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Factors determining forestry adaptation level among tribal farmer's in kolli hills

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Abstract
Forests play a role in the adaptation of broader society and on the most effective investments to assist farmers strengthen factors (media, extension officials, neighboring farmers, age, experience of the farmer, education level of the household head, gender, temperature, water availability, rainfall, farm income and credit availability) influencing their choice of adaptation measures. This study uses the Heckman Probit Model to analyze the two-step process of adaptation measures to forestry, which initially assesses a farmer's perception about forestry and followed by an examination of the response to this perception form of adaptation. Simple purposive random sampling was used to select the farmers out of six revenue villages of kolli hills. The dependent variables are adaptation measures perceived by farmers, where the independent variables are those natural, socio-economic, institutional and physical factors influencing the choice of these measures. The results indicate that media, information from neighbouring farmers, experience of farmers and rainfall are significant variables which influences the awareness of farmers about forestry. Variables that significantly affect adaptation decision are water availability, credit availability, education level of farmer and land holding size. Being non- significant, variables like age, gender, guidance from government officials, low temperature and farm income are not affecting the decision criteria of farmer.

Keywords: Forestry, perception, adaptation, heckman probit model.

Introduction
Forests play a role in the adaptation of broader society ('forests for adaptation'). Forests provide services that enhance human well-being and reduce social vulnerability, which must be consider in planning adaptation policies and practices across broader areas of the economy. Modern forestry including the provision of timber, fuel wood, wildlife habitat, natural water quality management, recreation, landscape and community protection, employment, aesthetically appealing landscapes, biodiversity management, watershed management, erosion control and preserving forests as sinks for atmospheric carbon dioxide. The conservation and sustainable management of ecosystems and their services can generate multiple socio-ecological benefits and promote long-term approaches to forestry adaptation.

Methodology
The selected study area, Kolli Hill (Kollimalai in Tamil) has an area of 371.30 sq. km. It stretches 29 km from north to south and 19 km from east to west. A pilot survey of the study was stipulate to achieve firsthand knowledge about the study area and scope for the study. It was decided to limit the sample size to 240 randomly selected sample farmers distributed equally at the rate of 40 sample farms in six revenue villages of kolli hills.
Adaptation to forestry in tribal region implicates a two-stage process: first observing change and then fixing whether to adopt or not to adopt a distinct measure. This give rise to sample selectivity problem since only those who observed the forestry will adopt, whereas we might wish to make declaration about the adaptation made by the population of tribal peoples. This implies using Heckman's sample selectivity probit model.
The awareness of our sample farmers about forestry and the decision to select adoption measures was considered a two-stage process. The first stage is whether tribal people are aware of forestry ecosystem or not. The second stage involved whether the tribes who are aware of changes are likely to adopt certain strategies to adapt to forestry. The second stage, called the "outcome" stage was considered a sub-sample of the first stage, the "selection" stage. Since the outcome stage is a sub-sample of the selection stage, it is likely that the sub-sample would be non-random and different from those farmers who are not aware of forestry in the full sample. A sample selection bias may occur, which could diagnose by the maximum likelihood Heckman's two-step or Heckit selection procedure (Heckman, 1979) [5]. The Heckman two-step estimation is a way of estimating treatment effects when the treated sample is self-

selected. The application of this model in this study is to estimate the determinants of an individual tribal decision to select adoption. The first step is to identify the tribes who are aware of forest ecosystem, and then given that results the outcomes (adaptation) would be modeled (Deressa *et al.*, 2009) [3].

Heckman's sample selection model assumes that there exists an underlying relationship, which consists of the latent equation given by:

$$y^*_j = x_j\beta + u_{1j} \quad \text{..... (1)}$$

Where, y^*_j is the latent variable (the propensity to adapt to forestry), x is a k-vector of explanatory variables, which includes different factors hypothesized to affect adaptation, β is the parameter estimate and u_{1j} is an error term. Therefore, only the binary outcome given by the probit model is observed as

$$y_j^{probit} = (y^*j > 0) \quad \text{..... (2)}$$

The dependent variable is observed only if the observation j is observed in the selection equation:

$$y_j^{select} = (z_j\delta + u_{2j} > 0) \quad \text{..... (3)}$$
$$u_1 \sim N(0, 1)$$
$$u_2 \sim N(0, 1)$$
$$\text{corr}\ (u_1, u_2) = \rho$$

Where, y_j select is whether a farmer has observed forestry or not, z is an m vector of explanatory variables, which includes different factors hypothesized to affect perception; δ is the parameter estimate, $u_{2j,}$ u_1 and u_2 are error terms, which are normally distributes with mean zero and variance one. Thus, the first stage of Heckman's two-step model is the selection model (equation 3), which represents the perception of forest ecosystem. The second stage is the outcome model (equation 1), which represents whether the farmer adapted to forestry, and is conditional upon whether this has been observed.

When the error terms from the selection and the outcome equations are correlated or when $\rho \neq 0$, standard probit techniques applied to equation yield biased results. Thus, the Heckman probit provides consistent, asymptotically efficient estimates for all parameters in such models (Van de Ven & Van Praag 1981) [9]. Hence, the Heckman Probit Selection Model is employed to analyze the perception and adaptation to forestry among tribes in the study area.

