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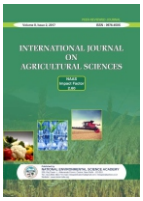

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ENHANCING ADOPTION OF AGRO FORESTRY IN THE NORTH WESTERN AGRO ECOLOGICAL ZONE OF TAMIL NADU

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Review Article

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ABSTRACT

The present study was undertaken in North Western Zone of Tamil Nadu, to analyze the factors determining the agro-forestry and problems faced by them in adoption of agroforestry practices. Primary data were collected through a pre-structured questionnaire from a sample of 300 respondents who were selected using multi-stage random sampling technique. Data analysis was done by using simple percentages, Ordinary Least Squares (OLS) multiple regression analysis, perception index and weighted score method. Most of the farmers in study area have positive perception towards adoption of agroforestry practices. The goal of this study was to determine the characteristics that influence the adoption of agroforestry by small and marginal farmers. Crop diversification, Increasing soil fertility, Improve soil and water conservation, Long time taken to get income from forestry, high returns and Reduce chances of crop failure were the major motivational factor, whereas small landholding size, lack of awareness and poor knowledge, poor market accessibility, lack of subsidy, credit facility, lack of good quality planting material and longer gestation period of trees were the major problems faced by the farmers in the study area. Thus, study suggested that farmers can be encouraged to practice agroforestry through improved mobilizing farmers to join groups, improving the quality and coverage of extension services, consideration of gender issues and intensifying agro forestry training among farmers with low levels of education groups and distribution of quality planting material to farmers.

Keywords: Agroforestry – adoption – enhancing- ecological zone.

INTRODUCTION

A good deal of attention is given now-a-days to development of sustainable farming systems. While pursuing the objective of attaining sustainable farming systems, agro forestry is rising in importance for reducing pressure on natural forests as well as tackling climate change. At the same time, it provides the higher returns to small scale farmers and improving livelihood security. Agro forestry is seen as an alternative paradigm for rural development worldwide that is centred on species-rich, low-input agricultural techniques including a diverse array of new indigenous tree crops, rather than on high-input monocultures with only a small set of staple food crops (Bijalwan et al., 2017). It is currently practiced on 13.5 million ha area in India (Chavan *et al.*, 2015). Therefore, the adoption of agroforestry systems holds the potential for addressing the solution of current problems like the rapid increase in the human population, deforestation and environmental degradation (Banyal *et al*., 2015).

Farmers in Tamil Nadu have long been growing a variety of native trees in their farm lands to maintain land productivity and to provide for subsistence needs, such as timber, fodder for livestock and fuel wood for cooking. However, modern agro forestry with exotic fodder and grass species is still a relatively new practice in Tamil Nadu. The decline in fodder, fuel wood, and timber production in public and community forests due to widespread deforestation has led farmers in recent years to increase the number of fodder and other trees

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on their farm lands Several studies indicate improvements in tree growing on the private farm lands to compensate the loss of trees in the forest. The decline in forest cover has been associated with increased soil erosion, lowered soil fertility, and reduced agricultural productivity. Moreover, most of the research on agroforestry has been carried out on a biophysical perspective but analyzing farmers' perception, attitude towards agroforestry are important for increasing its adoption rate among the farmers. Therefore, the present study was undertaken in North Western Zone of Tamil Nadu with the specific objectives to analyze the factors determining agro-forestry adoption level in the study area. The study has also attempted to identify the problems faced by the farmers in the adoption of agroforestry practices in the study area.

