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ADOPTION OF ECO-FRIENDLY CONSERVATION PRACTICES IN THE NILGIRIS DISTRICT OF WESTERN GHATS

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ABSTRACT

Green revolution related agricultural practices played major threat and challenges to human and animal health as well as to ecological niche of The Nilgiris biosphere reserve in various dimensions. The commercial agricultural practices have tripled the agricultural production but resulted in the rapid erosion of crop and livestock diversity, loss of inherent soil fertility; break down of biological pest regulation, soil erosion and environmental problems. Due to increased use of expensive and poisonous chemicals fertilizers and pesticides which finally made the farmers poorer and more dependent on markets and outside agencies. In this context, the eco-friendly conservation practices minimize the agricultural production risks and conserve the sustainable management of the The Nilgiris biosphere reserve. The study was conducted purposefully in The Nilgiris district of Tamil Nadu and ex- post facto research design was used for the study. The samples of 80 farmers were selected from all four blocks. Totally, 320 respondents were selected from the district. Thus, 118 adopters and 202 non- adopters were identified. Further, it infers that the 118 adopters are not supposed to be the adopters of all the identified 58 eco friendly conservation practices in total. There existed non- adopters also in the post stratified adopter categories. The relative advantage of eco friendly conservation practices would naturally demanded for optimum yield, sustainable productivity and better quality of the products. The adoption of eco-friendly conservation practices were measured by using 58 items of eco-friendly agricultural practices. These are the important eco-friendly conservation practices documented in that study area. They were listed in the categories of afforestation practices, agro forestry practices, integrated farming system, soil and water conservation practices, watershed management, biodiversity conservation practices, low external input for sustainable agriculture and agronomic practices for crop cultivation. Nowadays, The Nilgiris district farmers are getting awareness and they are very much eager to protect the environment, in order to satisfy their basic needs at present and also in future. This is the major reason for switching over to practicing the eco friendly conservation practices. But only slightest percentage of farmers is practicing the eco friendly conservation practices.

KEYWORDS: Green Revolution, Agricultural Production Risks, Products

INTRODUCTION

BACK GROUND OF THE STUDY

The Nilgiris biosphere reserve is one of the "Biodiversity Hotspots" as declared by the National Biodiversity Authority in the year 1998. The Nilgiris is a unique biosphere in the Western Ghats characterized at the higher altitudes by

savanna (grasslands) and shola (evergreen montane) forests in the ravines, moist and dry deciduous forests and thorn and scrub in the middle and lower ranges, and evergreen and semi-evergreen forests to the West. The biosphere thus encompasses a very diverse variety of climatic and geographic micro regions at heights ranging from 400 m to over 2500 m above mean sea level.

The NBR is very rich in plant diversity. About 3,200 species of flowering plants can be seen here of which 132 are endemic to the reserve. Of the 175 species of orchids found here, 8 are endemic. The fauna of the NBR includes over 100 species of mammals, 350 species of birds, 80 species of reptiles and amphibians, 300 species of butterflies and innumerable invertebrates. 31 amphibians and 60 species of reptiles that are endemic to the Western Ghats also occur in The Nilgiri Biosphere Reserve (Daniel, R.J 1996).

CHANGING LAND USE OF THE NILGIRIS DISTRICT

The establishment of Ootacamund as a hill station, it was not long before British government settlers began to have an impact on land use and agriculture. European vegetables such as potatoes, carrots and beans introduced, in 1820s were quickly taken up particularly by local people. In 1838 the British government introduced coffee to the region and then in 1885 tea was cultivated for the first time. The expansion of these two crops in commercial plantations dominated The Nilgiris agriculture as they the catalysed the major livelihood change in this region. Large tracts of forest were cleared for the new tea and coffee estates. The exotic vegetables like potato, carrot, etc also cultivated in the district.

The long-term implications of estate and plantation agriculture have been created ecologically problems likes increases in chemical fertilisers and pesticide usage which results in soil nutrient decline; deforestation has also dramatically reduced the soil's water retention capacity as well as significantly increased soil instability resulting in a series of serious landslides in the district (Pranjali, 2010).

CROPPING PATTERN

The plantation crops like tea and coffee are grown in major areas of The Nilgiris district. The annual crops like potato, cabbage and carrot are grown in three different seasons *viz.*, irrigated (February-June), the main crop of *Karbogam* (April-August) and autumn crop or *Kadaibogam* (August- November). Paddy is cultivated in two seasons in Gudalur taluk *viz.*, rainfed paddy in June-September and irrigated paddy in December-April.

