# RESEARCH ARTICLE

# FOREST DEPENDENCY, PARTICIPATION IN FOREST MANAGEMENT AND ENVIRONMENTAL SUSTAINABILITY: A CASE STUDY IN WEST BENGAL, INDIA

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## ARTICLE INFO

## ABSTRACT

This study was conducted to examine the extent to which the rural poor living in the forest fringe areas of West Bengal, India were dependent on forest for their subsistence. The study also analysed their participation in forest management and its impact on the environment. Total 300 households in 9 villages in the districts of Bankura and Purulia were surveyed. Both statistical and econometric techniques (Censored Tobit Model) were used to analyse the determinants of collective action in forest management. Logit Regression Method was used to analyse the nexus between active forest management and forest degradation. The results of the study indicated that in those households where the percentage of the agricultural income to the total income is very low, the participation in forest management is very active. The study also revealed that collective action in forest management is positively related to the percentage of common forest resource income to total income of the rural households. The result also confirmed that forest management has a critical role in reducing forest degradation.

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## INTRODUCTION

Forests contribute extensively to the social and economic well-being of the rural poor. A majority of the rural poor in India are largely dependent on common property resources such as forest resources. One fifth of the land area of India is covered by forest. As per World Bank Report (2006), an estimated 275 million people in rural areas of India depend largely on forests. According to the report, about half of India's 89 million tribal people, the most disadvantaged section of the Indian society, live in forest fringe areas, and they tend to have close cultural and economic links with the forest. Forest products, including the non-timber forest products (NTFPs) like food, fruits, flowers, medicines etc., provide the means of subsistence for the rural poor. The incentive involved in common property resource (CPR) management was first established by Gordon (1954) and later by Hardin (1968). Hardin formulated that over exploitation of the common property resources led to depletion of shared limited resources as several individuals acted independently in their own self-interest. The concept of decentralized collective management of the common property resources was postulated by Berkes (1989) and Ostrom (1990). Ostrom (1990) was of the view that the CPR management would be successful if there were defined boundaries, an

efficient and effective conflict-resolution and monitoring mechanism. Several empirical researches dealing with the dependence of common property resources of the rural poor were conducted in different regions in India. Noteworthy, amongst them are Jodha (1986), Iyengar (1997), Beck and Ghosh (2000), whose theories highlighted the danger of depletion of the common property resources due to pressure from privatization. The importance of participatory management in resolving the crisis of CPRs in India was postulated by Chopra *et al.* (1989).

On the study of historical perspective of Joint Forest Management, Sarker and Das (2006) observed that resistance movement of the forest communities in Midnapore in West Bengal was the key to the success of the Joint Forest Management (JFM) programme. The authors were also of the view that the immediate survival needs, generating mainly subsistence and income from non-timber forest products (NTFPs) for the forest protection committee members were the key to the long term sustainability of Joint Forest Management system. Highlighting the practice of JFM across the states of India in general and West Bengal in particular, this paper assesses the nature of participation in forest management and examines the relationship between forest dependency and participation in forest management in our study area. The paper also focuses the relationship between the intensity of management practice and the degradation of forest resources.

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## MATERIALS AND METHODS

The evidence presented in this paper is based on the primary data collected from field survey on Common Property Resources conducted in 2011. The field survey was undertaken in 6 villages in the district of Bankura in West Bengal, India; viz. Ramjibanpur (Bandhghat), Ramjibanpur (Seolibona), Dulaltora, Panjhoria and Tantirdanga and 3 villages in the district of Purulia in West Bengal, India; viz. Jiyathole, Marbediya and Ambari. Total 300 households were surveyed. These villages were selected for the survey because the villages were in close proximity to the forest area and it was presumed that the collection and dependency on CPRs in these villages are very high. Further, Joint Forest Management is well established in the study area.On the basis of the information gathered during the survey, we have analysed how the socio-economic factors and dependency on forest products affect the level of participation and collective action in Joint Forest Management. We have used a tabular method to quantify the Forest Management and enforcement of forest protection scheme by comparing JFM in 9 villages of these two districts. We have used both statistical and econometric techniques (Censored Tobit Model) to analyse the determinants of collective action in JFM and to test the hypotheses. Logit Regression Method was used to analyse the nexus between active forest management and forest degradation. In this paper we have tested the following hypothesis:

$H_1$: There is a strong relationship between forest dependence and active participation in JFM

$H_2$: Active participation in forest management plays a positive role in alleviating the environmental degradation.