Data and Methodology

Tamil Nadu is divided into seven major crop zones based on the agro-climatic conditions of the state. These are North Eastern Zone, North Western Zone, Cauvery Delta Zone, Southern Zone, Western Zone, High Rainfall Zone and Hilly Zone. Among this zone the study was conducted in the North Western Zone of Tamil Nadu. This zone occupies 23.39 % of the total geographical area and about 36 % of the cultivated area of the state. Within the NWZ, Dharmapuri district was selected purposively. Multi-stage random sampling design was used for the selection of the sample in the study area. At the first stage, out of five developmental blocks, Palacode and Pappireddipatti were selected randomly where agroforestry practices were more predominant. In the next stage, three villages with the major agroforestry practices were selected from each selected block. At the final stage, 50 farmers from each selected villages were selected who were involved in agroforestry practices. In totality, a sample of 300 households was drawn for the study. Data were collected on well designed pre-tested schedules by adopting a personal interview method from the selected households in the study area. The secondary data required for the study were obtained from Seasonal Crop Report, Tamil Nadu, Directorate of Economics and Statistics, various published materials etc. The data collected was analyzed using simple percentages, Ordinary Least Squares (OLS) multiple regression analysis, perception index and Friedman Test. While the percentages were used for the presentation of socio–economic characteristics, the regression analysis was used to determine the factors affecting the adoption for two models for Agri-Siliviculture and two models of Siliviculture. The implicit model of the regression was:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 6_2 + \beta_7 X_7 + \beta_8 X_{8+} + u$$

where,

Y	=	Number of trees planted on farm
X_1	=	Age of the head of the rural household (years)
X_2	=	Educational level (years)
X_3	=	Household Size of Farmers (Number of Persons)
X_4	=	Experience in Agro forestry practices (Years)
X_5	=	Size of farm holding (ha)
X_6	=	Farmers Income (₹ /annum)
X_7	=	On- Farm Monetary Benefits of planting trees (yes=1; no=0)
X_8	=	Cost of establishing and managing tress (moderate to very large Influence=1; no influence and little Influence=0)
X_9	=	Trees for future generation (moderately important and very important=1; Unimportant and slightly important=0)
β_0	=	Intercept
u	=	Random error term

The value of b 1 measure the change in the mean value of dependent variable per unit change in the indepedent variables.

Perception towards Adoption of Agro forestry

Perception is the process of understanding sensation or attracting meaning based on past experience to signs (Taneja, 1989). In the present study, it refers to the users' perception

about the adoption of agro forestry. List of items seeking different contents of agro forestry practices such as increase soil fertility, increase farm income, soil and water conservation, reduce chances of crop failure, household expenditure reduction through tree fodder and fuel, long time taken to get income from forestry and maintained/ improved environmental condition were prepared.

The respondents were asked to state on a five point continuum *viz*., strongly disagree, disagree, neutral, agree, strongly agree with the score of 5, 4, 3, 2 and 1 respectively. Based on the scores, the Perception Index was calculated by using the following formula.

$$\text{Perception Index} = \frac{\text{Individual respondent score}}{\text{Total Score}} \times 100$$

Friedman test

To rank the factors determining the adoption of agro forestry, Friedman test was used. The Friedman test is a non-parametric test that compares three or more matched or paired groups. The Friedman test first ranks the values in each matched set (each row) from low to high. Each row is ranked separately. It then sums the ranks in each group (column). If the sums are very different, the P value will be small. Prism reports the value of the Friedman statistic, which is calculated from the sums of ranks and the sample sizes. The two factors included in the Friedman test are ecological factors and economic factors. The ecological variables influencing the adoption of agro forestry were soil erosion reduction, wood and other product, increasing soil fertility, shelter against wind, nitrogen fixation, waste assimilation, carbon storage, provision of shades, livestock feed, employment opportunities and recreation. The economic factors influencing the adoption of agro forestry are agricultural income, energy provision, diversification of Agro forestry products, overall family income, sustainable agriculture and subsidiary income

The orders of the merit assigned by the respondent were converted into ranks using the formula were

$$\bar{r}_{.j} = \frac{1}{n}\sum_{i=1}^{n} r_{ij}$$

$$\bar{r} = \frac{1}{nk}\sum_{i=1}^{n}\sum_{j=1}^{k} r_{ij}$$

$$SS_t = n\sum_{j=1}^{k}(\bar{r}_{.j} - \bar{r})^2$$

,

$$SS_e = \frac{1}{n(k-1)}\sum_{i=1}^{n}\sum_{j=1}^{k}(r_{ij} - \bar{r})^2$$

The test statistic is given by $Q = \frac{SS_t}{SS_e}$. The value of Q as computed above does not need to be adjusted for tied values in the data. Finally, when n or k is large (i.e., n > 15 or k > 4), the probability distribution of Q can be approximated by that of a distribution.

