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Adoption of climate resilient agricultural technologies through integrated farming system for mitigating climate change

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ABSTRACT

Climate change and its impact on agriculture and food security is the major threatening factor in the recent agricultural scenario. Attempts were made to integrate the climate smart agriculture and allied components and its potential on climate change mitigation and adaptation practices. The present study was carried out in Nambiyur and Gobichettipalaym during 2014-15 and 2015-16. The study was taken up in the farmer's field and the components and climate resilient technologies adoptions like crop production, dairy, back yard desi bird rearing, mixed fodder, biogas, nutrition garden, vermi-compost production and water management practices as suggested by Tamil Nadu Agricultural University, Coimbatore. Adoption and integration of above said technologies reduces on an average of 17.3 ton of CO_2 emission per year and this might be due to reduction in firewood consumption & waste burning, efficient utilization of farm wastes and organic input production at farm level. The study indicated that the average net income has increased from Rs.64, 417 to Rs. 1, 46,025 per hectare. The integration of components reduced the external input cost by 43.53 percent. The overall result indicated that adoption and integration of appropriate crop and animal husbandry components are efficient model climate resilient agricultural technologies.

1. Introduction

Small holder agricultural production systems are the main source of food and income of most of the poorest people in the world. Increases in productivity achieved in the past are attributed in part to the significant use of fossil fuels, contributing to the greenhouse gas emissions and wasting considerable amount of energy along the chain (FAO, 2011). Climate change is emerging as a major threat on agriculture, food security and livelihood of millions of people in many places of the world (IPCC, 2014). Modern industrial agriculture contributes a great deal to climate change. It is the main source of potent greenhouse gases (nitrous oxide and methane). Globally, agricultural CH4 and N_2O emissions have increase nearly by 17% from 1990 to 2005. It is heavily dependent on fossil fuels and contributes to the loss of soil carbon to the atmosphere, especially through deforestation to make more land available for crops and plantations. This situation led to the disturbances in soil reaction, development of nutrient imbalances in plants, increased susceptibility to pests and diseases and decrease in soil life. Many of the farmers are not aware of best using the agricultural and farm wastes for increasing productivity without affecting the soil fertility and bio-diversity of the native soil. Due to the improper utilization of the agricultural and home wastes and it will produce unpleasant odour along with the emission of greenhouse gases like CO_2, CH_4 etc., it will leads to the environmental degradation and unfavorable micro climatic situations for the crop production. In order to sustain a positive growth rate in agriculture, a holistic approach is the need of the hour. The emergence of integrated farming system approach has enabled us to develop a frame work for an alternate development model to improve the sustainability of the

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farm production in an eco-friendly manner (Manjunatha *et al.,* 2014). Integrated farming system refers to agricultural systems that integrate livestock, crop production and other allied components. In this system, inter- related set of enterprises used so that the waste from one component becomes an input for another part of the system which reduces cost and improves production and income (Rajju Priya Soni *et al.,* 2014). Climate Smart Agriculture (CSA) is another approach that has recently achieved much prominence, given the adaptation and mitigation challenges facing humanity (FAO. 2013). Climate Smart Agriculture is defined by three objectives as follows

1. Increasing agricultural productivity and increases income
2. Increasing adaptive capacity at multilevel from farm to nations
3. Decreasing greenhouse gas emissions and increasing carbon sinks

Climate Smart Agriculture integrates climate change into planning and implementation of integrated farming system and informs priority setting. Keeping this view in mind, the present study was taken up with the objectives of how integrated farming system helped in improving the farmer's income, lowering the input cost and the impact of IFS on carbon saving climate smart agriculture

2. Materials and Methods

The present study was conducted in Two taluks in Erode District namely Talavadi and Gobichettiapalayam. In each taluk, two villages were selected namely M.P.Doddi and Maalankuli villages in Talavadi taluk & Valayapalayam and Arakkankottai villages in Gobichettipalayam taluk of Erode District. Talavadi is located in the western ghats of Erode District and Gobichettipalayam located in the centre part of the district. Maize, onion, finger millet and French beans are the major crops cultivated in the study area and in some pockets the farmers are cultivating banana and sugarcane crop where they are having irrigation facilities. The list of farm families adopting integrated farming system is obtained from the KVK database, of which, 25 farm families from each village were selected for this study. Personal interview with well-structured interview schedule and focused group discussion was employed in the study for data collection. ICAR–KVK, MYRADA is promoting 12 components (Cropping, Clean cattle shed with urine collection chamber, Biogas, Vermicompost, onsite organic pest repellent production, mixed fodder, nutrition garden with drip system, grain storage, on bund biomass plantation, rain water harvesting, green manuring/intercropping with pulses and mulching) in the integrated farming system. The study considers that any component that supports directly and indirectly to increase the productivity, resilience, adaptation and mitigation to agriculture under climate change and vulnerability can be considered as a climate smart agricultural technologies. The detailed information in existing IFS components and its suitability to the location specific were focused group- discussion. This will help us to identify the most appropriate suitable technologies for IFS which serve as a CSA technology. The identified CSA technologies were presented in Table 1.