## RESULTS AND DISCUSSION

### Forest Management in the Study Area

The villages in the study area are situated in the forest fringes below the hills. The villagers collect forest products in the form of twigs, snails, fodder/grasses, fuel wood, cow dung, herbal medicine, bamboo, timber, fruits, honey, vegetables, fish, birds and broom. As these forest products have several uses in the socio-economic lives of the rural poor, they are becoming concerned about protecting these resources.The Joint Forest Management was initiated in the study villages in 1992 after the JFM resolution 1990 of state Govt. of West Bengal. The Forest Department of the state Government of West Bengal is actively involved in the Joint Forest Management and along with the villagers are jointly responsible for protection of the forest and wildlife.A Forest Protection Committee (FPC) in the study areas has been formed whose prime responsibility is to protect the forest. The FPC involves the local people in planning, development of the forest and regeneration of the forest through plantation of trees. In case, anyone breaks the rule enforced by the Forest Protection Committee or engage in illicit felling of the forest trees, then the villagers reprimand him. In case he continues to illegally cut the forest trees then, when caught, the Forest Protection Committee take away his cutting implements and impose a penalty ranging from Indian Rupees 100/- to 500/- depending upon the seriousness of the crime. The participation of households and the enforcement of forest protection scheme in the study villages have been depicted in Table 1 below:

From the table, it is observed that the incidents of cases of violation of rules have shown a declining trend in most of the surveyed villages during the period 2008-2010. From the above data it is also observed that in the villages of Ramjibanpur, Seolibona and Baldanga the incidents of cases of rule violation and refusal of penalty imposed are high as compared to other villages in the study area. It is further observed that in the year 2010, the number of incidents of 'refused to pay penalty' is nil in the villages of Dulaltora in Bankura district and Jiyathole in Purulia district. This implies that forest management is more active in these villages as compared to other villages in the study area.

### Collective Action in Joint Forest Management

Collective action refers to concerted actions of people that share a common interest, perceive that interest and act to achieve it (World Bank, 1998). It is voluntary or mandatory depending on the type of action being executed and the institutions within or through which the action is executed (Gregario, *et al*., 2004).Our primary focus in this paper is to explore how forest dependency influences household's active participation in Joint Forest Management. Local communities, whose income from agriculture or other sources is uncertain, are very much dependent on forest for their income and consumption and are thus more interested to conserve forest resources. Initially, the households who were very much dependent on the forest and whose income from forest resources was high could not afford the cost of restrained forest use. These households therefore did not show any interest in the conservation of the forest resources as they stayed out of the JFM programme and collected forest products illegally. Later they realised that if they did not conserve the forest resources then it was not possible to smoothen their income and consumption during the period of agricultural uncertainty.

The Joint Forest Management becomes effective only if the local rural community whole heartedly participates in the managing of the common forest resources. In order to protect the forest from illegal felling of the trees, the forest patches has to be guarded and monitored day and night by the villagers as per the guidelines laid down in the JFM. Since a large part of their participatory labour is to be involved in JFM activity, there is always a question of trade off with that of agricultural operations. The villagers are involved in agriculture primarily for their own consumption. The agricultural activity is seasonal. This is due to the fact that there is lack of proper irrigation facility in the villages and the villagers have to depend heavily on the rain for their cultivation. Hence the villagers have to decide about allocating their endowed labours either in agricultural activities or in forest protection activities that also produces means for their subsistence. Now, the forest resources that can be managed effectively by the local rural communities depend on the strength of the collective action i.e. joint action of the community to conserve forest resources as well as improve rural livelihood.We have explained the determinants of collective forest management through