In this case the p-value is given by $\mathbf{P}(\chi^2_{k-1} \geq Q)$. If n or k is small, the approximation to chi-square becomes poor and the p-value should be obtained from tables of Q specially prepared for the Friedman test. If the p-value is significant, appropriate post-hoc multiple comparisons tests would be performed.

If the P value is small, null the hypothesis idea that all of the differences between columns are due to random sampling can be rejected, and conclude instead that at least one of the treatments (columns) differs from the rest. Then look at post test results to see which groups differ from which other groups.

If the P value is large, the data do not give any reason to conclude that the overall medians differ. This is not the same as saying that the medians are the same. Just have no compelling evidence that they differ. If they have small samples, Friedman's test has little power.

RESULTS AND DISCUSSION

Pattern of Investment in Agro forestry

The functional allocation of land for agriculture and forestry does not appear to be capable of meeting the multifarious demand of the growing population and industries. The answer could be found in integrating agriculture and forestry. “Agro-forestry system” is the only viable system that can solve the present problem. In agro-forestry systems, there are many well established systems in which one or more woody perennials will serve as base crop.

It could be observed from the Table 1 that the investment in agro forestry contributed for small, semi –medium, medium

Table 1: Pattern of Investment in Agro forestry. **(₹ /hr)**

Groups	Owned Fund	Borrowed Fund	Total Amount invested in Agro forestry
I (1 to 2 hectare)	5188 (8.49)	7209 (20.44)	12397 (15.19)
II (2 to 5 hectare)	9292 (15.21)	13936 (39.52)	23228 (28.46)
III (5 to 10 hectare)	16773 (12.15)	4286 (12.15)	21059 (25.80)
IV(more than 10 hectare)	29835 (27.89)	9835 (27.89)	24939 (30.55)
Total	**61088 (100.00)**	**35266 100.00)**	**81623 (100.00)**

(Figures in parentheses indicate percentage to the total)

and large farmers, that the investment in agro forestry contributed from small farmers group by 15.19 per cent total amount invested in agro forestry. The contribution of borrowed fund to agro forestry from semi medium group was higher as 39.52 per cent among group of farmers. The contribution of owned fund to agro forestry from large farmers share was 27.89 per cent which is higher among the all groups of farmers.

Spatial Zone

The different agro-forestry systems, Agri-Silviculture system is popular in Dharmapuri district. In this system, Agricultural crops are grown along with tree crops and this can be further classified into groups such as temporal and spatial. The spatial group is further classified into spatial mixed and spatial zoned. Temporal is rotational. The percentage wise classification is furnished in Table 2.

It was found that agricultural crops are grown separately and the tree crops are allocated a separate zone, an ideal tree growing areas, about 164.11 hectares which accounts 42.16 per cent.

Table 2: Spatial Zone.

Sl. No	Types of Agro forestry	Area Covered (ha)
1	Spatial zoned	164.11(42.16)
2	Spatial mixed	224.06 (57.56)
3	Rotational	1.06 (0.28)
Total		**389.23 (100)**

(Figures in parenthesis indicate the percentage of the system in total cultivated area)

Spatial Mixed

It was revealed that agricultural crops are intercropped with tree crops. The trees are grown in alternate row or in borders. This system was practiced in 57.56 per cent of the study area.

Rotational

It was revealed that agricultural crops and tree crops are grown in rotation. This kind of system was not popular and it was found to be 1.06 hectares with the share of 0.28 per cent to the total area.

Factors Affecting Adoption of Agro forestry

The adoption is calculated as the number of tree planted per farm. The implicit model of the regression is as follows: $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, e)$. The independent variables were age of the head, educational level, household size, farming experience, farm size, farmers' income, on-farm monetary benefit, cost of establishing and managing tress and trees for future generation were used.

