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Sustainable and Successful Integrated Farming System Model for Dry Land Agriculture- An Initiative towards Climate Change

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Abstract—*Dry land agriculture plays an important role in Indian economy. Dry land crops accounts for 48 percent area under food crops and 52 percent area under nonfood crops. However the prevailing factors like erratic rainfall, poor or steeply sloped soil, drought and flood are more vulnerable in continuing the farming activity in arid and semi-arid tropics. In this condition, farming with one enterprise is not viable and makes an uncertainty in the livelihood of the farmers. To address these issues, we introduced a model of integrated farming system through National Initiative on Climate Resilient Agriculture project at Kattusiviri village in Mailam block of Villupuram district. Before intervention, the socio economic status of the farmers in the village has been studied. We found that the small farmers in the village having 1-1.4 ha of land could able to cultivate two seasonal crops viz; greengram and blackgram during kharif and paddy and or groundnut during rabi season with the available water resources. However some farmers have grown amaranthus and atrimisia as remunerative crop during the non-cropping season. Overall findings revealed that an annual net income of Rs.1, 46,650 was realized by the small farmers in the village.*
We selected a small farmer having 1.4 ha of land and gave demonstrations and trainings on integration of crop farming with sheep, poultry and fodder seed production as dry land IFS model. The farmer purchased 30 pairs of sheep each costing Rs.4000 per pair at 2 months old and reared up to 8 months old. At this age, the animals were sold @Rs 6000/sheep and given a net income of Rs 2, 18,000. In the backyard, 25 nos of Nandanam-4, a dual purpose strain of poultry chicks were introduced. Average production of 140 eggs were obtained against the desi bird of 93 eggs/ year. Sale of eggs fetched net income of Rs7350 /- with the selling price of Rs.10/egg and Rs 200/kg for male bird on live weight basis. Guinea grass rooted slips of 8000 nos were cultivated in 0.2 ha area. Selling of rooted slips @ Rs.1.50 per slip gave an additional net income of Rs.28800. At the end of one year, we found that after introduction of sheep, poultry and fodder production as IFS components, the farmer could able to gain an additional net income of Rs.2,54,150 per annum. It was realized that integrating livestock, poultry and fodder components has attributed 49 percent increase in the annual net income with a BCR value of 2.66. From our results it is concluded that a small farmer with 1.4 ha of land with an IFS model of Crop + Sheep(60nos) + Poultry(25nos) + Fodder seed production(0.2ha) will certainly double his income and ensures the livelihood, employment, nutrition security of the farm family in dryland condition.

1. INTRODUCTION

In India weather plays an important role in crop production under dry land situation. Dry land constitutes 142 m ha in the country contributing about 42 percent of total food production [6].Dry land crops accounts for 48 percent area under food crops and 52 percent area under nonfood crops. However the prevailing factors like erratic rainfall, poor or steeply sloped soil, drought and flood are more vulnerable in continuing the farming activity in arid and semi-arid tropics. In this condition, farming with one enterprise is not viable and makes an uncertainty in the livelihood of the farmers In addition, the climate change plays a major role in erratic and ill distribution of rainfall coupled with high rate of evaporation in dry climate.

This often leads to periods of water deficit and has serious implications on crop and its allied activities [3].Present farming system in dry land area is characterized by low and unpredictable yield due to an inefficient use of rain and soil, rare use of fertilizers, high yielding short duration varieties and improved water and soil conservation measures [4].The sustainability in crop and animal husbandry activities in dry land farming situation become uncertain due to climate change. In India, the warm period is observed in post monsoon and winter season with little variation during monsoon season.

The projected change for India is that the increase in temperature is likely to be less in Kharif than in Rabi season. The Rabi rainfall may exhibit large uncertainty whereas Kharif rainfall is likely to increase by as much as 10 per cent. Such global climate changes will affect agriculture considerably through its direct and indirect effect on crops, cropping systems, livestock, pests and diseases, weeds etc., threatening the food security. Thus the climate change and its sequlae become more vulnerable for the livelihood,

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employment and social status of the farm family in dry land condition.

In this Juncture, Indian Council of Agriculture Research launched a network project on National Innovations in Climate Resilient Agriculture (NICRA) in February 2011[2]. This project is being monitored and funded by Central Research Institute for Dry land Agriculture (CRIDA), Hyderabad. Our KrishiVigyan Kendra, functioning under the aegis of TamilNadu Agricultural University, Coimbatore has implemented the NICRA project at Kattusiviri village of Mailam block in Villupuram district of TamilNadu. Kattusiviri village is having 495 households with a total cultivable area of 220.35ha. Paddy, Groundnut and sugar cane are the major crops being cultivated and the average annual income of the small marginal, and large farm family is Rs.25,000/- Rs.50000/- and 1 lakh respectively. However some farmers have grown amaranthus and atrimisia as remunerative crop during the non – cropping season and received an annual income of Rs.1.46 lakhs. The prevailing situations of low annual income due to seasonal cropping, unawareness of scientific and integrated farming practices and poor economic returns in dryland farming made us to introduce a sustainable Integrated Farming System (IFS) in the village.