**Table 1.**

## Forest Management and Enforcement of Forest Protection Scheme

| District | Name of Village | No. of House holds | No. of Households participated in JFM (2010) | Active JFM participants (2010) | Incidents of cases of violation of rules | | | No. of Overuse caught, warned and freed | | | No. of cases imposed penalty | | | No. of cases refused to pay penalty | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2008 | 2009 | 2010 | 2008 | 2009 | 2010 | 2008 | 2009 | 2010 | 2008 | 2009 | 2010 |
| Bankura | Panjhoria | 26 | 26 | 18 | 7 | 6 | 4 | 4 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 1 |
| | Ramjibanpur | 20 | 10 | 2 | 9 | 7 | 6 | 5 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Seolibona | 54 | 40 | 20 | 13 | 10 | 9 | 8 | 5 | 5 | 5 | 5 | 4 | 3 | 2 | 4 |
| | Baldanga | 7 | 2 | 0 | 6 | 5 | 5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 |
| | Dulaltora | 18 | 18 | 15 | 6 | 4 | 3 | 4 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 0 |
| | Tantirdanga | 25 | 17 | 14 | 8 | 6 | 5 | 5 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 2 |
| Purulia | Jiyathole | 81 | 78 | 70 | 7 | 3 | 1 | 3 | 3 | 0 | 4 | 2 | 1 | 1 | 1 | 0 |
| | Marbediya | 26 | 15 | 8 | 12 | 8 | 6 | 8 | 6 | 3 | 4 | 3 | 3 | 3 | 3 | 2 |
| | Ambari | 43 | 35 | 23 | 9 | 7 | 4 | 5 | 4 | 2 | 4 | 3 | 2 | 2 | 1 | 1 |
| | **TOTAL** | **300** | **241** | **170** | **77** | **56** | **43** | **45** | **33** | **21** | **32** | **26** | **21** | **21** | **15** | **16** |

Source:Survey data 2011

econometric analysis to give an understanding of the relationship between forest dependency and active forest management. Collective action in forest management is measured by time involvement in the management of forest resources. The 9 villages in our study area from the two districts of Bankura and Purulia have been considered separately and their results have been compared. Attempt has been made to capture the relevant socio-economic variables that influence the strategy of collective action in forest management in the study area. In this context following Bwalya (2004), we have specified an econometric model of collective action and discuss the choice and expected signs of explanatory variables.

We estimate the following econometric model of collective action

$$L_{M_i} = a_{i1} + \sum_{j=2}^{n} b_{ij} Y_{ij} + \in$$

where $a_{i1}$ denotes community dummies, $Y_{ij}$ is set of explanatory variables including the index of individual organisational experience, livelihood activities, socio-cultural heterogeneity, age, gender, household size, wealth, forest condition and $\in$ is the error term. $L_M$ is the dependent variable defined as the amount of labour household contributes to local management and $i$ and $j$ indexes communities and individual variables respectively. Our intension is to examine the impact of forest dependency on collective action in JFM. Here the dependent variable is the number of man days per year involves in JFM activities. Field survey data shows that about 25 percent of the total respondents in Bankura district and 15 percent in Purulia district allocated zero man days to JFM activities. Hence we have applied Censored Tobit model as it makes survey data more convenient to analyse. Since the dependent variable is censored from below, we apply maximum likelihood estimation to estimate the Censored Tobit model.

Our specified model is

$$L_{M_i} = a_0 + b_1 FSIZE + b_2 FEMPER + b_3 AVRAGE + b_4 AVRSCH + b_5 PERAGRIN + b_6 PERCPRIN + b_7 PERCPRCSM + b_8 WEALTH + \in$$

Here $a_0$ is constant and $b_i (i = 1, 2, ..., 8)$ are the coefficients associated with the explanatory variables and $\in$ is the random disturbance term. Here the dependent variable is Collective Action $(L_M)$ i.e. number of mandays contributed in monitoring, planning & implementation and management of community forest resource.