Where,

Y= Number of tree planted per farm

X_1= Age of the head of the rural household (years)

X_2= Educational (years)

X_3= Household Size of Farmers (Number of Persons)

X_4= Farming Experience of Farmers (Years)

X_5= Farm Size of Farmers (Hectares)

X_6= Farmers Income (₹ /annum)

X7 =On- Farm Monetary Benefits of planting trees (yes=1; no=0)

X8= Cost of establishing and managing tress (moderate to very large Influence=1; no influence and little Influence=0)

X9= Trees for future generation (moderately important and very important=1; Unimportant and slightly important=0)

Table 3: Result of regression analysis for Teak.

Sl. No	Particulars	Co-efficient	Standard Error	Significance
	Dependent variable (Number of tree planted on farm)			
1	Intercept	-571.976	124.21	NS
2	Age of the head of the rural household (years)	2.05	0.233	**
3	Education level	1.163	0.498	NS
4	Household Size of Farmers	0.026	0.514	NS
5	Experience in agro forestry practices (Years)	4.563	0.047	***
6	Size of farm holding (ha)	2.301	0.011	**
7	Farmers Income	4.233	0.527	***
8	On- Farm Monetary Benefits	1.672	0.325	***
9	Cost of establishing and managing trees	4.272	0.570	NS
10	Trees for future generation	2.77	0.136	*
	R			0.802
	F-Ratio		14.708	
	Number of observation		48	

Note: *** Significance at 1 per cent ** Significance at 5 per cent
* Significance at 10 per cent NS – Non significant

It could be revealed that Table 3 that the coefficient of multiple determination (R^2) of Silviculture I (Teak) has a value of 0.80 indicating that the independent variables (X_1, X_2,……., X_8) jointly explained 80 per cent of the variation in the dependent variable. The regression constant was found to be negatively significant to the dependent variable (number of tree planted on farm). The reason behind was cost of establishing and managing trees was difficult in teak cultivation.

The result revealed from the table that farming experience, farmers' income and on-farm monetary benefits of planting trees was found to be 1 per cent significant level with the value of 4.563, 4.233 and 1.672 per cent respectively. Farmers' age and size of farm holding was significant at 5 per cent to the dependent variable. It was observed from the table that education level of the farmers, household size and cost of establishing and managing trees.

The F-ratio which determines the overall significance of a regression is statistically significant at the 1 per cent level of probability because the F-calculated value (4.286) is greater than the F-tabulated value (2.82). This implies that the independent variables jointly exerted great influence on the adoption level of agro forestry practices. The farmers' socio-economic characteristics are positively significantly related to the adoption level of agro forestry practices in the teak cultivation.

The regression result for Agri-Silviculture II (Tamarind + Sorghum) observed that R^2 is 0.791 which implies that 79 per cent variation in number of tree planted per farm is being accounted for by the independent variables in the Table 4. From the result, it could be seen that size of farm holding and farmers income was significant at 1 per cent levels with the value of 1.328 and 2.778 respectively to the dependent variable.

Further, Experience in agro forestry practices and on-farm monetary benefits are found to be 10 per cent significant level. Age of the farmers, education level, household size, cost of establishing and managing trees and trees for future generation was found to be non- significant to the number of tree planted per farm.

Table 4: Result of regression analysis for Tamarind + Sorghum.

Sl. No	Particulars	Co-efficient	Standard Error	Significance
	Dependent variable (Number of tree planted on farm)			
1	Intercept	2.373	1.055	**
2	Age of the head of the rural household (years)	0.174	0.284	NS
3	Education level	0.141	0.385	NS
4	Household Size of Farmers	0.089	0.698	NS
5	Experience in agro forestry practices (Years)	0.295	0.490	*
6	Size of farm holding (ha)	1.328	0.589	***
7	Farmers Income	2.778	0.762	***
8	On- Farm Monetary Benefits	-0.403	-0.415	*
9	Cost of establishing and managing trees	0.392	0.385	NS
10	Trees for future generation	0.215	0.716	NS
	R^2		0.791	
	F-Ratio		16.233**	
	Number of observation		69	

Note: *** Significance at 1 per cent ** Significance at 5 per cent
* Significance at 10 per cent NS – Non significant

This may imply that experience in agro forestry practices X6 and X7 could have important implication on the adoption of agro forestry practices in the study area. The positive sign implies that an increase in these variables will enhance agro forestry practices in adoption level of Tamarind + Sorghum.

