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SUSTAINABLE LIVELIHOOD THROUGH AGRO-FORESTRY AND LIVESTOCK BASED INTEGRATED FARMING SYSTEM IN RAINFED ALFISOLS OF SOUTHERN TRANSITIONAL ZONE (STZ) OF KARNATAKA

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ABSTRACT

The Southern Transitional Zone (STZ) of Karnataka is characterized dry sub-humid to semi -arid climate with an annual rainfall of 600-1000 mm. Nearly 70% of the total cropped area of 7.3 lakh ha is under rainfed farming consisting > 80% of small and marginal farmers. FCV tobacco is the major commercial crop grown in this belt followed by cotton, maize, finger millet and Rabi pulses. Even though the growing conditions are congenial for production of various arable crops and dry land horticulture, the lack of scientific land use system/diversified farming is greatly affecting the sustainable farm/animal productivity as well as the stability of the farm income in this rainfed ecosystem. Considering the resource availability, crop diversity and socio economic conditions of this zone, a diversified farming system in 1.0 acre model with an integration of various components was developed and evaluated at CTRI Research Station, Hunsur during 2005-06 to 2009-10. The model comprised of the Agro-forestry systems cropping systems and subsidiary enterprises involving livestock, vegetable farming and manure production units. Rain water harvesting structures for providing life/supplemental irrigation and border tree plantation with silver oak and Jatropha as live fence for favourable micro-climate were established. The economic evaluation of the model for the five years period has been very promising with a revenue generation of ₹20,584 from one acre area with a C: B ratio of 2.83. The five years study has revealed that livelihood income as well as total farm productivity of the small and marginal farmers could be sustained and further enhanced by adopting suitable integrated farming system involving agro-forestry, livestock enterprises and other subsidiary components with the cropping system practices of the area in this rainfed environment of the STZ of Karnataka.

Keywords:

Integrated Farming System,
Livelihood,
Sustainability
Silver oak
Jatropha

INTRODUCTION

The State of Karnataka situated between 11.5^0 and 18.5^o N Latitude and 74.0^o and 78.5^o E Longitude with a cultivable area 120 lakhs ha is divided into 10 Agro-Climatic Zones. The Southern Transitional Zone (STZ) No.7 situated in the Southern part of Karnataka is characterized by dry sub humid to semi-arid climate with an annual rainfall of 600-1000 mm having growing period of 180-190 days. Out of cultivable area of 7.30 lakh ha in this zone, nearly 5.00 lakh ha is under rainfed farming, with majority of the farmers being small and marginal. FCV tobacco is the major commercial crop cultivated followed by Hybrid cotton, Maize, finger millet, red gram and other pulses under rainfed situations. Cattle rearing, mainly for field operations is the only subsidiary activity followed by majority of the farmers.

The majority of the soils are red sandy to sandy loam with undulating topography and poor soil organic carbon and soil fertility status. Lack of any Agro-forestry systems and diversified farming practices coupled with unpredictable rainfall is largely affecting the sustainability of the farm/animal productivity as well as the farm income of the small and marginal farmers in this zone. The natural resources are underutilized due to lack of scientific soil and crop management practices, resource recycling and ideal cropping/farming systems. Agroforestry and livestock based integrated farming system could be an ideal option for sustaining the farm productivity and family income and nutrition security for the small scale farmers with limited resources.

The farm size holding in India has been declining over the years and 80 million operational holdings are below the size of 1.0 ha (Mahapatra and Bapet, 1992) and IFS is not only reliable way of obtaining higher productivity but also a concept of sustainable ecological soundness leading to agricultural sustainability (Swaminathan, 1987). Considering the resource base and socio- economic conditions of this zone, development and evaluation of an integrated farming system model suitable for the STZ No.7 of Karnataka was attempted by integrating the various Agro-forestry systems and livestock enterprises with the

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cropping system practices to minimize the risks, increase the farm productivity and family income on a sustainable basis in this rainfed environment.

