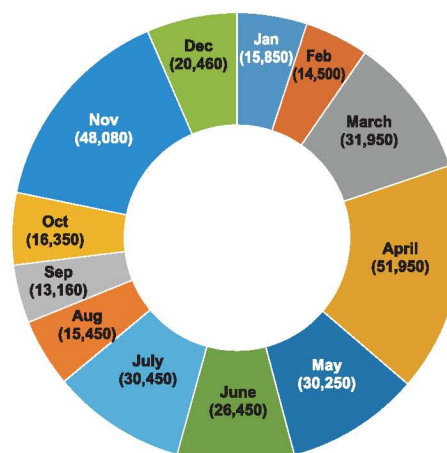
## Farming System

Farming system approach signifies optimization of various components and their integration in a multi-enterprise mode for sustainable production under diverse situations and farm categories. Location-specific Integrated Farming Systems (IFS) not only increase system productivity, profitability and livelihood security of the farming community but also help in resource conservation and mitigating risks and uncertainties. There is growing consensus that world hunger and poverty could be drastically reduced by supporting smallholder family farming. Consistent with this, the year 2014 has been declared as the 'International Year of Family Farming' (IYFF) by the United Nations. The IYFF aims at promoting international awareness, builds on existing country and/or regionally led initiatives and strengthens contribution of family farmers and smallholders for sustainable agriculture development.

**Family farming model for nutrition and round the year income:** A five member family farming model on one hectare plot comprising diversified cropping systems [(0.78 ha) + horticulture (0.14 ha) + dairy (2 cows) + goat (11 no.) + fish (0.1 ha) + ducks (25 no.) + boundary plantation (225 subabul plants and 50 *Moringa* plants)] in the South Bihar Alluvial Plain zone in middle Gangetic Plains provided round the year income (₹ 13,160 to 51,950/ha/month). Diversified cropping systems [rice–wheat–greengram (grain + residue incorporation), rice–maize + potato–cowpea (fodder), rice–mustard–maize (grain) + cowpea (fodder), sorghum + rice bean – berseem/oat–maize + cowpea (fodder) and seasonal vegetables (brinjal, tomato, cauliflower, cabbage, vegetable pea, okra, lettuce)] grown in 0.78 ha area (unreplicated) could meet the entire family requirement of 1100, 95, 125, 185 and 640 kg of cereals, pulses, oilseeds, fruits (guava and papaya) and vegetables and the livestock requirement of 29.5 and 6.6 tonnes of green and dry fodder per annum. The model also meets the milk, egg and fish



Crop+horticulture+dairy+goat+fish+duck+boundary plantation family farming model at AICRP on IFS centre, Sabour (Bihar)



Round the year net income (₹/ha) for the family from crop (0.78 ha) + horticulture (0.14 ha) + dairy (2 cows) + goat (11 no's) + fish (0.1 ha) + ducks (25 no's) + boundary plantation (subabul and moringa) farming system model at Sabour (Bihar)

requirements (550 l, 900 no. and 120 kg respectively) of the family. Besides meeting the family and livestock requirement, the model produced marketable surplus of cereals (4810 kg), vegetables (986 kg), fruits (35 kg), milk (4243 l), egg (950 no) and fish (124 kg), which resulted in round the year income. The model also ensured fuel wood availability of 4 tonnes/year and could add 4 tonnes of enriched vermicompost and 2.3 tonnes of manure. The value of recycled products and by-products worked out to ₹ 1.29 lakh which reduced the total cost (₹ 3.1 lakh) of the model by 42% and family labour (730 man days) saved another 37% of the cost; only 21% (₹ 0.68 lakh) of total cost was incurred in the form of inputs purchased from market. The total net return was ₹ 3.14 lakh, which is 3.2 times higher than existing pre-dominant crop+dairy system of the zone.

**Resource recycling in crop + horticulture + dairy + poultry + fish model:** Integrated Farming System (IFS) model for 1 ha plot developed for Vindhyan zone (UP-8) in Eastern Himalayan region comprised diversified cropping systems (0.81 ha), horticulture (0.06 ha), dairy (6 cows), poultry (200 numbers in 6 batches) and fishery (0.10 ha). The diversified cropping systems (rice–wheat–greengram, rice–barley–greengram, rice–mustard–blackgram, bottle gourd–cabbage–sponge gourd, sudan chari–berseem + mustard–sudan chari, pigeonpea + pearl millet–sudan chari) aimed at better recycling of products besides meeting 100% requirement of food and fodder. Boundary plantation (200 karonda trees and 50 banana plants), mushroom (only button during winter) and vermicompost production were income supplementing activities. The value of products





Crops+horticulture+dairy+poultry+fishery model for efficient resource recycling at AICRP on IFS centre, Varanasi (Uttar Pradesh)

recycled into the system worked out to be ₹ 1.92 lakh which reduced cost by 39%. The value of marketable surplus after meeting the household need of a 7-member family stood at ₹ 1.97 lakh/annum. A net return of ₹ 2.59 lakh/ha/year can be obtained from the model. The model recorded 3.2 times higher net income than the prevailing farming system (crop + dairy) of the region.