Commercial growing of beans, cabbage, cauliflower and carrot during normal times has been concentrated mainly in and around the towns of The Nilgiris over an elevation of 1524 meters. There are two main seasons generally when the vegetables are grown *viz.*, January to June and June to October. Potato is cultivated throughout the year (i.e) during summer (March-August), autumn (August-December) and winter (January-May).

Temperate crops such as potato, cabbage, cauliflower, plums, pears and peaches are grown in the high plateau of hills, while sub-tropical crops like mandarin orange, tea and coffee are grown in the mid region of the hills. Various humid tropical crops like clove, nutmeg, cinnamon, pepper and ginger and fruits like mangos, durian, grapes, rambutan, litchi etc., grow in the lower elevations.

ECO-FRIENDLY CONSERVATION PRACTICES

Green revolution related agricultural practices play major threats and challenges to human and animal health as well as to our ecological niche of The Nilgiris biosphere reserve in various dimensions. These non-eco-friendly agricultural practices have tripled the agricultural productions but resulted in the rapid erosion of crop and livestock diversity, loss of inherent soil fertility; break down of biological pest regulation, soil erosion, salinization and environmental problems. Due to increased use of expensive and poisonous chemicals fertilizers and pesticides which finally made the farmers poorer and more dependent on markets and outside agencies.

Eco-friendly conservation practices are a comprehensive system of widespread introduction of eco-friendly conservation which could be justified through the following arguments: (i) Eco - friendly conservation practices offer the possibility of long term sustainability. (ii) Eco-friendly agriculture is affordable for resource poor farmers (iii) Problem of farm unemployment could be minimized through ecological based alternate livelihood activities. (iv)The Nilgiris biosphere reserve's traditional farmers have a long heritage of farming with traditional wisdom, which acts as the basis for ecological knowledge.

In this context, the eco-friendly conservation practices minimize the agricultural production risks and conserve the sustainable management of the The Nilgiris biosphere reserve. Hence, the present study aimed to study the adoption level of farmers towards eco-friendly conservation practices in the Nilgiris district of Western Ghats.

METHODOLOGY

In this research study, the researcher had no control over the variables and only what has happened or what is happening was reported in this paper. Thus, the major objectives of adoption of eco-friendly conservation practices in The Nilgiris district of Western Ghats with varied dimensions at farm and field level were assessed through the ex post facto research design.

The study was conducted purposefully in The Nilgiris district of Tamil Nadu and data were collected by using the interview schedule during the year 2014. Keeping in the bio diversity conservation, diversified agricultural practices and geographical variations in The Nilgiris district, all four blocks was taken for this study. The samples of 80 farmers were selected from all four blocks. Totally, 320 respondents were selected from the district. The respondents have been selected based on the simple random sampling technique. The farmers interviewed in correspondence with the objective set forth. As explained initially the total sample size was 320 initially. After the data collection, the sample was post stratified based on the adoption of eco friendly conservation practices. Thus, 118 adopters and 202 non- adopters were identified. Further, it infers that the 118 adopters are not supposed to be the adopters of all the identified 58 eco friendly conservation practices in total. There existed non- adopters also in the post stratified adopter categories.

Measurement of the Adoption of Eco-Friendly Conservation Practices

The adoption of eco-friendly conservation practices was measured by using 58 items of eco-friendly agricultural practices. These are the important eco-friendly conservation practices documented in that study area. They are listed in the categories of afforestation practices, agro forestry practices, integrated farming system, soil and water conservation practices, watershed management, bio diversity conservation practices, and low external input for sustainable agriculture and agronomic practices for crop cultivation. In consultation with the agricultural scientists, extension experts, researchers

and other available sources. The adopters were categorized as who are all practicing minimum ten documented eco-friendly conservation practices. In the two types of responses rated 0, and 1 to no adoption and adoption of eco-friendly conservation practices respectively.

FINDINGS AND DISCUSSIONS

Factors Influencing Adoption of Eco Friendly Conservation Practices

The five relative attributes of innovativeness which are given by Rogers (1983) have been taken for this study and the results are presented in Table 1.