MATERIALS AND METHODS

The integrated farming system model was developed and evaluated at CTRI Research farm, Hunsur, Mysore District, Karnataka coming under the southern part of the STZ. The model developed and established in the farm since 2005-06 in one acre area consisted of Agro-forestry systems (Agri-horti and Silvipasture), recommended cropping systems of the zone and subsidiary enterprises components (Livestock, organic production units, vegetable farming, farm ponds *etc*.) with emphasis on tree based farming.

The soils of the site were red sandy loams with neutral pH, low in organic carbon and medium in available P_2O_5 and K_2O status. The structure of the model and the area of the individual components are given in Table 1.The model developed was evaluated for its economic returns, cost: benefit ratio and the soil organic carbon status for the five years period from 2005-06 to 2009-10 and the average returns for five years were calculated. The soil organic carbon was estimated at the end of the each season for the five years' period .The model developed is being demonstrated for large number of farmers for its economic sustainability and viability.

Components of the model

Agri-horticulture system

In this system, dry land horticultural crops like Mango, Sapota, Tamarind and Pomegranate were planted and short duration intercrops are raised in the interspaces between the fruit trees. The grafted fruit tree saplings of these crops (16 numbers.) were planted at a spacing of 8 × 8m and in the inter space of horticultural crops various pulses like green gram, black gram cowpea and horse gram and oilseed crops like castor were cultivated in different years to improve soil fertility and to increase cropping intensity as well to generate mid-term income for the farmers till the fruit crops comes to marketability.

Silvi-pastoral System

In this system, fuel wood tree species like Eucalyptus and Casuarina (total 130 numbers) were grown at 1.5 × 1.5 m spacing. Similarly timber wood species like Neem and Acacia (10 numbers) were grown at 7 × 7 m spacing. In between these perennial tree species, short statured forage legume *Styloxanthus hamata* and Co-3 fodder grass were raised to serve as fodder for dairy animals/goats in the system. The input and operational cost of the system was very low and required no tillage or cultivation favouring conservation agriculture.

Cropping Systems

The cropping system activities were carried out in two blocks of 0.2 acre each. Both food crops and commercial crops were grown using integrated nutrient and integrated pest management practices and adopting recommended agronomic practices for the zone. Inter-cropping systems involving Hybrid Maize + Cowpea (1:1) and Redgram + Groundnut (2:8) in one block and sole crops of finger millet and hybrid cotton in another block were cultivated. In the *Rabi* season, taking the benefit of North East Monsoon, field bean and horsegram were also raised in maize and finger millet grown plots to increase the cropping intensity as well as to maintain soil fertility. Crop rotations practices were followed between the cropping system blocks to keep the soil borne pests/disease under check and also for maintaining the soil health. The various agri-wastes generated after harvesting the grains in this system were effectively recycled as raw material for quality FYM and vermicompost production in the system.

Table 1: Structure of the integrated farming system Model and its components (1.00 acre)

Systems	Components involved	Area
Agri-Horticulture System	Fruit trees (Sapota, Mango, Tamarind, Pomegranate) + Pulses/oilseed crops (cowpea/horse gram/castor)	0.20 acre
Silvi-pasture System	Fuel (*Eucalptus*,*Casurina*) and Timber wood trees (Indian babul and Neem) + Co-3 Fodder grass and *Styloxanthu hamata* (Forage legume)	0.20 acre
Cropping System I	Hybrid Cotton (*Kharif*) – Fallow *(Rabi)* Red gram + groundnut (2:8) (*Kharif*) – Fallow *(Rabi)*	0.10 acre 0.10 acre
Cropping System II	Maize + Cow pea 1:1 (*Kharif*) – Horse gram *(Rabi)* Finger millet (*Kharif*) - Field bean *(Rabi)*	01.0 acre 0.10 acre
Subsidiary Systems	Vegetable/nutrition garden, Fruit trees, Animal husbandry, FYM/vermicompost unit, farm pond etc. and teak plantation (25 nos.)	0.20 acre

Border trees: 125 nos. of silver oak and casuarina with Jatropha as live fence

Subsidiary systems

In this system various vegetables (tomato, brinjal, chillies, and greens) along with perennial crops like coconut, banana, curry leaf *etc*., were raised to support the nutrition requirements of farm family with generation of additional income. Based on the carrying capacity of the system, one cross breed cow and two goats were reared for production of meat and milk on regular basis and also to generate enough organic manure.