The independent variables are:

$FSIZE$ =Average number of population of the household (Size of the family)
$AVRAGE$ =Average age of the respondent
$AVRSCH$ =Average year of schooling of household
$PERAGRIN$ =Percentage of Agricultural income to Total income
$PERCPRIN$ = Percentage of income from common property resources to Total income
$PERCPRCSM$ =Percentage of CPR consumption to Total consumption
$WEALTH$ =Total household assets
$WEALTH$ = 1 for 'Well to do' household
$WEALTH$ = 0 for poor household

The key independent variables are percentage of Agricultural income to total income ($PERAGRIN$) and CPR income to total income ($PERCPRIN$). It was expected that households whose agricultural income is steady are less interested in active participation in JFM. On the other hand household whose percentage of CPR income to Total income are high i.e. more dependent on forest resource are actively involved in collective action in Joint Forest Management.

Empirical estimation of model specified in the above equation is described in the following Table 2.

percent level and Purulia at 1 percent level. This indicates that the households participate in the JFM, primarily to gain access

**Table 2. Determinants of Collective Action**

Dependent Variable: LABJFM (Contribution of labour in JFM)
Method: ML-Censored Normal (TOBIT)
Sample: 1 300

**Bankura District and Purulia District**

| Variable | Coefficient | z-Statistic | Prob. | Coefficient | z-Statistic | Prob. |
|---|---|---|---|---|---|---|
| C | -8.939720 | -0.773580 | 0.4392 | 4.171649 | 0.524970 | 0.5996 |
| FSIZE | 1.763608 | 2.330597** | 0.0198 | 1.553762 | 2.968042* | 0.0030 |
| AVRAGE | 0.280050 | 1.451314 | 0.1467 | 0.109737 | 0.826905 | 0.4083 |
| AVRSCH | -0.009263 | -0.011940 | 0.9905 | -0.070155 | -0.131468 | 0.8954 |
| PERAGRIN | -0.595780 | -3.232150* | 0.0012 | -0.910248 | -7.382397* | 0.0000 |
| PERCPRIN | 0.540002 | 2.309159** | 0.0209 | 0.550850 | 3.431650* | 0.0006 |
| PERCPRCSM | 0.083001 | 0.227227 | 0.8202 | 0.212440 | 0.836177 | 0.4031 |
| WEALTH | -4.858511 | -1.470618 | 0.1414 | -7.024702 | -3.107020* | 0.0019 |

*Significant at 1 percent level, ** Significant at 5 percent level, *** Significant at 10 percent level
Source: Estimated by EViews7 computer software using field survey data of 2011

We have observed from the determinants of Collective Action in JFM that most of the parameter estimates for household variables have expected sign and are statistically significant. Results show that family size ($FSIZE$) and average age ($AVRAGE$) have a positive effect on collective action in JFM in the surveyed villages of both Bankura and Purulia district. Family size ($FSIZE$) is positive and significant suggesting that a larger family size collects more CPR product and thus increases the scarcity of the forest resources. So they are bound to actively participate in the JMF in order to conserve the forest resources. Positive effect of average age of the respondent ($AVRAGE$) implies that aged people, due to their experience, are more interested to allocate labour in Joint Forest Management. In the cases of $AVRAGE$, the result is not significant. In both the districts we have observed that education ($AVRSCH$) has a negative effect on collective action in JFM. This implies that educated people are mostly involved in the service sector or off-farm wage labour and hence they get less time to devote in monitoring or silvicultural activities in the JFM. However, this result is insignificant in both the districts. Actually in some cases educated household understand the importance of preservation of forest resources and are thus more likely to actively participate in the JFM activity and also motivate other villagers to participate as well.