Table 1: Distribution of Respondents based on the Factors Influencing Adoption of Eco Friendly Conservation Practices (n=118)

Sl. No.	Factors	Respondents	Percent
1.	Relative advantage	62	52.54
2.	Compatibility	17	14.41
3.	Complexity	24	20.34
4.	Trialability	11	9.32
5.	Observability	4	3.39
	Total	**118**	**100.00**

It could be observed from Table 1 that in the relative advantage (52.54%) was major reason for adoption of eco friendly conservation practices followed by complexity (20.34%), compatibility (14.41%), trial ability (9.32%) and observability (3.39%) of the practices.

The relative advantage of eco friendly conservation practices would naturally demanded in low external inputs usage for optimum yield, sustainable productivity and better quality of the products. Also it supports the ‘saving the environment’ ‘Saving human health’ and ‘low cost technology’. The eco friendly conservation practices are less complex in nature. Hilly areas naturally help to adopt eco friendly conservation practices in an integrative manner. Remaining factors i.e., comparability, trial ability and observability supports the farmer in the adoption process.

Adoption of Eco-Friendly Conservation Practices

The detailed findings on adoption of various eco friendly conservation practices are given in this area.

* - Multiple responses

Afforestation Practices

The distribution of respondents with respect to adoption of afforestation practice is presented in Table 2.

Table 2: Adoption of Afforestation Practices (n=118)

Sl. No.	Afforestation Practices	Adopters		Non Adopters	
		No	%	No	%
1.	Maintenance of social forestry in degraded lands	19	16.10	99	83.90
2.	Afforestation in villages	40	33.90	78	66.10

In that Table 2 totally16.10 per cent of the farmers adopted the practices of maintenance of social forestry in degraded lands for the promotion of greens with respect to the unproductive agricultural lands. The rest (83.90%) were found to have not adopted the practices of forestry in degraded lands. With respect to afforestation in villages, 33.90 per

cent of farmers adopted Afforestation in villages and the rest (66.10%) were non- adopters, mostly because of the non-availability of lands near to their home.

The maintenance of social forestry in degraded farm lands helps to promote the afforestation in farmer's field. It provides subsidiary income i.e., giving timber, fruits and honey. It benefited the The Nilgiris biosphere reserve through green cover rehabilitating grazing lands and rangelands with soil and water conservation practices. Afforestation in villages helps for appropriate land use according to land availability of the community. It helps villagers in cultivating plantation crops and horticultural crops as it gives subsidiary income to the farmers.

Agro Forestry Practices

Agro forestry or agro-silviculture is a land use management system in which trees or shrubs are grown around or among crops or pastureland. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy, and sustainable land-use systems. The distribution of respondents with respect to adoption of agro forestry practices is presented in Table 3.

Table 3: Adoption of Agro Forestry Practices (n=118)

Sl. No.	Agro Forestry Practices	Adopters		Non Adopters	
		No.	%	No.	%
1.	Inter cropping of forest trees with agricultural crops	33	27.97	85	72.13
2.	Multispecies plantation	38	32.20	80	67.80
3.	Silvi pastoral practices	24	20.34	94	79.66
4.	Shade trees inside plantations	58	49.15	60	50.85

Table 3 reveals with respect to agro forestry practices, (27.97%) of farmers adopted inter cropping of forest trees with agricultural crops. Multispecies plantation was adopted by (32.20%). Further, the table infers 20.34 per cent farmers adopted silvipastoral practices. About half of the farmers (49.15 per cent) adopted shade trees inside plantations.

Agro forestry practices likes inter cropping of forest trees with agricultural crops, multispecies plantation, silvipastoral practices and shade trees inside plantations encourages the biodiversity conservation practices. Agro forestry systems would be advantageous over non-eco friendly conservation practices. Biodiversity in agro forestry systems is typically higher than in non-eco friendly conservation practices. Two or more interacting plant species in a given land area create more complex habitat that could support a wider variety of birds, insects, and other animals. That's why relatively significant section of respondents adopted the agro forestry practices. More areas of plantation and vegetable crops are the main causes of more number of non-adopters of the Afforestation practices.

Integrated Farming System

Integrated farming system practice encourages the tree cover areas near to the adjacent forest areas. The distribution of respondents with respect to adoption of integrated farming system practices is presented in Table 4.

