

Sugarcane based integrated farming

system models for enhancing farmers' income and livelihoods

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Indian agriculture plays a vital role in India's economy (54.6% of the population is engaged in agriculture contributing 17.4% to the country's Gross Value Added Product) and as a whole is undergoing several transformative changes. Growing population, changing lifestyles, expanding urbanization and accelerating climate changes are creating new challenges for national agricultural research and development. Sugarcane occupies an important position in agrarian economy of India. It is grown in diversified cropping systems under varying edaphic and climatic conditions. As a result, not only sugarcane production fluctuates over the years but also the cost per tonne of cane produced varies considerably. The different sugarcane based farming system models for enhancing the farmer's income and livelihoods, have been discussed.

Keywords: Cropping system, Income, Integrated farming, Sugarcane

THE goal of sugarcane farming system is to produce sustainable sugarcane to meet society's sweeteners requirement, food, energy and biofuel needs in the present without compromising the ability of future generations to meet their own

needs. Practitioners of sustainable sugarcane farming seek to integrate three main objectives into their work, viz. a healthy environment, economic profitability, and social and economic equity. Every person involved in the food system—growers, sugar

industry, food processors, distributors, retailers, consumers, and waste managers—can play a role in ensuring a sustainable cane farming system. About 7 million farmers, their dependents and large number of agricultural labours are involved in the cane cultivation. Being an important agro-industrial annual

crop, sugarcane involves more than 50 million skilled and unskilled workers for various activities. The area under sugarcane during 2017-18 soared up to 5.04 million ha and produced 411 million tonnes of cane with an average productivity of 81.5



Sugarcane + Maize (for green cobs) intercropping system



Banana cultivation in sugarcane based farming system



Sugarcane + Fenugreek intercropping



Sugarcane + Coriander intercropping

tonnes/ha. Weakening of the traditional joint family concept combined with unchecked linear growth in human population lead to indiscriminate fragmentation of land holdings. Per capita availability of land in India has declined from 0.5 ha in 1950-51 to 0.12 ha in 2015-16. Small and fragmented land holdings do not allow a farmer to

keep independent farm resources and other sophisticated machineries for various cultural operations. Further, most of the inputs have become costly and out of reach of the resource poor farmers making farming an uneconomic and unsustainable enterprise. Farming system in sugarcane agribusiness may hold promise to mitigate such problems and may prove as resource management strategy to enhance the income and sustained production of farm households while preserving resource base and maintaining a high level environmental quality. In view of changing market scenario, consumers' preferences and global competitions, new income generating opportunities need to be created through crop diversification in sugarcane 'Produce to Product Chain'. This would help in increasing the land utilization efficiency, reducing the production cost,



Sugarcane + Garlic

economizing the use of market purchased costly inputs and making plant-ratoon system sustainable. Farming System refers to a particular arrangement of farming enterprises that are managed in response to physical, biological and socio-economic environment and in

accordance with farmer's goals, preferences and resources. The household, its resources and the resource flows and interactions at the individual farm levels are together referred to as a farm system. The Farming System, as a concept, takes into account the components of soil, water, crops, livestock, labour, capital, energy and other

resources with the farm family at the centre managing agricultural and related activities. The farm family functions within the limitations of its capability and resources, the socio-cultural setting, and the interaction of these components with the physical, biological and economic factors.



Karonda planting on S-IFSR field boundary



Oyster mushroom cultivation in S-IFSR based farming system

Apart from sugarcane based intercropping systems, components of the farming systems viz. horticulture, apiary, and plantation crops (banana, papaya etc.) along with intercropping in sugarcane crop may increase net profit significantly. This in turn raises the socio-economic status of small and marginal resource constrained farmers and generates employment especially for rural women and youths, which also help mitigate the goal of doubling the farmers' income. The information of sugarcane based intercropping with cereals, pulses and oilseeds are available, however, research on intercropping of high value crops and its integration with other agricultural enterprises is meagre. Considering above points different sugarcane based farming

2018-2019 at ICAR-Indian Institute of Sugarcane Research, Lucknow. Different farm size holdings and components of farming systems were taken into consideration. The technical programme of the integrated farming system models is given as below:

- Area of the IFS model : 1 ha (about 2.5 acre)
1.5 acre
1.0 acre
- Family size : Seven members

Components of sugarcane based IFS Model

- Sugarcane (Sole)/Intercropping with cereals/pulses/oilseeds/vegetables >(0.6 ha) : > 60% area
- Mushroom, beekeeping and land for house (0.1 ha)

system models were developed for enhancing the farmer's income and livelihoods.

