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Farming Systems Approach: A Real Time Way for Sustainability and Profitability in Agriculture

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Abstract

Small and marginal farmers are the core of Indian agricultural rural economy consisting 80% of total farming community but possessing only 36% of total operational land holdings. The declining per capita land availability poses a serious challenge to sustainability and profitability of these farmers. Majority of farm holdings are dry lands and even irrigated areas depends on monsoon. If farmers concentrate only on crop production, they will be subjected to high degree of unsustainability in income. Environmental degradation, depletion of soil health, unstable income of the farmer will further add to the intensity of the problem. As there is no scope for horizontal expansion of agricultural land, only alternative approach is for vertical expansion through various farm enterprises requiring less space and time, but, giving high productivity and ensuring periodic income is possible only through Integrated Farming System approach.

1. Introduction

The human population of India has increased to 1.385 billion at a growthrateof1.2% in 2020 and isestimated to increasefurther to 1.52 billion by 2036 with 70% of increase in urban areas.On the other hand, our national food grain production for past 3-4 years is hoveringaround 234 million tones. There are projections that demand for food grains wouldincrease to 355 million tonnes in 2030. The average size of land holding has declinedto 1.21ha during 2009-10 from 2.30ha in 1970-71. Declining size of land holdingswithout any alternative income augmenting the opportunity is resulting in fall offarm incomeandcausing agrariandistress. The current scenario in the country indicates that area under cultivation may further decrease and more than 20% of current cultivable area will be converted into non-agricultural purposes by 2030 (Gill et al., 2005).

The need for farming systems approach in the present scenario is mainly due to high cost of farm inputs, fluctuation in the market price of farm produce, risk of crop harvest due to climatic vagaries

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and biotic factors. To meet the multiple objectives of poverty reduction, food security, competitiveness and sustainability, several researchers have recommended the Farming Systems Approach to research and development.

2. What is Farming Systems Approach and what it does

It is an approach for developing farm - house hold systems, built on the principles of productivity, profitability, stability and sustainability. All the components are complimentary and supplementary to each other and the development process involves participation of rural communities. The Farming Systems Approach emphasizes understanding of farm house hold, community interlinkages, reviews, constraints and assesses potentials and it combines improvements desired from better technology. It needs efficient support services and requires better policies. It is continuous, dynamic and interactive learning process based on analysis, planning, testing, monitoring and evaluation.

3. Farming systems: Concept, Objectives, Principles, Classifications and Strategies

3.1. Concept of Farming Systems

Farming system concept was developed in1970 and it is designed to understand farmer priorities, strategies and resource allocation decisions and is anintegrated set of activities that farmers perform in their farms under their resources and circumstances to maximize the productivity and net farm income on a sustainable basis. In other words, it is an appropriate mixes of farm enterprises and the means available to the raise them for profitability. In its real sense it will help in lifting the economy of agriculture and standard of living of the farmers of thecountry as a whole. Its goal is to develop sustainable land use system which will optimize resource use and increase income and employment for farm families. The integration is made in such a way that the output of one enterprise/ component should be the input for the other enterprises with high degree of complementary effects (Panke et al., 2010). Crop residues can be used for feeding to animal, while enhancing the agricultural productivity should be done through utilization of manure from livestock by intensifying nutrients that improve soil fertility as well as reducing the use of chemical fertilizers (Gupta et al., 2012).

Farming System represents an appropriate combination of farm enterprises (Cropping systems horticulture, livestock, fishery, forestry, poultry etc.,) and the means available to the farmer to raise them for profitability. It interacts adequately with environment without dislocating the ecological and socio-economic balance on one hand and attempts to meet the national goals on the other.

3.2. Specific Objectives

1. To identify existing farming systems in specific areas and access the irrelative viability.

2. To formulate farming system model involving main and allied enterprises for different farming situations.

3. To ensure optional utilization and conservation of available resources and effective recycling of farm residues within system

4. To maintain sustainable production system without damaging resources/environment

5. To rise overall profitability of farm household by complementing main /allied enterprises with other

3.3. Key principles of Farming systems are

❖ **Cyclic**: Farming system is essentially cyclic (organic resources– livestock –land–crops). Therefore, management decisions related to one component may affect the others.