**Agroforestry system for carbon neutral households:** Emission of greenhouse gases (GHG), viz. CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from farm households in Meerut district was assessed. The total mean emission of GHGs (CO<sub>2</sub>-equivalent) from farm households in the western plain zone of Uttar Pradesh was 9.76 tonnes/farm household/year with net emission of 6.16 tonnes/farm household/year. Among different emission sources, livestock contributed 58.2%, followed by agricultural soils (22.5%) through N application, farm households (11.4%), farm operations (5.78%), residue burning (1.35%) and paddy cultivation (0.8%). Adopting agroforestry with 273 trees per farm household of size 2.07 ha will make the households 'carbon neutral'. Further, by adopting balanced fertilization, better livestock management, reducing farm operations and adopting energy efficiency measures by farm families can make the farm households 'carbon negative' by 1.18 tonnes CO<sub>2</sub> equivalent/farm household/year in the district.

**Conservation agriculture for productivity enhancement:** A field experiment was conducted during 2010–13 in the sandy loam soil to study the effect of Conservation agriculture (CA) practices and balanced fertilization on the performance of maize (DHM 117)-horsegram (CRIDA 18R) cropping sequence and to evaluate the impact of CA on nutrient use efficiency and profitability. Pooled data showed that grain (3.8 tonnes/ha) and stover (5.6 tonnes/ha) yields in maize in CA was at par with conventional tillage (CT). Significantly higher grain (5.3 tonnes/ha) and stover (6.5 tonnes/ha) yields were realized with balanced fertilization with NPKSZnB compared to seed yield (3.8 tonnes/ha) and stover (5.6 tonnes/ha) with CT. In case of horsegram, significantly higher yields were obtained in CA (0.36 tonne/ha) compared to CT (0.24 tonne/ha). Maize equivalent yield (4.37 tonnes/ha) was higher in CA.

**Post-emergence herbicides for control of *Cyperus rotundus*:** Infestation of purple nutsedge (*Cyperus rotundus*) during the initial growth stages of summer greengram is adversely affecting crop productivity. Herbicides, viz. quizalofop-p-ethyl @ 60 g/ha and imazethapyr @ 100 and 150 g/ha applied at 25 days after sowing significantly reduced the density of purple nutsedge at 50 days. Hoeing was not effective because of underground tubers and corms of purple nutsedge. Maximum seed yield was recorded with imazethapyr @ 150 g/ha, which was at par with its lower dose and quizalofop-p-ethyl application.

**Intercropping with horticultural crops:** An integrated farming system consisting of one hectare of coconut (var. West Coast tall, 40 years old, 175 palms/ha, 140 nuts/palm/year) with livestock components generated about 24,500 nuts, 11,229 litres of milk, 1,020 quail bird eggs, 5,854 hen eggs, 2,009 kg banana, 362 kg pepper and 80 kg goat meat, with a net income of about ₹ 311,490, further establishing its profitability and sustainability.

Green bajra (Napier hybrid, CO 4) recorded maximum fodder yield of 102 tonnes/ha/year with integrated nutrient management (50% organics produced in the system and 50% inorganics) followed by 96 tonnes/ha/year with fully organic practice. Evaluation of organic cultivation of coconut in coastal agro-ecosystem showed that organic treatments recorded significantly higher nut yield. Complementary role of intercropping was evident from higher coconut productivity under cropping system treatments compared to monocropping of coconut.

Economic analysis of an arecanut based mixed farming system indicated that the net income from the dairy unit with 3–5 milch cows gradually increased from ₹ 17,800 to 2.24 lakh/year over a period of five years.

For promoting precision farming in coconut, soil fertility/deficiency maps were developed for the littoral sandy (CPCRI farm at Kasaragod) and Onattukkara sandy soils (Kayamkulam). Site-specific nutrient management strategies based on the soil nutrient status were evolved.

Rice–potato–wheat system, under a long-term manurial/fertilizers trial, recorded higher productivity (9.7 and 18.5% over maize–potato–onion and groundnut–potato–moong bean cropping system).

Rice–blackgram–short duration cassava was profitable and generated added returns of ₹ 1.5–1.8 lakh/ha over sole cassava. Rice–greengram–short duration cassava and rice–soybean–short duration cassava were also feasible giving an added profit of ₹ 1 lakh/ha over sole crop. There was a possibility to reduce full P, half FYM and N to cassava in these systems.