The work on development of sugarcane based integrated farming system models was conducted from 2016-17 to



Bee keeping in sugarcane based integrated farming system

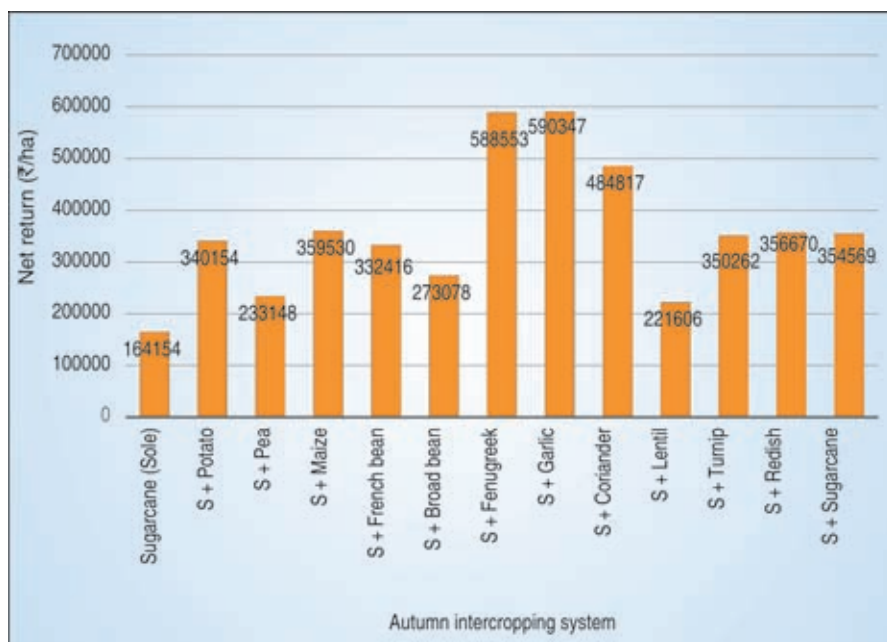
- Horticulture – Banana, Papaya (0.1 ha each) and plantation of fruit crops
- Food/fodder/vegetable and other crops for household use (0.1 ha)
- Karonda (*Carissa carandas*) as boundary plantation (0.1 ha)
- Fish farming
- Duck rearing
- Poultry

During the autumn season, 13 cropping systems, viz. Sugarcane (Sole)- CoPk 05191; Sugarcane + Potato (Kufri Chandramukhi); Sugarcane + Pea (Azad P-3); Sugarcane + Maize (VMH-174); Sugarcane + French bean (Arun); Sugarcane + Broad bean (SWS 1 white); Sugarcane + Fenugreek (Rajendra kranti); Sugarcane + Garlic (Polish white); Sugarcane + Coriander (CO.2); Sugarcane + Lentil (PL-639); Sugarcane + Turnip (Purple Top sultan); Sugarcane + Radish (Clear white); Sugarcane + Sugar beet (LS-6) were tested and respective yield and economic gain were analysed.

Under banana field, three intercropping systems viz. Banana + Tomato (Mansuri); Banana + Brinjal (Pusa purple Long); Banana + Maize (VMH-125) were tested and respective yield and economic gain were analysed. Under apiculture farming, two jangi strat type (*Apis mellifera*) boxes were maintained. Oyster mushroom was produced under mushroom farming.