It is evident from the analysis that collective action in JFM is negatively related to percentage of agricultural income to total income of the household ($PERAGRIN$) in both the district of Purulia and Bankura. In Bankura district, it is significant at 1 percent level of significance and in Purulia district it is highly significant. This implies that household who has steady income from agriculture does not bother much about forest resources and are therefore less interested in active participation in JFM. On the other hand, household who depend on CPR products because of uncertain agricultural income are more interested in conserving forest resources and give more labour time in different activities of JFM. In line with our expectation, we observe a positive relation between percentage of CPR income to total income ($PERCPRIN$) and collective action in JFM in both the districts and the result is significant for Bankura at 5

to the forest outputs from the forest resources, so as to overcome the uncertainty and insecurity in their livelihood. We have hypothesised a positive relation between percentage of CPR consumption to total consumption ($PERCPRCSM$) and active participation in JFM. In fact the households who depend more on CPR for their consumption purposes are very much concerned about forest resource conservation and hence actively participate in JFM. However, the coefficient is positive in this case in both the districts although the result is insignificant. The coefficient of wealth ($WEALTH$) have the expected negative signs on collective action management in the two surveyed districts and significant at 1 percent level in Purulia and 10 percent in Bankura. This signifies that wealth reduces the incentive among the households to actively participate in the JFM. In few cases 'well to do' households participate in the JFM only for social capital i.e. personal interest, self-esteem, respect, etc. or for their compulsion of strong ties with the Government officials. The above result indicates a strong relationship between forest dependence and active participation in JFM.More active the management practice is, greater is the probability of efficient use of forest resources. Forest management lowers the degree of over exploitation and hence the degradation of forest resources.

**Collective Action and Forest Conservation**

Forest management has its inherent impact on the conservation of forests. More active the management practice is, greater is the probability of efficient use of forest resources. Forest management lowers the degree of over exploitation and hence the degradation of forest resources. We now examine the role of forest management to reduce forest degradation by using logit regression model. A range of socioeconomic and environmental variable has been considered.

The logit-regression model has been fitted as follows:

$$\log(\frac{P_i}{1-P_i}) = a + b_1 AVRAGE + b_2 AVRSCH + b_3 FSIZE + b_4 OWNLAND$$

$+b_5 LIVESTOCK + b_6 POVR + b_7 FMACT$

Here the dependent variable is forest degradation ($FDGR$) which is a dummy variable equal to '1' if there is 'more degradation' and equal to '0' if there is 'less degradation'. Forest Degradation is measured on the basis of the data collected in the village survey from three different variables - Extent of forest damage visually seen (FD), Condition of the forest informed by the respondents as compared to that of earlier times (FC) and Forest use penetration i.e. the depth into the forest from the village boundary where use pressure was evident (FP). All these three variables (FD, FC, FP) are coded (using four point scale) so that increasing values shows more forest degradation.

The dependent variable is $FDGR$ i.e. Forest Degradation
$FDGR$ =1, if there is more degradation
$FDGR$ =0, if there is less degradation
The Explanatory variables are:
$FSIZE$ =Average number of population of the household (Size of the family)
$AVRAGE$ =Average age of the respondent
$AVRSCH$ =Average year of schooling of household
$OWNLAND$ =Total land owned by the household
$LIVESTOCK$ =Total number of livestock condensed into animal units
$POVR$ =Poverty of the household
$POVR$ =1; if household belongs to BPL
$POVR$ =0; if household belongs to APL
$FMACT$ =Active Forest Management
$FMACT$ =1 in case of active forest management
$FMACT$ =0 in case of inactive forest management

The logit regression model has been tested using the household level data through field survey of Bankura and Purulia districts. The result is given in Table 3 below:

Management activity ($FMACT$) in both the districts. In fact every family member of the household engages themselves in collecting forest products and thus degrades the environment to a large extent. Hence in the case of households with large family size ($FSIZE$), the probability of the incidence of forest degradation is high. However, the result is significant only in Purulia district. The positive relation between ($AVRAGE$) and ($FDGR$) suggest that experienced elder members degrade the forest resources critically by collecting more CPR products from forest. However, the result is insignificant in both the districts. Again, households with large number of livestock ($LIVESTOCK$) damage the environment by accumulating fodder to feed animals. Hence larger the number of livestock more is the probability of incidence of forest degradation. The coefficient of poverty ($POVR$) is positive and significant in both the districts which suggest a strong positive relationship between poverty and forest degradation.As expected education ($AVRSCH$) is negatively related to forest degradation. Educated people have many alternative income opportunities and hence less interested in collecting forest products. Thus educated people help to reduce the incidence of forest degradation. However, the result is significant in Bankura district only. In the case of ($OWNLAND$), the negative relationship indicates that the household who own large agricultural land get less time to collect CPRs from forest and hence causes less forest damage. Here the impact is insignificant in both the districts. The most important finding of this study is the role of active Joint Forest Management (JFM) in reducing the forest degradation. In line with our hypothesis, Forest Management activity ($FMACT$) has the expected negative sign i.e. active forest management is associated with a smaller extent of forest degradation.