❖**Ecologically sustainability**: Combining ecological sustainability and economic viability, the integrated livestock–farming system maintains and improves agricultural productivity while also reducing negative environmental impacts.

❖**Rational:** Using crop residues more rationally is an important route out of poverty. For resource-poor farmers, the correct management of crop residues, together with an optimal allocation of scarce resources, leads to sustainable production.

3.4. Criteria for classification of Farming systems

Available natural resource base, including water, land, grazing areas and forest; climate of which altitude is one important determinant; land scape, including slope; farm size, tenure and organization; dominant pattern offarm activities and house hold livelihoods, including field crops, livestock, trees,aquaculture, hunting and gatheringand processing off farm activities; and taking into account the main technologies used, which determine the intensity of production and integration of crops, livestock and other activities.

Farming systems can be divided into eight broad categories depending on climate, resources and so on, available to the farmers in the regions. They are:

1. Irrigated farming systems
2. Wetland rice-based farming systems
3. Rainfed farming systems in humid areas of high resource potential
4. Rainfed farming systems in steep and high lands
5. Rainfed farming systems in dry or cold low potential areas
6. Dualistic (mixed large commercial and small holder) farming systems
7. Coastal artisanal fishing
8. Urban based farming systems, typically focused on horticulture and livestock production.

3.5. Key role of Farming Systems Approach in Agriculture is

- ❖ Food security
- ❖ Provide balanced food
- ❖ Quality food basket
- ❖ High productivity and enhanced farm income
- ❖ Effective recycling of resources
- ❖ Minimizing environmental pollution
- ❖ Employment generation

3.6. Farming Systems Strategies are

In view of serious limitations on horizontal expansion of land and agriculture, only alternative left is for vertical expansion through various farm enterprises required less space and time but giving high productivity and ensuring periodic income specially for the small and marginal farmers located in rainfed areas, dry lands, arid zone, hilly areas, tribal belts and problem soils. The location specific systems must be developed based on the available resources which will result into sustainable development of the region.

3.7. *The following farm enterprises could be combined:*

- ❖ Agriculture alone with different crop combinations
- ❖ Agriculture+ Livestock
- ❖ Agriculture + Livestock + Poultry
- ❖ Agriculture + Horticulture + Sericulture
- ❖ Agroforestry+ Silvipasture
- ❖ Rice+Fishculture
- ❖ Rice + Fish + Mushroom cultivation
- ❖ Floriculture + Apiary (bee keeping)
- ❖ Fishery+ Duckery+ Poultry

3.8. Farming Systems Research for different Agro-Climatic zones in India are

1. High altitude cold deserts: pastures with forestry, goats, rabbits and settled agricultural crops like millets, wheat, barley and fodders.

2. Arid and desert region: Animal husbandry with the camels, sheep and goats and growing fodder and field crops.

3. Western and central Himalayas: Horticultural crops as a major component and agriculture mainly on the hill terraces and slopes with maize, rice, wheat, pulsesand foddercrops.

4. Western Ghats: Major activity on plantation crops, cultivating rice and pulsesare the secondary agricultural activity. Cattle, sheep and goat are the livestock components which in most parts are maintain as large herds.

5. Delta and coastal plains: Rice cultivation with other enterprises like fishery, poultry and piggery etc., capture fisheries of marine ecosystem is a specializedenterprise.

6. Eastern Himalayas: Primitive crop husbandry with rice, millets and pulses etc.Agroforestry system is common. Piggery and poultry are the chief livestockactivity.

7. Indo-Gangetic plains: Intensive crop husbandry like rice–wheat–maize/mustard/pulses and livestock, dairy, cattle and buffaloes.

8. Central and southern highlands: Cotton – sorghum – millets/pulses with dairy cattle, sheep and goats and poultry are thesecondary livestock and animalhusbandryenterprises.

3.9. *Factors influencing Integration of Farm Enterprises*

1. Soil and climatic features of the selected area.
2. Availability of the resources, land, labor and capital.
3. Present level of utilization of resources.
4. Economics of proposed integrated farming system.
5. Managerial skill of farmer.