Table 4: Distribution of Respondents based on the Adoption of the Integrated Farming System (n=118)

Sl. No.	Integrated Farming System	Adopters		Non Adopters	
		No.	%	No.	%
1.	Cultivation of agricultural crops and forestry trees.	22	18.64	96	81.36
2.	Cultivation of agricultural crops and fodder crops.	12	10.16	106	89.84
3.	Cultivation of agricultural crops, fodder crops and live stock	24	20.33	94	79.67

From the above Table 4 it could be seen that 18.64 per cent of respondents were found cultivating agricultural crops and forest trees together, followed by 10.16 per cent of the respondents who cultivated agricultural crops and fodder crops, 20.33 per cent of the respondents were found with cultivation of agricultural crops, fodder crops and live stock.

The fundamental role and function of agro-ecosystems on nutrient cycles includes preserving and enhancing soil fertility, maintaining and improving a diverse environment. These could be the reasons the farmers would have adopted the IFS. More areas of plantation crops and vegetable crops are supported to be the main causes for more number of non-adopters of the afforestation practices category.

Soil and Water Conservation Practices

In The Nilgiris biosphere reserve, degraded areas, denuded gullies, and steep slopes contribute greatly to the sedimentation and siltation of stream channels. Huge amount of soil particles that are washed away settle in farm areas in the low lands through surface runoff thereby destroying agricultural crops. This creates pollution and damage to the eco system.

The distribution of respondents with respect to adoption of soil and water conservation practices is presented in Table 5.

Table 5: Distribution of Respondents based on the Adoption of Soil and Water Conservation Practices (n=118)

Sl. No.	Soil and Water Conservation Practices	Adopters		Non Adopters	
		No.	%	No.	%
A.	**Cropping System based Soil and Water Conservation Practices**				
1.	Fallow land	35	29.66	83	70.34
2.	Conservation tillage	34	28.81	84	71.19
3.	Cover cropping	33	27.97	85	72.03
4.	Mulching	58	49.15	60	50.85
5.	Crop rotation	45	38.13	73	61.17
B.	**Vegetative Method of Soil and Water Conservation Practices**				
1.	Treatment of land slip areas with vegetative barriers	17	14.41	101	85.56
2.	Staggered trenching with vegetative methods	18	15.25	100	84.75
3.	Strip cropping	15	12.71	103	87.29
4.	Agave plantations in the areas prone to landslides	13	11.02	105	88.98
5.	Regeneration of vegetation over slope	26	21.03	92	78.97
6.	Choice of crops and cropping system	38	32.20	80	67.80

From the above Table 5 among the practices, fallow land, conservation tillage, cover cropping, mulching, and crop rotations were found with relatively more number of adopters (29.66%, 28.81%, 27.97%, 49.15% and 38.13 respectively).

In vegetative method, treatment of land slip areas with vegetative barriers, staggered trenching with vegetative methods, strip cropping, agave plantations in the areas prone to landslides, regeneration of vegetation over the slope and choice of crops and cropping systems were adopted by 14.41 per cent, 15.25 per cent, 12.71 per cent, 11.02 per cent, 21.03 per cent and 32.20 per cent respectively.

Soil and water conservation practices like fallowing of lands, conservation tillage, cover cropping; mulching and crop rotation are low cost agricultural cultivation practices. It is very effective in the farm fields than the structural rehabilitation measures such as check dams, stone walls, bench terracing and gabions which are considered very effective

as rehabilitation measures.

Vegetative soil and water conservation practices like treatment of land slip areas with vegetative barriers, staggered trenching with vegetative methods, strip cropping, agave plantations in the areas prone to landslides, regeneration of vegetation over slope and choice of crops and cropping system enhances the biomass of the farm fields. Grasses or trees can be used as vegetative strips or cover in various ways. Vegetative strips can be planted to conserve soil moisture, nutrient recycling and prevent soil erosion.

Agave plant is grown as a hedge plant in tribal areas of high altitude in The Nilgiris district. It protects the soil from soil erosion. And so, the agave plant yields quality fibre useful for preparation of ropes, mats and decorative materials. These possible advantages would be responsible for adoption ofsoil and water conservation practices.

Biodiversity Conservation Practices

Bio-diversity conservation has been classified into two major categories ‘in situ’ and ‘ex situ’. The distribution of respondents with respect to adoption of biodiversity conservation practices presented in Table 6.