2. MATERIALS AND METHODS

Integrated Farming System in dry land

The selection of enterprise is based on the cardinal principle of minimizing the competition and maximizing the complementarity between the enterprises. Based on the technology demonstration components of NICRA project, we have introduced crop (pulses & oilseeds) + horticulture crop + sheep rearing + poultry + fodder bank in the small farmer field having a cultivable area of 1.4ha. Earlier, the farmer used toraise Black gram (0.4ha), Green gram (0.2ha), Groundnut (0.6ha) and amaranthus (0.2ha) in 1.4ha.Through our intervention, we introduced sheep rearing, poultry maintenance at backyard and establishment of guinea grass fodder bank at his same 1.4haof land to allot for different enterprise as follows:

Table 1: Shows the distribution of land for different components

Enterprise	Area modified (ha)
Amaranthus	0.1
Guinea grass	0.2
Green gram	0.2
Black gram	0.2
Ground nut	0.4
Sheep rearing	0.2
Backyard Poultry	0.1

Crop varieties

Climatic Vulnerability prevailing at Kattusiviri village plays a major role in the selection of crop and varieties. During Kharif and Rabi, the recorded no of dry spells and noof rainy days are as follows:

Table 2: Rainfall data

Historical Trends in Rainfall	Decadal Average			
	1980-90	1990-2000	2000-2010	2010-2017
No of rainy days	48.3	54.3	53.1	67.1
No of dry spells				
>10 days	0.9	1.1	2.0	2.5
>15 days	0.4	0.3	1.0	1.4
>20 days	0.1	0.1	0.7	1.1
No of Intensive rain spells				
>60 mm/day	0.8	4.3	2.0	5.8

Intermittent dry spells, made us to introduce the short duration CO-8 green gram variety for the khar if season. Amaranthus (CO-3) cultivation is being engaged by the farmer throughout the year. During Rabi season through North East Monsoon, the village gets more than 60mm per day during intensive rain spells. During this season we have given black gram (VBN-6) and ground nut (TMV-13) as terminal drought tolerant varieties.

Fig. 1: Cultivation of Amaranthus (CO-3)

Sheep and Poultry components:

Before our intervention, the farmer used to rear native sheep which is having a marketing weight of 12kg per animal. To improve the birth weight and marketing weight of the native sheep, we introduced a Madras Red ram in to the native sheep flock to curtail inheritance of poor economic traits of inbreeding.

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Fig. 2: Recording birth weight of lambs after crossing of Madras Red ram with native ewes

To replace the low yielding native breeds of chicken, we have introduced 25 nosof Nandanam-4 chicken for backyard rearing. Nandanam -4 is a dual purpose strain released by Tamil Nadu Veterinary and Animal Sciences University Chennai (TANUVAS), which was identified for coloured plumage, brown shelled eggs, optimum egg number of 200 eggs per annum and its longer survival rate under backyard condition.

Fig. 3: Nandanam-4 dual purpose chicken rearing

Fodder Bank

Establishment of fodder bank as a remunerative enterprise, it was proposed to plant 8000 nos of Giunea Grass (GG-3) rooted slips in an area of 0.2ha with the objective of fodder for sheep and selling of rooted slips to other farmers.

Water Management

Due to uncertainty in the availability of water for crop and livestock, judicious use of water and insitu moisture conservation technologies were introduced. Rain gun method of irrigation was advised to follow for amaranthus & fodder crop during the late Rabi and summer season. Raised bed and broad bed furrow method were followed for amaranthus cultivation.

Fig. 4: Guinea grass fodder bank with Rain gun irrigation

3. RESULTS AND DISCUSSION:

We selected a small farmer having 1.4 ha of land and gave demonstrations and trainings on integration of crop farming with sheep, poultry and fodder seed production as dry land IFS model. Before our intervention the farmer used to raise Black gram (0.4ha), Green gram (0.2ha), Groundnut (0.6ha) and amaranthus (0.2ha) and gained an annual net returns of Rs 57712. He cultivated the crops whenever the water is available and otherwise he depended upon the daily wages for his subsistence of the family.