Table 5: Result of regression analysis for Tamarind.

Sl. No	Particulars	Co-efficient	Standard Error	Significance
	Dependent variable (Number of tree planted on farm)			
1	Intercept	18.852	16317.96	NS
2	Age of the head of the rural household (years)	0.392	0.385	NS
3	Educational level	0.062	0.650	**
4	Household Size of Farmers	0.686	1.064	NS
5	Experience in agro forestry practices (Years)	-0.812	0.716	**
6	Size of farm holding (ha)	2.504	2117.66	***
7	Farmers Income	2.951	0.597	***
8	On- Farm Monetary Benefits	1.089	1.860	NS
9	Cost of establishing and managing tress	-0.409	0.590	NS
10	Trees for future generation	0.546	0.709	***
	R^2		0.652	
	F-Ratio		3.723	
	Number of observation		47	

Note: *** Significance at 1 per cent ** Significance at 5 per cent
* Significance at 10 per cent NS – Non significant

In case of adoption of tamarind farms (Silviculture model II), the estimated function was valid for interpretation as shown by R^2 which was 0.65. However, the function had explanatory power, *i.e.*, R^2 value which could indicate that 65 per cent of variation in farm investment could be explained by the explanatory variables included in the function. The value of R^2 and statistically significant value of the intercept would indicate that there might be omission of qualitative variables that could not be measured. From the result, it could be seen that size of farm holding, farmers income and trees for future generation was significant at 1 per cent levels with the value of 2.504, 2.951 and 0.546 per cent respectively tot the endogenous variable.

Further, Age of the farmers, household size, on farm monetary benefits and cost of establishing and managing trees was found to be non- significant to the dependent variable. This may imply that experience in agro forestry practices size of farm holding, farmers income and trees for future generation could have important implication on the adoption level of tamarind farmers. The positive sign implies that an increase in these variables will enhance tamarind farming in the study area.

Perception of Agro forestry

The respondents were aware of the economic and environmental benefits of agro forestry practices under favorable attitude towards their practices are mentioned in the Table 6. It may be due to the fact that significant portions of respondents were literate. It could be concluded from the table that most of the respondents strongly agreed that agro-forestry practices increased soil fertility, soil and water conservation, reduced the chances of complete crop failure, household expenditure reduction through tree fodder and fuel, long time taken to get income from agro forestry and improve environmental condition.

These households realized that plantation of trees under unutilized portion of the farmland has not dwindled in the overall output of the farmland and livestock contributed to increases the overall household income. Thus, these practices had reduced the chances of complete crop failure.

It was noticed that the respondents under agreed statement was more when compared to statement under strongly agree agro forestry practices from which saved time opened up avenues for other farming activities. It is noteworthy that these households have experienced improved greenery and saw increased role of farm trees to meet their need of fodder and firewood. However, they agreed with the statement that, it takes long time to get income from agro forestry practices. This is due to the fact that tree species are long duration crops. Finally, 5 per cent of the respondent was increased farm income were strongly disagreed these adoption practices in the study area.

Table 6: Perception towards Adoption of Agro forestry Practices.

Statement	Responses				
	SDA	DA	N	A	SA
Agro forestry Practices					
Increase Soil Fertility	-	36 (15.00)	52 (21.67)	108 (45.00)	44 (18.33)
Increase farm income	15 (5.00)	20 (8.33)	34(14.16)	138 (57.50)	36 (15.00)
Soil and water Conservation	-	-	52 (21.67)	36 (15)	152 (63.33)
Reduce chances of crop failure	-	-	54 (31.25)	108 (45.00)	78 (32.50)
Household expenditure reduction through tree fodder and fuel.	-	-	-	75 (31.25)	165 (68.75)
Long time taken to get income from forestry	-	40 (16.67)	45 (18.75)	73 (30.42)	82 (34.17)
Maintained/improved Environmental condition	-	-	-	101 (42.08)	139 (57.92)

Figure in parentheses is percentage.
Source: Field Survey, 2018
Note: 5 = Strongly Disagree, 4 = Disagree, 3 = Neutral, 2 = Agree, 1 = Strongly Agree

Ecological Factors Influencing the Adoption of Agro forestry Species.