Table 6: Distribution of Respondents based on the Adoption of Biodiversity Conservation Practices (n=118)

Sl. No.	Biodiversity Conservation Practices	Adopters		Non Adopters	
		No.	%	No.	%
A	**In-Situ Conservation Practices**				
1.	Cultivating traditional crop varieties	41	34.75	77	65.25
2.	Cultivating location specific crops	43	36.44	75	63.56
3.	Conserving the micro organism, population	44	37.29	74	62.71
4.	Preserving soil biota	26	22.03	92	77.97
5.	Utilization of locally available resources	38	32.20	80	67.80
6.	Maintenance of crop diversity	38	32.20	80	67.80
7.	Use of biological control methods	37	31.36	81	68.64
B.	**Ex-Situ Conservation Practices**				
1.	Maintenance of seed banks for traditional crops	16	13.56	102	86.44
2.	Preservation of extinct varieties	18	15.25	100	84.75
3.	Use Indigenous post harvest, storage and value addition practices	12	10.17	106	89.83

Table 6 reveals that among the in situ conservation practices, cultivating location specific crops, conserving the micro organism population, preserving soil biota, utilization of locally available resources, maintenance of crop diversity, use of biological control methods were adopted by 34.75 per cent, 36.44 per cent, 37.29 per cent, 22.03 per cent, 32.20 per cent, 32.20 per cent and 30.36 per cent of farmers respectively.

Ex-situ conservation practices like maintenance of seed banks for traditional crops, preservation of extinct varieties, use of indigenous post harvest, storage and value addition practices were adopted by 13.56 per cent, 15.25 per cent, and 10.17 per cent of the respondents respectively.

In-situ conservation means conserving plants in their natural habits (on site) through conservation of biodiversity with cultivating traditional crop varieties and location specific crops. And so, the in-situ conservation practices provides various non -timber forest produces like fruits, fibre, fodder, medicinal plants etc.

Organic Soil Fertility Conservation Practices

Among the eco friendly conservation practices, adoption of the organic soil fertility conservation practice play very important role. The distribution of respondents with respect to adoption of organic soil fertility conservation practices is presented in Table 7.

Table 7: Distribution of Respondents Based on the Adoption of Organic Soil Fertility Conservation Practices (n=118)

Sl. No.	Organic Soil Fertility Conservation Practices	Adopters		Non Adopters	
		No.	%	No.	%
1.	Green manuring	47	39.83	71	60.17
2.	Green leaf manuring	45	38.13	73	61.87
3.	Organic manure	95	80.50	23	19.50
4.	On farm residues for soil conservation	53	44.92	65	55.08
5.	Organic farming with analogue forestry	44	37.29	74	62.71
6.	Organic herbicides application	39	33.05	79	66.95

Table 7 infers that in the practices of green manuring, green leaf manuring, organic manure, on farm residues for soil conservation, organic farming with analogue forestry, organic herbicides were found to have been adopted by (39.83%, 38.13%, 80.50%, 44.92%, 37.29% and 33.05%) of the respondents respectively.

Organic soil fertility conservation practices enrich the nutrient recycling. It gives sufficient minerals (trace elements) for plant nutrition. It also contains soil organic matter that improves soil structure and soil moisture retention.

Low External Input for Sustainable Agriculture

The low-external-input and sustainable agriculture is defined as the optimal use of locally available natural and human resources (such as soil, water, vegetation, local plants and animals, and human Labour, knowledge and skill) and which is economically feasible, ecologically sound, culturally adopted and socially adjustable.

The distribution of respondents with respect to adoption of low external input for sustainable agriculture practices is presented in Table 8.

Table 8: Distribution of Respondents based on the Adoption of Low External Input for Sustainable Agriculture Practices (n=118)

Sl. No.	Low External Input For Sustainable Agriculture	Adopters		Non Adopters	
		No.	%	No.	%
1.	Integrated nutrient management	39	33.05	79	66.95
2.	Integrated pest management	29	24.58	89	75.42
3.	Integrated disease management	27	22.88	91	77.12
4.	Integrated weed management	12	10.17	106	89.83

Table 8 suggested that integrated nutrient management, integrated pest management, integrated disease management and integrated weed management were found to have been adopted by (33.05%, 24.58%, 22.88% and 10.17%) of respondents respectively.