Small vermicompost unit (10'× 4'× 3') with a capacity to produce 3-4 tons of vermicompost annually was established and operated for production of quality organic manure for use in crop production activities. Excess run-off during the rainy season from the catchment area of entire one acre was effectively harvested in mini farm pond (8 × 8 × 2 m) constructed at the lower end of the field. Twenty teak wood trees were raised and established on the border of the subsidiary block as a long term investment.

Apart from the above components, about 125 numbers of straight and fast growing trees like Silver oak and Casauraina were raised at 2.0 m spacing all along the border of the 1.0 acre model which serves as effective wind break and aids in soil and water conservation.

RESULTS AND DISCUSSIONS

Economics of the integrated farming system model

The cost of cultivation, the gross returns, net reruns and the Cost: benefit ratio were calculated for the five years period from 2005-06 to 2009-10. The mean economic indices (pooled of 5 years period) of the integrated farming system model for the individual components and for the total system productivity (Table 2).

Table 2: Economic analysis of the Integrated Farming System Model (Average of 5 years)

Components/systems	Cost of cultivation (₹)	Gross returns (₹)	Net returns (₹)	C:B ratio
Agri-Horticulture system (Fruit tress + pulses)	500	1115	615	2.23
Silvipasture (Fuel /Timber wood tress+ fodder components)	100	268	168	2.68
Cropping system I Hybrid Cotton - Fallow Redgram + Ggroundnut (2:8)-Fallow	1290	2150	860	1.66
Cropping system II Maize + cowpea (1;1) - Horsegram Finger millet - Field bean	1300	1771	471	1.36
Subsidiary components involving Vegetable/nutrition garden, Fruit trees, Animal husbandry, FYM/ vermicompost unit, farm pond etc.	4080	15280	11200	3.74
Total from 1.0 acre	7270	20584	13314	2.83

The mean total income generated from all the components during five years period (2005-06 to 2009-10) indicated total gross revenue of ₹ 20,584 from 1.0 acre area with a cost: benefit ratio of 2.83. While the agro-forestry system (consisting of Agri-horti and silvi-pasture systems) and the cropping systems contributed, around 6 and 10% of the total net returns generated, the subsidiary components of the model contributed 80-85% of the total income generation. This clearly indicates the importance of the subsidiary components/enterprises in the development of integrated farming system for sustaining the livelihood of the small and marginal farmers under this rainfed ecosystem of STZ of Karnataka. While it is natural to expect the net return generation to be lower in the initial period in the agro-forestry systems due to the long gestation period, the cropping systems involving the arable cropping systems could not raise the income levels in the system due to their inherent risks and the inconsistent productivity and income due to rainfall variation, market fluctuation and other biotic stress involved. On the other hand even though the total net returns were far lower in eth Agro-forestry systems the cost: benefit ratio was much higher in these systems compared to the regular cropping systems due to the lower investment and the better returns from the pulse intercrops.

In many farmers' cases where only the cropping systems are practiced, there is likelihood of lower C: B ratio because of the higher operational cost involved in the form of inputs, labour and processing costs. Within the cropping systems, the cropping system I involving hybrid cotton, and red gram + ground nut intercropping proved better with 45% higher net returns and better C:B ratio compared to cropping system II involving the maize + cowpea system and sole finger millet due to the higher commodities prices realized for the cotton, red gram and ground nut. The study revealed that as the cropping systems alone are not remunerative for sustainable income generation for the poor and small farmers, the integration of farming with the relevant subsidiary enterprises and agroforestry systems would play a greater role in stabilizing the family income of the resource poor farmers.