4. Integrated Farming Systems (IFS) Approach

IFS is a component of Farming system research introduces a change infarming techniques for maximum

production in the cropping pattern and takes care of optimal utilization of resources. The farm wastes are better recycled for productive purposes in the IFS. Unlike the specialized farming system, IFS's activity is focused round a few selected, interdependent; inter related and often interlinking production systems based on few crops, animals and related subsidiaryprofessions. IFS envisage harnessing the complementarities and synergies among different agricultural subsystems, enterprises and augmenting the total productivity, sustainability and gainful employment.

An intensive IFS addresses two issues; reduction of risk with the monoculture activities and promoting enterprise diversification, value addition and development of alternative income sources with efficient utilization of farm resources and it brings about enterprise diversification for sustainability and additional benefits, better management of important farm resources like land, labour and capital etc., provides an opportunity for effective recycling of the product and by–products, helps to generate flow of cash to the farmers round the year by way of disposal of milk, fruits, fuel, manure etc., beside other agricultural output.

4.1. Goals of IFS are

❖ Maximization of yield of all component enterprises to provide steady and stable income.

❖ Rejuvenation of system's productivity and achieve agro-ecological equilibrium

❖ Avoid the build-up of insect-pests, diseases and weed populations through natural cropping system management and keep them at a low level of intensity.

❖ Reducing the use of chemicals (fertilizers and pesticides) to provide chemical-free healthy produce and environment to the society (Manjunatha et. al., 2014)

4.2. Different components of IFS are

1) Field crops 2) Crop production 3) Vegetables 4) Fruit cultivation 5) Poultry farming 6) Livestock integration 7) Duckery 8) Aquaculture 9) Agroforestry 10) Bee-keeping 11) Mushroom cultivation and 12) Bio-gas plant.

4.3. Integrated Farming System models for different farming situations are

Wetland situation: Rice based cropping system with poultry cum fish culture

Crop –poultry–fishery
cropping with diary

Cropping with goat rearing
cropping with aquaculture

Irrigated areas: Cropping with diary, biogas and silviculture

Rainfed areas: Cropping with goat and silvipasture

Hill regions: Majority ofthe farmers in the region are maintaining fruit tree likeapple, dairy cattle and the major sources of green fodder comes from lopping of the fodder trees and locally available grasses.

4.4. Recommendations on present existing farming system models in the farmer fields are

❖ The farmer should be actively involved in all kinds of agricultural operations preferably with his family members instead of engaging laborer's paying high wages.

❖ Size of the unit should be at least one acre/hectare with diverse components.

❖ It should be a closed system with only marginal external inputs from outside.

❖ No model can be said to be complete or the most profitable which can be recommended at all locations.

❖ Model should be formulated taking into account the soil type, climate and resources of the farmers and the marketability of the commodities produced in the system.

❖ The model should ideally be a flexible one with scope for modifications.

5. Research on Integrated Farming Systems at ANGRAU-RARS, Maruteru, AP

The preliminary research investigations under IFS approach advocates the benefits of farm productivity improvement by 30-50% and more than double increase in the employment generation than arable farming alone, depending upon the number and kind of enterprises integrated. Integrated farming system works as a system of systems, which ensure that the wastes and/or by product from one enterprise become a resource for another enterprise with high degree of synergy and complimentary effects on each other.

By analyzing these facts an improved IFS model was designed, tested and validated for 0.6 ha (1.5 acre) area to support a farm family of five members at RARS, Maruteru under AICRP on IFS Scheme with the main objective of generating adequate income and employment for the small and marginal farmers and identifying appropriate cropping systems with high productivity which suits the specific needs of the Godavari zone and efforts will be made with the aim to double the real

farm income. The IFS model, presently have different enterprises *viz.*, crop production, horticulture, dairy, fishery, poultry, boundary plantation and vermicompost/ recycling of farm waste (Figure 1). This IFS model is eco-friendly having great potential to small and marginal farmers of Andhra Pradesh.

Figure 1: Model Wetland IFS unit of RARS, Maruteru

❖ Among all the components in IFS unit, dairy component share is 44% and Horticulture and Fish component share is 13% each. Value addition itself contributes 12% of overall profit (Table 1).

❖ This clearly shows that in wet land IFS model unit dairy, fishery and horticulture becoming 70% of the overall profits and these three components integration become more viable and sustainable.

❖ Without much effort value addition like selling of milled rice is much more economical and ensure additional profits.