*This result demonstrates that improved management has a positive role to check environmental degradation. Again it is observed that the association between Forest Management activity ($FMACT$) and forest degradation ($FDGR$) is negative*

**Table 3.**

**Determinants of Forest Degradation**

Dependent Variable: FRDGR
Method: ML-Binary Logit
Sample: 1 300;

**Bankura District and Purulia District**

| Variable | Coefficient | z-Statistic | Prob. | Coefficient | z-Statistic | Prob. |
|---|---|---|---|---|---|---|
| C | -4.808023 | -1.314529 | 0.1887 | -0.061882 | -0.016411 | 0.9869 |
| AVRAGE | 0.067295 | 1.230044 | 0.2187 | 0.025670 | 0.427301 | 0.6692 |
| AVRSCH | -0.963454 | -2.578651* | 0.0099 | -0.401253 | -1.111541 | 0.2663 |
| FSIZE | 0.259937 | 0.675353 | 0.4995 | 1.240305 | 2.248578** | 0.0245 |
| OWNLAND | -0.497346 | -1.257761 | 0.2085 | -0.375603 | -1.424570 | 0.1543 |
| LIVESTOCK | 2.019892 | 2.139753** | 0.0324 | 0.627338 | 1.226470 | 0.2200 |
| POVR | 6.757563 | 2.228042** | 0.0259 | 3.689960 | 1.670545*** | 0.0948 |
| FMACT | -6.082197 | -2.812468* | 0.0049 | -5.095440 | -2.545240** | 0.0109 |

*Significant at 1 percent level, ** Significant at 5 percent level, *** Significant at 10 percent level
Source: Estimated by E Views 7 computer software using field survey data of 2011

From the analysis it can be observed that forest degradation ($FDGR$) is positively related to average age ($AVRAGE$), family size ($FSIZE$), number of livestock ($LIVESTOCK$) and poverty ($POVR$) whereas negatively related to education ($AVRSCH$), total land owned ($OWNLAND$) and Forest

*and significant in both the districts. This is in line with our hypothesis that active participation of the rural poor in forest management helps in reducing the environmental degradation. It is further observed that most of the rural poor depend on common property resources for their livelihood. Hence the*

*CPRs should be properly managed so that the rural poor can get maximum benefit but not at the cost of nature.*

## Conclusion

The empirical evidence based on the survey of 6 villages in Bankura and 3 villages in Purulia suggest that the rural households are highly dependent on Common Property Resources for their subsistence and are therefore very much concerned about the regular depletion of the forest resources. In order to ensure the availability of the forest resources in the long run, the rural households have actively participated in the Joint forest Management activity in the study area. Empirical evidence suggests that 75.33 percent of the surveyed household in Bankura district and 85.33 percent of the surveyed household in Purulia district participate in JFM. We have explained the determinants of collective forest management through censored Tobit model to give an understanding of the relationship between forest dependency and active forest management. It is evident from the analysis that income from agriculture plays an important role in the participation of JFM. In those households where the percentage of the agricultural income to the total income is very low, the participation in JFM is very active. We further observed that collective action in JFM is positively related to percentage of CPR income to total income and the impact is significant in both the districts. Therefore the result is consistent with our hypothesis. In fact, the households participate in the JFM activity to gain access to the forest resources and thus mitigate any uncertainty and insecurity in their income. We had hypothesised that active participation in forest management plays a positive role in alleviating environmental degradation. The logit regression result confirms that Joint Forest Management has a critical role in reducing forest degradation. Improved forest management plays a positive role in sustainable forest ecosystem.

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