Risk minimization

The major advantage of the integrated farming system is the risk minimization and the stability of the income generation over the years. In all the five years if the farmer has adopted only the cropping systems on his entire land, he would have end up with a net income generation of only ₹ 4,300 (Cropping system I) or 2,355 (Cropping system II) from an area of 1.0 acre, while the integration of the different components resulted in ₹ 13,314.

In the worst years, there could be even negative income from the crop components alone, in which case the integration of subsidiary systems will minimize the risks. While the crops and horticulture production with share of 44% in the household income is dominant income source in irrigated and assured rainfall areas, the contribution of livestock to overall household income is higher than the crops and horticultural income in arid and semi-arid environments implying greater risks in crop production in such an unpredictable environments (Ramachandra and Samra, 2012). Moreover, if small farmers start practicing specialization/single cropping system, the production and price risk would cause irrecoverable loss to them, as seen in the case of tomato farmers of Karnataka (Eastern dry zone) due to price distress during peak harvesting season and under such situations, diversification by rearing cross breed animals or vegetable production or mulberry cultivation in more than one combination generates them an assured income (Chenagappa and Arun, 2012). In the present study, the contribution from the subsidiary systems involving livestock components (milching animals and goats) and vegetable production contributed to more than 70% of the total income generated from the system, indicating importance of the subsidiary occupation in minimizing the risks in the rainfed situations.

Soil fertility maintenance

The soil analysis done during the end of the each crop season for five years indicated no appreciable change in organic carbon content, the soil pH and the electrical conductivity in different systems. While the organic carbon in the agro-forestry systems (Agri-horti and Silvi-pastoral systems) were either enhanced or maintained, the cropping system blocks indicated marginal decline in the organic carbon status due to exhaustion and repeated ploughing with no live mulching (Figure 1).

The agro-forestry systems maintained comparatively higher organic carbon status over the years due to the leaf litter added and also due to the inclusion of legumes as intercrops in the production practices. Growing of trees in association with crops in a unified agro-forestry systems helps in improving soil organic carbon, sequestration of carbon to moderate global warming and other environmental and ecosystem services (Singh, 2012). In case of the subsidiary systems, the intensive cultivation with vegetable farming and other perennials involved, the organic carbon status fluctuated over the years which may be due to the continuous high intensity vegetable production and the associated tree components especially the teak plantation around this system. In general the organic carbon status was in the medium status in the different components at the end of the five years period, which indicated the sustenance of the organic carbon in the system as whole.

From the five years study, it could be concluded that livelihood income as well as total farm productivity of the small and marginal farmers could be sustained and further enhanced by adopting the suitable integrated farming system involving agro-forestry, livestock enterprises and other subsidiary components along with the cropping system practices of the area in the rainfed environment of the STZ of Karnataka. The development of site specific farming system models open the avenue for integration of various enterprises by the farmer on a unit land area to produce food, fuel, fodder, fiber *etc*., to sustain the livelihood without deteriorating the ecological resources and the environment.

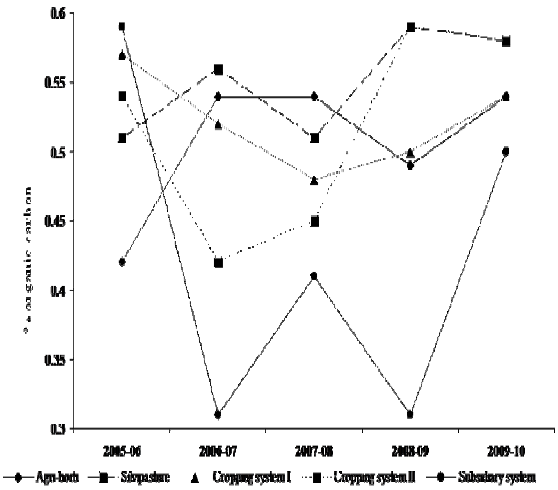

Fig. 1. Soil organic carbon status of soil (over the years) in different systems of the IFS model

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