Table 3: Shows the economic returns of crop farming alone

Before the intervention of NICRA					
	Area	**Income**	**Expen diture**	**Net Income**	**BCR**
Black gram	0.4	32000	11336	20664	2.82
Green gram	0.2	9648	6500	3148	1.48
Groundnut	0.6	26000	9500	16500	2.74
Amaranthus	0.2	24200	6800	17400	3.56
	1.4	91848	34136	57712	2.65

After our intervention, the farmer purchased 30 pairs of sheep each costing Rs.4000 per pair at 2 months old and reared up to 8 months old. At this age, the animals were sold @Rs 6000/sheep and given a net income of Rs 2, 18,000. Introduction of Madras Red in the native flock has given good birth weight of 2.2 kg against the local breed lamb weight of 1.6 kg. This gain in birth weight of 0.6 kg would resulted in a better market weight of 15 kg at eight months old. In the backyard, 25 nos of Nandanam-4, a dual purpose strain of poultry chicks were introduced. Average production of 140 eggs were obtained against the desi bird of 93 eggs/ bird/ year. Sale of eggs fetched net income of Rs7350 /- with the selling price of Rs.10/egg and Rs 200/kg for male bird on live weight basis. Guinea grass rooted slips of 8000 nos were cultivated in 0.2 ha area. Selling of rooted slips @ Rs.1.50 per slip gave an additional net income of Rs.28800. At the end of one year, we found that after introduction of sheep, poultry and fodder production as IFS components, the farmer could able to gain an additional net income of Rs.2,54,150 per annum. It was

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realized that integrating livestock, poultry and fodder components has attributed 49 percent increase in the annual net income with a BCR value of 2.66.

Table 4: Shows the economic returns of IFS

After the intervention NICRA					
	Area	**Income**	**Expen diture**	**Net Income**	**BCR**
Amaranthus	0.1	12100	3400	8700	3.56
Guinea Grass fodder	**0.2**	**40000**	**11200**	**28800**	**3.57**
Green gram	0.2	9648	5440	4208	1.77
Black gram	0.2	16000	6800	9200	2.35
Ground nut	0.4	20800	7290	13510	2.85
Sheep rearing	**0.2**	**342000**	**124000**	**218000**	**2.76**
Backyard Poultry	**0.1**	**16860**	**9570**	**7290**	**1.76**
	1.4	457408	167700	289708	2.66

The results and findings of this integrated farming system model for dry land has proved the results of[7], who has got maximum potential through crop+dairy+goat farming. Similarly maximum returns was obtained [8]in the integrated farming system with goat and sheep rearing under dry land of Punjab region of India. Introduction of small ruminants like sheep / goat forms an important economic and ecological niche in Asian mixed farming systems [3].Our study also revealed that an additional net income of Rs.2, 18,000 was earned from sheep enterprise alone. In a situation like dry land condition cultivation of cereals, paddy and other food crops alone is not at all possible due to erratic rainfall and low moisture in the soil. The highest BCR of 3.57 was gained in fodder cultivation and provided economic returns on monthly basis by selling the rooted slips. Though the BCR values of the two models were not varied significantly, in terms of economic returns the IFS model of Crop + Sheep(60nos) + Poultry(25nos) + Fodder seed production(0.2ha) has recorded highest income over a period of last two years.

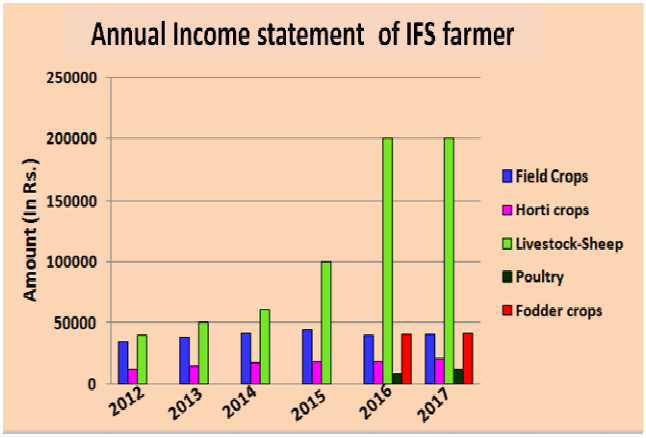

Fig. 5: Year wise annual income of the farmer

Thus the objective of sustainable agriculture including efficient use of land and water to produce nutrients for human consumption, climate resilience and income of the farmer has been fulfilled successfully [5]. To combat climatic vulnerability, the IFS components has been modified in such way that the farmer should get a daily, monthly, quarterly and half yearly income respectively from cultivation of amarnthus [9], fodder grass, Nandanam-4 chicken in the backyard and sheep farming.

From this study it is concluded that a small farmer with 1.4 ha of land with an IFS model of Crop + Sheep(60nos) + Poultry(25nos) + Fodder seed production(0.2ha) will certainly double his income and ensures the livelihood, employment, nutritional security of the farm family in dryland condition.

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