Organic farming produced 31% higher yield over conventional practice in dwarf white yam by the third year, though production systems did not vary significantly. Organic farming was equally stable as that of conventional practice in yield stability index analysis of the long-term performance of organic vs





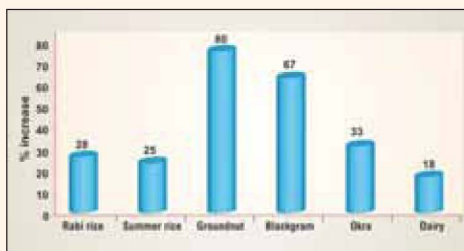
## Success story

### Realizing respectable revenue through farming system approach

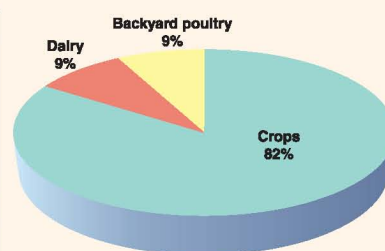
The AICRP on Integrated Farming Systems at the Dryland Agricultural Research Station, Chettinad (Tamil Nadu Agricultural University) adopted 60 farm households in Sivagangai district of Tamil Nadu for on-farm farmer participatory research in farming systems involving low and no cost interventions. The average annual rainfall in the area is 940 mm with rice-rice as the predominant cropping system. Shri Francis Pritto, a marginal farmer who hails from a small hamlet (Ammayenthal) located in Thirupathur block, deriving livelihood from 1 ha land for his six member family (2 adults and 4 children), was one of the beneficiaries. He used to grow rice during the monsoon season followed by blackgram, groundnut and vegetables (okra) during summer and maintained two crossbred cows and a calf, besides *desi* poultry birds in the backyard. The annual net income obtained from marketable surplus of all components was only ₹ 75,230/year with a net return of ₹ 1 per rupee invested.



Seed drill sowing of groundnut to maintain spacing



Improvement in yield of grain and milk due to constraint specific interventions



Post-intervention contribution of components of farming system to net income

Production constraints were identified by the AICRP staff and improved system based packages were advocated to resolve them, which included introducing high yielding varieties and hybrids (MDU 5 rice, VBN 5 blackgram, VRI 7 groundnut), soil test crop response (STCR)-based fertilizer application for all crops including foliar nutrition with 'TNAU groundnut consortia' and 'TNAU pulse wonder' during 50% flowering stage, and pest surveillance based IPM strategies which include traps and bioinoculants. Seed drill sowing of rice (direct seeded rice against transplanted rice), cultivation of blackgram and groundnut and early post-emergence herbicides such as Bispyribac Sodium and Azimsulfuron, Imazethapyr and Quizalofop-ethyl in rice and pulses were demonstrated. Year round supply of green fodder for livestock with bajra Napier Hybrid CO 5, supplementation of area and species-specific mineral mixture, artificial insemination (AI) with Jersey and HF semen, and deworming at regular intervals resulted in additional milk yield of 0.9 L/animal/day, increased the lactation period (224 days) and reduced inter-calving intervals considerably (339 days). Dual purpose chicks, NKL (Namakkal) 1 and Giriraja with proper vaccination, resulted in additional income of ₹ 2,800 for the family. Azolla and vermicompost production with low cost portable Silpaulin bags were also integrated as additional options. Yield improvement in crops and dairy was in the range of 18 to 80%. The household earned net income of ₹ 119,470/year with a net return of ₹ 1.51 per rupee invested. Crops contributed bulk of the income (82%).

conventional management in yams and aroids over a five year period. Among the different organic manures tested to substitute FYM, green manuring *in situ* with cowpea was the best, recording a tuber yield of 31.90 tonnes/ha, which was significantly superior to FYM @12.5 tonnes/ha (24.90 tonnes/ha). Sustainability of cassava was established through continuous cultivation without manures and fertilizers from the same field for 23 years with an average yield of 12.14 tonnes/ha.

**Participatory sea cage farming:** Participatory sea cage farming of cobia, *Rachycentron canadum* was undertaken by two SHGs at Gulf of Mannar. About 1,800 cobia seeds of 20–30 g size were stocked in four circular GI cages of 7.0 m diameter and 3.5 m depth at a density of 4.1/m<sup>3</sup>. They were fed *ad lib* twice a day. In farming period of seven months they attained size of about 2.0–3.5 kg with FCR of about 5.9 giving total production of four tonnes. The farmers invested ₹ 134/kg and at farm gate price of ₹ 250/kg could generate net income of ₹ 464,000. Additional, participatory sea cage farming of cobia is being

undertaken at Tamil Nadu, Karnataka, Kerala, Goa and Maharashtra. Sea cage farming of other species undertaken in participatory mode includes silver pompano in districts Pedda Kammavaripalem, Nagayalanka and Krishna in Andhra Pradesh and spiny lobster at Kovalam, Chennai in Tamil Nadu and Veraval in Gujarat.

**Watershed interventions for enhancing groundwater recharge and water use efficiency:** An initiative was taken to develop technological options in participatory mode for sustainable agricultural production through integrated watershed interventions in Parasai-Sindh Watershed, Jhansi. To develop agroforestry interventions in the watershed, 9,954 seedlings of different species were planted on 57 farmers' fields/households and its survival varied from 55 to 72% by the end of December 2013. Teak based agroforestry (bund plantation) was scaled up to 60 ha. Wheat was shown in majority of the agricultural land (88.4%) followed by mustard and chickpea. During *kharif* 2013, participatory demonstration of soybean;