3. Results and Discussion

Adoption level of CSA technologies

The study revealed that, out of 12 CSA technologies, 8 technologies were practiced by more than 75 percent of the farmers which indicates that the farmers were satisfied with the technologies promoted by ICAR KVK, MYRADA. Among the 12 technologies, clean cattle shed and grain storage technologies were adopted by all the farmers. The technologies like onsite pest repellent, nutrition garden, bio gas and mulching practices were adopted by more than 80 percent farmers. The data indicates that, the rain water harvesting technologies recorded the least preferred and adopted technologies against others since it has not much influenced in agricultural purposes. The detailed adoption level of all the CSA technologies are presented in the Graph 1. The adoption of these technologies can also help to offset the impact of climate change and variability in agriculture.

Cost Economics

From the table 2, it was observed that the gross cost of cultivation reduced drastically which indicates that the CSA technologies influenced on the cost of production. The production of organic inputs at farm level reduced the cost towards buying of external inputs such as chemical fertilizers and pesticides. Before implementing integrated farming system, the farmers earned the average net income of Rs. 64,417.00/ha. After adoption of integrated farming system technologies, the net income increased upto Rs. 2,15,570.00 / ha with the average net return of Rs. 1,46,025.00 /ha. This much net returns difference was due to expansion of area under difference IFS components. The average benefit cost ratio was increased from 1.53 to 2.48. The higher benefit cost ratio recorded due to the better adoption and management practices. Similar results were also reported by Ansari *et al,* (2014) and Yadav *et al.* (2013).

Graph 1: CSA technologies adoption level (percentage)