The model specification for the present study is as follows:

The first stage of estimation is concerned with the factors affecting the tribal farmer's awareness about forestry. The empirical econometric equation is as follows.

$$AWARE_i = \beta_0 + \beta_1 MEDIA + \beta_2 NTRIBAL + \beta_3 EXTEN + \beta_4 AGE + \beta_5 EXP + \beta_6 EDU + \beta_7 GENDER + \beta_8 TEMP + \beta_9 WATER + \beta_{10} RAIN + \beta_{11} FINCOME + \beta_{12} CREDIT$$

The second stage of estimation deals with the probability of factors influencing the tribal farmer's adaptation decision to forest ecosystem.

$$ADAPT_i = \beta_0 + \beta_1 MEDIA + \beta_2 NTRIBAL + \beta_3 EXTEN + \beta_4 AGE + \beta_5 EXP + \beta_6 EDU + \beta_7 GENDER + \beta_8 TEMP + \beta_9 WATER + \beta_{10} RAIN + \beta_{11} FINCOME + \beta_{12} CREDIT$$

Results and Discussion

The descriptive statistics of the variables used in the model are presented in table 1. The table gives the mean and standard deviation values of the variables taken for analysis. The estimated model indicated classification rates of 83 per cent for adaptation, 17 per cent for non-adaptation and for the overall classification rate (86 per cent). In Heckman model farmer's perception about forestry was taken as dependent variable for selection and adaptation of forestry was taken for outcome stage.

The results indicate that the adaptation function of the Heckman probit model was significant (wald χ^2 472.00, with $p<0.0000$), showing strong explanatory power of the model (Deserra *et al*., 2010).

The analysis of farmers' perceptions about forestry indicates that most of the farmers (86 per cent) aware about forestry in the study. The results further indicate that farmers get awareness about forestry by their own experience, information from media, neighboring farmers and discussing with officials. In this study, 83 per cent farmers have adapted more than three adaptive measure. Major factors such as level of education level of the household head, size of the land holding, credit availability, rain, availability of water and credit availability are positively influencing the decision of farmers regarding adaptation to forestry. When rainfall increase, it reduces the quality of the timber value hence it is negatively influenced. Other factors such as media, neighbouring farmers, extension officials, age of the household head, gender, temperature, farm income are not significant in affecting the farmers' awareness and adaptive level of forestry.

Table 1: Descriptive Statistics of Heckman Probit Model Variables

Selection Model Dependent variable			**Outcome model Dependent variable**			
Description	**Farmers awareness about forestry (%)**	**Farmers did not aware about forestry (%)**	**Description**	**Farmers reported to have adapted (%)**		**Farmers reported not to have adapted (%)**
Perception to forestry	**86**	**14**	**Adaptation to forestry**	**83**		**17**
S. No	**Independent Variables**		**Selection Model**		**Outcome model**	
			Mean	**SD**	**Mean**	**SD**
1.	Information given by media		0.30	0.46	0.30	0.46
2.	Information from neighboring farmers		0.37	0.48	0.37	0.48
3.	Information from officials		0.15	0.36	0.15	0.36
4.	Age of the household head		56.87	12.70	-	-
5.	Experience of the tribes		34.62	18.66	34.62	18.66
6.	Educational level of tribes		2.46	4.45	2.46	4.45
7.	Gender of the household head		0.88	0.32	-	-
8.	Land holding size		-	-	1.65	1.19
9.	Low Temperature		-	-	0.85	0.37
10.	Water scarcity		-	-	0.15	0.35
11.	Precipitation of rain		-	-	0.07	0.26
12.	Income from forest crops		-	-	23500.03	12900.65
13.	Availability of subsidy		-	-	0.34	0.52

Table 2: Results of Heckman Probit Selection Model

S. No	Variables	Selection Model				Outcome Model			
		Regression		Marginal Effects		Regression		Marginal Effects	
		Co-efficient	P Value	Co-efficient	P Value	Co-efficient	P Value	Co-efficient	P Value
1.	MEDIA	0.0921*	0.080	0.0362	0.062	0.7841	0.383	0.1561	0.383
2.	NFARMER	0.1962**	0.041	0.0801	0.040	0.3677	0.269	0.3181	0.269
3.	EXTEN	0.0510	0.448	0.0076	0.436	0.5333	0.378	0.4324	0.378
4.	AGE	0.0027	0.775	0.0007	0.212	-	-	-	-
5.	EXP	0.1030***	0.532	0.0027	0.000	0.6302	0.918	0.0756	0.918
6.	EDU	0.1452	0.414	-0.0237	0.392	0.2032***	0.003	0.1512	0.003
7.	GENDER	0.0032	0.973	0.0164	0.974	-	-	-	-
8.	FSIZE	-	-	-	-	0.1587**	0.025	0.0060	0.024
9.	TEMP	0.0403	0.721	0.0059	0.666	0.3589	0.734	0.1329	0.737
10.	WATER	-	-	-	-	2.2867***	0.003	0.6788	0.003
11.	RAINFALL	0.2465***	0.002	0.0612	0.000	-0.6132***	0.000	-0.7132	0.000
12.	INCOME	-	-	-	-	2.01 e-05	0.512	0.13e-07	0.512
13.	CREDIT	-	-	-	-	0.5620*	0.061	0.0172	0.060

Notes: ***- 1% significant level, **- 5% significant level, *- 10% Significant level respectively.

Kolli hills farmers are surviving with forest ecosystem and comprised with agriculture, tree crops and livestock. According to this surrounding system, sustainably in the forthcoming years to combat with forestry crops and measures they take to adapt and mitigate it. Hence it is needed to provide timely and relevant information and tackling measures to adaptive forestry to be made available for farmers through forest and extension officials. These analysis of the factors that influence farmers perceptions of an adaptation to forestry suggest number of different policy options. These options include raising awareness about forestry among farmers and appropriate methods, facilitating and availability of credit for the forest crops, technology packages for increasing the farm income are better suited for the hill areas.

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