Tables 7 indicate the Statistical test of Ecological factors influencing farmers' adoption of agro forestry species by using Freidman test.

Table 7: Ecological Factors Influencing the Adoption of Agro forestry Species.

Ecological Factors	Mean Rank	Test Statistics
Soil erosion reduction	4.55	N = 240
Wood and other product	3.17	Chi-Square=399.564
Increasing soil fertility	2.77	Degree of freedom = 10
Shelter against wind	1.88	Asymp.Sig.= 0.004
Nitrogen fixation	4.28	
Waste assimilation	4.40	
Carbon storage	3.27	
Provision of shades	5.23	
Livestock feed	2.62	
Employment opportunities	4.63	
Recreation	5.46	

Source: Field Survey, 2018-19.

It could be concluded from the table that the most influencing factors are: Shelter against wind with 1.88 mean rank followed by livestock feed, increasing soil fertility, wood and other products, carbon storage, waste assimilation, reduction of soil erosion, nitrogen fixation, employment generation, provision of shades and recreation with mean rank of 2.62, 2.77, 3.17, 3.20, 4.28, 4.40, 4.55, 4.63, 5.23 and 5.46 respectively. With Friedman statistical test with p-value of 0.004 at significance level 0.05, there is a statistical significance difference as p-value is less than 0.05. Therefore, there is a significant difference between ecological factors influencing farmers to adopt agro forestry species in the study area.

Economic Factors Influencing Farmer's Adoption of Agro forestry Species

There are different economic factors influencing farmer's adoption of Agro forestry species in farmland as shown in Table 8. It was evidence from table that the first economic factor influencing farmer's adoption of Agro Forestry species is the diversification of products such as timber, fodder. Stakes, wood for cooking and constructing houses with the mean rank of 1.72. Next were overall family income, energy provision, sustainable agriculture and subsidiary income with the mean rank of 2.68, 3.16, 4.38 and 4.50 respectively. The last economic factor influencing farmers' adoption is the agricultural income with 4.56 mean rank. As the p-value of 0.007 at significance level 0.05 is less than 0.05, there is an overall statistical significant difference between the economic factors influencing farmers to adopt agro forestry in the study area.

Table 8: Economic factors influencing farmers' adoption of agro forestry.

Economic Factors	Mean Rank	Test Statistics
Agricultural income	4.56	N = 240
Energy provision	3.16	Chi-Square=468.662
Diversification of Agro forestry products	1.72	Df = 5
Overall family income	2.68	Asymp. Sig.= 0.007
Sustainable agriculture	4.38	
Subsidiary income	4.50	

Source: Field Survey, 2018-19.

CONCLUSIONS AND RECOMMENDATIONS

Although the study was limited to Tamil Nadu State constituted the sample of the study, certain reasonable conclusions have been made from the results of the study. The study conducted in North Western Zone of Tamil Nadu has revealed that the farmers are mostly marginal with farm size of less than 1.0 ha. This definitely confines them to practice agro forestry farming on a small scale. The study has outlined the significance of age, educational level, income, access to credit, and extension contact in adoption of agro forestry technologies. This implies that adoption of agro forestry technologies require mainly young, educated, large and rich farmers with access to credit and higher contact with extension personnel. The study has made following recommendations.

- ✓ Promotion of Agro forestry will help to reduce the imbalance in the market of timber and poles and make the marketing of the product efficient. Formal education is vital in promoting Agro-forestry in the area through educating farmers on its importance and the risk of deforestation.
- ✓ Attention should be focused on farmers over 55 Years who are mainly the decision-makers in most households and conservatives in technology adoption. Small-scale farmers should be encouraged to grow more trees and to commercialize this investment so as to diversify on their source of income.
- ✓ The first broad implication is that need to provide extension education support to promote adoption of improved agro forestry technologies through the provision of knowledge and skills to small holder farmers.
- ✓ Farmers should be provided with loans preferably at market interest rates to solve farmers' problem of inadequate finance. The loans should be supervised to see that they are not diverted to wrong hands and ensure equally judicious utilization of such loans by farmers.

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