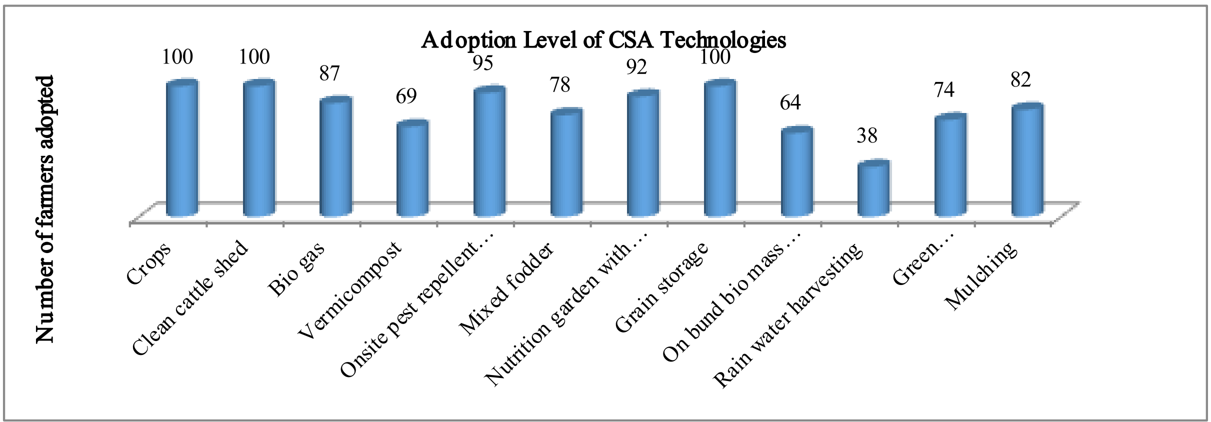

Table 1. Climate smart IFS technologies

Technologies	Adaptation and mitigation potential
I. Knowledge Smart	**Combination of science and traditional knowledge**
Improved varieties	Tolerant to drought, flood and heat stress
Seed bank	Conservation of seeds to manage climate risks
II. Nutrient Smart	**Improves soil nutrient status**
Green manuring	Improves soil fertility
Intercropping with legumes	Improves nitrogen supply and additional farm income
Vermicompost	Improves the nutrient status of farm yard manure
Site specific nutrient management	Reduces the excess use of fertilizer
III. Energy smart	**Improves energy use efficiency**
Bio gas	Reduces fuel wood usage and smoke free kitchen Wastes are act as a energy source for beneficial microbes
small farm implements	Reduces the labour energy and dependency
IV. Water smart	**Improves water use efficiency**
Micro irrigation	Minimize the water usage and maximize the productivity
Rain water harvesting	Use of water for agriculture
Mulching	Reduces evaporation of water from soil
V. Weather smart	**Interventions provide income security**
Clean cattle shed	Protection of livestock from adverse weather condition
VI. Carbon smart	**Reduces Green House Gas emission**
On bund bio mass	Promote carbon sequestration and lopping used as green leaf manure
Mixed fodder	Promote carbon sequestration and sustainable land use management
onsite organic pest repellent production	Reduces the usage of chemicals
Nutrition garden	Provides nutrition security and reduces GHG emission

Carbon Dioxide Balance Sheet

There are four reasons why integrated farming system technologies saves CO_2 emission and why absorbs CO_2 and emits O_2. The reasons are In integrated farming system, the waste was not burnt in the field and it observed that it was converted into compost. One kg of burnt waste emits 1.83 kg of CO_2. .The study revealed that, on an average, the five members' family used 4100 kg of crop and farm waste burnt in a year before implementing the IFS, which is equal to 7503 kg of CO2 emits. By adopting on bund biomass and compost/ vermicomposting technologies a family saved 7503 kg CO_2. By adopting nutrition garden with drip systems, the family saved 50 percent of water usage for vegetable production. This reduced the unnecessary transportation by using two wheelers for purchasing vegetables and other critical inputs like fertilizers and pesticides for their home and farm needs. The study revealed that, before adopting IFS, on an average the family members used 1025 litre of fossil fuel in a year. 1litre of fossil fuel emits 2.5 kg of CO_2. By adoption of these technologies a family saved 2563 kg CO_2 Firewood is the major fuel source for the many farm families for cooking and other purpose. The study revealed that, on an average, one family used 1095 kg firewood which is equal to 2004 kg

CO_2 emission. By adopting bio gas technologies one family saved 2004 kg CO_2 emission and the waste obtained from the bio gas acted as valuable manure for the agriculture. The digested slurry has more nutrient than the ordinary compost. The chemical fertilizer used in the modern agriculture also emits CO_2 not only in production but also in application. On an average, 5.272 kg of CO_2 released from the 1 kg of fertilizer. The study indicated that, 1000 kg of fertilizers used for crop production in a year per hectare area cultivation. This is equal to 5272 kg of CO_2 emission. By adopting various bio input productions like Vermicompost, onsite production of panchakavya, pest repellent, *etc.* overall study revealed that, the IFS family saved 17.3 ton of CO_2 (Table 3) emission / ha in a year.

4. Conclusion

The study highlighted the role of integrated farming system and how the IFS components are linked with prevailing climate conditions. After adoption of integrated farming system with good management practices gave more production and reduces the greenhouse gas emission. Increasing evidence shows that diverse and integrated farming systems that are based on location specificity can present a robust pathway towards climate smart agriculture.

Table 2. IFS technologies and its influences on cost economics of the farm

Village	Gross Cost (Rs/ha)		Gross Return (Rs/ha)		Net Return (Rs/ha)		BCR	
	Before	After	Before	After	Before	After	Before	After
M.P.Doddi	72500	56200	111900	141182	39400	84982	1.54	2.51
Maalankuli	112000	89780	168039	199574	56039	109794	1.50	2.22
Arkaankottai	138500	105420	217115	279174	78615	173754	1.57	2.65
Valayapalayam	160000	142000	243614	357570	83614	215570	1.52	2.52
Average	**120750**	**98350**	**185167**	**244375**	**64417**	**146025**	**1.53**	**2.48**

Table 3. IFS technologies and its influences on CO_2 savings

Sl .No	IFS / CSA technologies	Quantity (Kg or lit)	CO_2 emission (Per kg or lit)	CO_2 saved / year
1.	Prevent waste burning	4100	1.83	7503
2.	Reduction in fossil fuel	1025	2.5	2563
3.	Bio gas	1095	1.83	2004
4.	Reduction in chemical fertilizers	1000	5.272	5272
Total				**17342**

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