The low external input for sustainable agriculture related practices supports the effective utilization and management of cultural, mechanical, organic and reduces application of chemical pesticides. These practices conserve the

environment and sustainable agricultural production. More areas of plantation crops and vegetable crops and complexity of the practices is the main the cause of more number of non- adopters of the afforestation practices.

Eco Friendly Agronomic Practices

The distribution of respondents with respect to adoption of eco friendly agronomic practices is presented in Table 9.

Table 9: Distribution of Respondents based on the Adoption of Eco Friendly Agronomic Practices (n=118)

Sl. No.	Eco Friendly Agronomic Practices	Adopters		Non Adopters	
		No.	%	No.	%
1.	Optimum time of sowing	38	32.20	80	67.80
2.	Non- burning of crop residues	49	41.53	69	58.47
3.	Proper irrigation practices	24	20.34	94	79.66
4.	Prevention of livestock grazing	16	13.56	102	86.44
5.	Suitable drainage mechanism	13	11.02	105	88.98
6.	Alley cropping system	16	13.56	102	87.44
7.	Inter cropping system	37	31.36	81	69.64
8.	Mixed cropping system	31	26.27	87	73.73

From the table 9 it could be revealed that optimum time of sowing, non burning of crop residues, proper irrigation practices, prohibition of livestock grazing, suitable drainage mechanism, alley cropping system, inter cropping system, mixed cropping system were found to have been adopted by (32.20%, 41.53%, 20.34%, 13.56%, 11.02%, 13.56%,31.36% and 26.27%) respectively.

The condition of The Nilgiris biosphere reserve has been deteriorating due to high external inputs and contamination caused by our modern fertilizers and pesticides.

CONCLUSIONS

In this context, the eco-friendly conservation practices minimize the agricultural production risks and conserve the sustainable management of the The Nilgiris biosphere reserve. The relative advantage of eco friendly conservation practices would naturally demanded for optimum yield, sustainable productivity and better quality of the products. Nearly one fifth (16.10%) of the farmers adopted the practices of forestry in degraded lands, followed by 33.90 percent of farmers adopted the practices of afforestration in villages. With respect to agro forestry practices, (27.97%) of farmers adopted inter cropping of forest trees with agricultural crops. Multispecies plantations were adopted by (32.20%). Nearly one-fifth (18.64%) of the farmers were cultivating agricultural crops and forest trees together. Among cropping system based soil and water conservation practices, fallowing of land, conservation tillage, cover cropping, mulching, crop rotations were relatively more number of adopters (29.66%, 28.81%, 27.97%, 49.15% and 38.13%) respectively. With respect to vegetative method of soil and water conservation practices, Treatment of land slip areas with Vegetative barriers, Staggered trenching with vegetative methods, Strip cropping, Agave plantations in the areas prone to landslides, regeneration of vegetation over the slope, choice of crops and cropping systems were adopted by 14.41 per cent, 15.25 per cent, 12.71 per cent, 11.02 per cent, 21.03 per cent and 32.20 per cent respectively. In the ‘in situ’ conservation practices of cultivating traditional crop varieties, cultivating location specific crops, conserving the micro organism, population, preserving soil biota, utilization of locally available resources, maintenance of crop diversity, use of biological control methods were adopted by 34.75 per cent, 36.44 per cent, 37.29 per cent, 22.03 per cent, 32.20 per cent, 32.20 per cent and

30.36 per cent respectively. With respect to 'ex-situ' conservation practices, maintenance of seed banks for traditional crops, preservation of extinct varieties, use of indigenous post harvest, storage and value addition practices were adopted by 13.56 per cent, 15.25 per cent, and 10.17 per cent of respondents respectively. The practices of green manuring, green leaf manuring, organic manure, on farm residues for soil conservation, organic farming with analog forestry, organic herbicides were adopted by (39.83%, 38.13%, 80.50%, 44.92%, 37.29% and 33.05%) of the farmers respectively. The practices of integrated nutrient management, integrated pest management, integrated diseases management and integrated weed management were adopted by (33.05%, 24.58%, 22.88% and 10.17%) of the farmers respectively. The practices of optimum time of sowing, non-burning of crop residues, proper irrigation practices, prohibition of livestock grazing, suitable drainage mechanism, alley cropping system, inter cropping system, mixed cropping system were adopted by (32.20%, 41.53%, 20.34%, 13.56%, 11.02%, 13.56%,31.36% and 26.27%) respectively.

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