Table 1. Income from different farm enterprises

Cropping/Farming system	Income (₹) from 1 ha farm land
Agri (0.7 ha) – horti (0.2 ha) system	500474
Agri: Sugarcane + Fenugreek : ₹ 588553/ha. So, for 0.35 ha = ₹ 205993	
Agri : Sugarcane + Garlic : ₹ 590347/ha. So, for 0.35 ha = ₹ 206621	
Horti: Banana + Tomato: ₹ 439296/ha. So, for (0.2 ha): ₹ 87859	
Agri (0.7 ha) – api (0.05 ha) System ₹ 412614 + ₹ 3000	415614
Agri (0.7 ha) – Mushroom farming (0.05 ha) ₹ 412614 + ₹ 1000	413614
Agri (0.7 ha) – Horti (0.2 ha) – Api System ₹ 412614 + ₹ 87859 + ₹ 3000	503473
Agri (0.7 ha) – Horti (0.2 ha) – Mushroom (0.05 ha) ₹ 412614 + ₹ 87859 + ₹ 1000	501473
Agri (0.7 ha) – Api (0.05 ha) – Mushroom (0.05 ha) ₹ 412614 + ₹ 3000 + ₹ 1000	416614
Agri (0.7 ha) – Horti (0.2 ha)- Api (0.05 ha)-Mushroom (0.05 ha) System ₹ 412614 + ₹ 87859 + ₹ 3000 + ₹ 1000	504473
Income from Sole Sugarcane	164154



Net return (₹/ha) of Autumn sugarcane based intercropping systems
(Mean of 2 years)

Sugarcane based intercropping systems

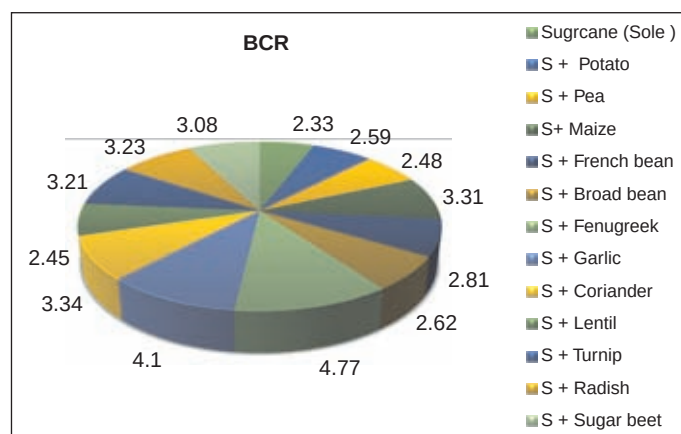
Autumn sugarcane yield (97.2 t/ha) was recorded under sugarcane + fenugreek intercropping system, which was closely followed by sugarcane + garlic (Table 1). The yield of sugarcane was significantly reduced under sugarcane + lentil (80.65 t/ha) and sugarcane + maize (84.50 t/ha) intercropping systems. The dual purpose fenugreek and coriander recorded 127.85 and 233.45 q/ha green leaves yield along with 18.30 and 7.30 q/ha grain yield respectively. Intercropping of autumn sugarcane + garlic fetched significantly highest net income of ₹ 59,0347/ha. The next best treatment was sugarcane + fenugreek (net income ₹ 588,553/ha). The other

intercropping systems found highly remunerative were sugarcane + coriander (net income ₹ 484,817/ha), sugarcane + maize (net income ₹ 359,530/ha) and sugarcane + radish (net income ₹ 356,670/ha). The net income from sole sugarcane was ₹ 164,154/ha. All the sugarcane based intercropping systems recorded significantly higher income than sole sugarcane. The above systems also recorded higher cane equivalent yield (119.00 to 247.95 t/ha) and B: C ratio (2.48 to 4.77). The data on Cane Equivalent Yield (CEY), which is the conversion of monetary benefit gain from the yield of intercrops, equated to the yield of sugarcane showed significant increase under all the intercropping systems. The