❖ Mean Net GHG emission of three years of IFS unit was – 4816.6 CO_2-e which indicates the established IFS model at RARS, Maruteru is more suited for

Table 1: Details of Wetland IFS unit of RARS, Maruteru

Farming System	Area (ha)	Details
Crops / cropping systems	2500 m^2	Rice-Rice-Pulses, Maize-Green gram-Sesamum, Red gram + Greengram-Sweet corn, Fodder Jowar- Cowpea-Fodder Maize
Horticulture-fruit orchards	1450 m^2	Fruit crops: Banana, Guava, Papaya, Mango, Apple Ber, Pomegranate, Pomelo Citrus, Vegetables: Bhendi, Cluster Bean, Gourds, Brinjal, Tomato and Green chillies Flower crops: Mari gold, Crossandra
Dairy	250 m^2	Two Desi Cows and One Calf
Poultry	40 m^2	30 Nos Kadaknath chicks
Fishery	1200 m^2	550 number fingerlings in trench fish farming
Mushroom	60 m^2	2 units
Boundary plantation	100 m^2	Rose wood, Sapota, Mango and Guava
Production from IFS on equivalent basis (t) (Mention the base crop)	-	12.10 tonnes from 1.5 acres
Base crop: Rice		
Market input cost excluding labour (Rs)	-	Rs. 1,52,158/-
Cost of purchased animal feed (Rs)	-	Rs. 15,000/-
Value of recycling excluding family labour (Rs)	-	Rs. 8,500/-
Cost of hired labour (Rs)	-	Rs. 7,500/-
Cost of family labour (Rs)	-	Rs. 2,19,000/-
Total Cost (Rs)	-	Rs. 40,500/- (excluding family labour)
Net returns (Rs)	-	Rs. 1,11,658/-
Net returns per rupee invested	-	Rs. 2.76/-
Initial Soil organic carbon (%)	-	1.02
Soil organic carbon (%) during 2020-21	-	1.24
Employment generation (family + hired) (man days)	-	464

environmental sustained and eco-friendly unit (Table 2). Further, there is an ample scope to include more number of components for better income generation and recycling of components. Hence, the IFS model of RARS, Maruteru sinks more carbon in the system and emits less CO_2 (Figure 2).

Table 2: Carbon Dioxide estimation from wetland IFS model

IFS model details	Year	Estimation unit	Source	Sink	Net
Cropping systems (0.12 ha) + Dairy (2 Desi cows) + Fishery (0.08 ha) + Poultry (30 Nos) + Horticulture (0.12 ha) + Compost /others (0.14 ha)	2018-19	kg CO_2 equivalent	3385.6	8096.7	- 4711.1
	2019-20	kg CO_2 equivalent	3502.2	8544.2	- 5042.0
	2020-21	kg CO_2 equivalent	4095.1	8792.0	- 4696.9
		Mean	3661.0	8477.6	- 4816.6

Figure 2: Arial view of Wetland IFS Unit of RARS, Maruteru

6. Constraints for Implementation of Farming System Models are

- ❖ Lack of farmer's participatory approach
- ❖ Inadequate training and planning on IFS models
- ❖ Initial investment cost
- ❖ Through knowledge on other enterprises
- ❖ Selection of good varieties and breeds
- ❖ Animal health issues and medication
- ❖ Concentrated feed and fodder for live stocks
- ❖ Lack of rural infrastructure,
- ❖ Policy implementation
- ❖ Socio-economic constraints
- ❖ More so interest of the family members

7. Future Research Thrust

❖ Need to study the sustainability of the identified systems under different topographical situations in the long run including high value crops.

❖ Need to study the nutrient dynamics of soil with continuous cropping and recycling of manurial resources with different systems over time.

❖ Modeling of the identified farming system options to suit a given agro–climatic and socio–economic situation.

❖ Need to identify the constraints in adoption of identified farming systems by the farmers for further refinement.

8. Conclusion

Efficient utilization of scarce and costly resources is the need of the hour to make crop production a viable pre-position in the present-day competitive scenario. Improving the integrated approach not only enhances farm income but also overcomes environmental pollution. A better planning and utilization of all available resources will make bright prospects for the farm economy as a whole. Lastly and importantly TAILOR-MADE IFS MODELS are only the option for better success at farmer's end.

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