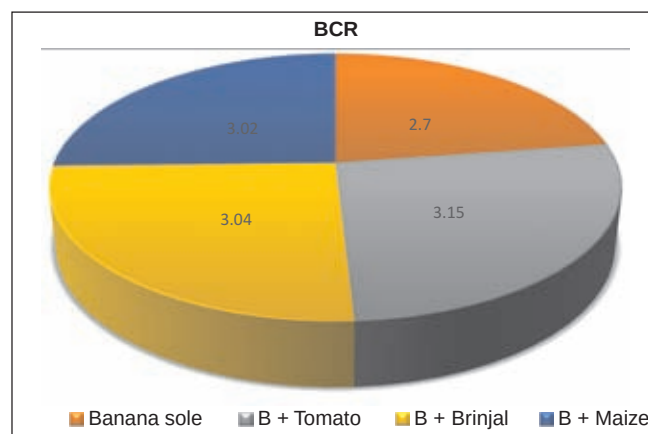
highest CEY (247.95 t/ha) was observed for sugarcane + garlic intercropping system, which was closely followed by sugarcane + fenugreek (236.45 t/ha). Highest Benefit: Cost ratio (4.77) was recorded by sugarcane + fenugreek intercropping system, however sugarcane + garlic fetched B: C ratio of 4.10. The results clearly indicate that autumn sugarcane based intercropping systems hold promise in increasing the net income 2-3 times compared to the sole sugarcane.

Horticultural crop based systems

Banana + Tomato fetched highest net income of ₹ 439,296/ha. The next best treatment was Banana + Maize (net income ₹ 419,499/ha) and Banana + Brinjal (net income ₹ 413,787/ha). The net income from sole banana was ₹ 290,809/ha. The above systems also recorded higher banana equivalent yield (508.2 to 519.7 q/ha) and B: C ratio (3.02 to 3.15). The papaya crop was intercropped with brinjal, onion, radish, french bean, broad bean, fenugreek and dill (soa). The intercropping of fenugreek and dill recorded yield of 270.6 and 147.7 q/ha respectively. The karonda (*Carrissa carandas*) plantation along the field boundary progressed well and recorded 110 kg of the fruits in 2 years. Under apiculture farming, two jangi strat type (*Apis mellifera*) boxes were maintained and 16 kg of honey was produced. Under mushroom farming 17 kg of oyster mushroom was produced.



Benefit Cost ratio of autumn sugarcane based intercropping system
(Mean of 2 years)



Benefit Cost ratio of banana based intercropping system
(Mean of 2 years)



Fishery with duck rearing and poultry



Dairy farming unit



Vermi-composting unit

Farming systems developed

The important agricultural enterprise combinations assessed through computing their net profit are presented in Table 1. The farming

systems developed were:

1. Agri (0.7 ha) - horti (0.2 ha) system (Net income: ₹ 500,474)
2. Agri (0.7 ha) - Api (0.05 ha) system: (Net income: ₹ 415,614)

3. Agri (0.7 ha) - Mushroom farming (0.05 ha): (Net income: ₹ 413,614)
4. Agri (0.7 ha)- Horti (0.2 ha)- Api system: (Net income: ₹ 503,473)
5. Agri (0.7 ha)- Horti (0.2 ha)- Mushroom farming (0.05 ha): (Net income: ₹ 5,01473)
6. Agri (0.7 ha)- Api (0.05 ha)- Mushroom farming (0.05 ha): (Net income: ₹ 4,16614)
7. Agri (0.7 ha)- Horti (0.2 ha)- Api (0.05 ha)- Mushroom (0.05 ha) system: (Net income: ₹ 5,04473)

The net income from sole sugarcane was ₹ 164,154/ha. From the results it is evident that income from farming systems is two to three times of sole sugarcane. The fishery/ poultry/ duckery/ dairy based sugarcane farming system models are under progress. Due to high initial cost of the establishment of different components of the system, these models are not very profitable, however, proved boon for the livelihood of marginal farm holders.

Owing to conversion of valuable irrigated agricultural lands for non-agricultural purposes viz. residential houses, industrial and business establishments and subdivision and fragmentation of holdings, the per capita availability of land is declining day by day. Therefore, no single farm enterprise is able to meet the growing demands of food and other necessities of the small and marginal farmers.

Hence, there is necessity of adoption of Farming Systems approach by these vulnerable sections of sugarcane farming community. Sugarcane based integrated farming systems hold promise in increasing the net income of 2-3 times to the sole sugarcane.

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