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# An Economic Inquiry into Collective Action and Household Behaviour in Watershed Management

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## I

## INTRODUCTION

The concept of integrated and participatory watershed management has emerged as the cornerstone of rural development in the dry, semi-arid and other rainfed regions of the world. Most watershed projects in India are implemented with the twin objectives of soil and water conservation and enhancing the livelihoods of the rural poor (Sharma and Scott, 2005). The experiences show that sustainability of watershed management is closely linked to the effective participation of the communities who derive their living from natural resources and the success of watershed development programs is largely dependent on the active participation of the watershed community. However, after more than three decades of planning and implementation, it is still unclear to what extent the programme has been successful in securing local villagers' participation in the watershed development and in ensuring collective action.

Although several studies on peoples' participation in natural resource management (Bouma, 2005; Pender and Scherr, 1999; Edmonds, 2001; Meinzen-Dick *et al.,* 2002; Gebremedhin *et al.,* 2003; Heltberg, 2001; Lise, 2000; Bardhan, 2000; White and Runge, 1995) have been conducted, still there is gap in the literature in terms of reasons for success and failure of household participation in natural resources management (NRM) and how government and donor interventions can shape that process. Also, empirical studies, which compare different levels of participation across households, and qualitative and quantitative analysis that identifies the key determinants of these different levels of household participation in NRM particularly in watershed management, are limited. This paper addresses household participation in watershed management in India.

Keeping these issues in view, the present paper addresses the following research questions: which type of farm households participate in collective action in watershed management, which type do not and why?. What factors influence farm households' decisions to participate in collective action? What institutional and

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financial arrangements need to be in place for people's participation and collective action to be sustained over time? What policy actions must be taken both at the micro and macro level to gear up peoples' participation in collective action for sustainable watershed management?. To address these research questions, the present study aims to study the people's participation, collective action in watershed management and farm household behaviour in micro watersheds in Western zone of Tamil Nadu, India. The specific objectives of the study are to (i) examine the extent of collective action exerted by the rural farm households, (ii) identify the factors that influence collective action in watershed management, and (iii) suggest appropriate policy measures to enhance people's participation and collective action for sustainable watershed management.

## II

## STUDY AREA AND DATA

The study area is Coimbatore district of Western Zone of Tamil Nadu state. The average annual rainfall of this district is 647.2 mm from winter, hot weather, southwest monsoons and northeast monsoons. The chief source of irrigation in the district is through wells. The district is also supplied water through irrigation tanks. There is a general decline in the water level in the entire Coimbatore district, which is attributed to the indiscriminate pumping of groundwater. The effect of groundwater resource degradation has resulted in the changes in crop patterns, well-deepening, an increase in well investments, pumping costs, well failure, and abandonment, and out migration. It is in this context that groundwater augmentation by artificial recharge through watershed development programmes has gained momentum.

Different types of watershed treatment activities are carried out both in private agricultural lands and village common lands. Activities in the private lands include soil and moisture conservation measures like contour/field bunding, land leveling, and summer ploughing. The activities carried out in common lands include drainage line treatment measures (loose boulder check dam, minor check dam, major check dam, and retaining walls); water resource development/management (percolation pond, and renovation of tanks); and horticulture plantation and afforestation (Sikka *et al.,* 2000; Palanisami and Suresh Kumar, 2002; Palanisami *et al.,* 2003). Training with reference to watershed technologies and related skills is imparted periodically to the people in the watershed. In addition, the members are also taken to other successful watershed models and research institutes for exposure.

### *Data*

To examine the type and extent of collective action in watershed management, this paper studies 12 micro watersheds in Coimbatore district, within these watersheds 60 user groups were selected and studied. The details of the selected watersheds and user groups are given in Table.1.

TABLE1 DETAILS OF STUDY WATERSHEDS AND USER GROUPS

| Name of watersheds (1) | Name of the block (2) | Stage of watersheds (3) | Project period | | Actual completion (6) | Number of user groups (7) | No. of households (8) |
|---|---|---|---|---|---|---|---|
| | | | From (4) | To (5) | | | |
| Paruvai | Sulur | Completed | 1998 | 2002 | March 05 | 4 | 20 |
| Salaiyur | Annur | Completed | 1998 | 2002 | 2002 | 4 | 12 |
| Karegoundampalayam | Annur | Completed | 1999 | 2003 | March 05 | 4 | 40 |
| V.Kallipalayam | Pongalur | Completed | 1999 | 2003 | March 05 | 3 | 10 |
| K.Ayyampalayam | Palladam | Completed | 1999 | 2003 | March 04 | 5 | 45 |
| Kallakinar | Pongalur | Completed | 1999 | 2003 | 2003 | 10 | 62 |
| Chettipalayam | Tirupur | On-going | 2002 | 2007 | .. | 4 | 32 |
| Thulukkamuthur | Avinashi | On-going | 2002 | 2007 | .. | 7 | 55 |
| Giddampalayam | Palladam | On-going | 2002 | 2007 | .. | 5 | 22 |
| Pattanam | Sulur | On-going | 2002 | 2007 | .. | 7 | 22 |
| Vadavalli | Annur | On-going | 2003 | 2008 | .. | 4 | 25 |
| Pogalur | Annur | On-going | 2002 | 2007 | .. | 3 | 23 |

*Source*: Field survey during 2005-2006.

The focus was on user groups actually taking over the operation and maintenance of the completed works or activities on common lands. A sample of 30 user groups was selected where the Project Implementing Agency had withdrawn its support (6 watersheds), i.e., post-project period. In order to study the functioning of these watershed institutions and what tasks different stakeholders perform 30 User Groups were selected from the watersheds where the programme is ongoing (6 watersheds). The details at the watershed level were collected from Watershed Committee, Project Implementing Agency and Village Panchayats. In addition, interviews were held with village elders and local leaders about village history and local institutions for resource management.

Proportionate random sampling procedure was employed to study the farm households. As the size of user group varies across the type of structures, 80 per cent of the user group members were randomly selected and studied for the purpose. A sample of 189 farm households was selected in completed watersheds and 179 farm households were selected in on-going watersheds. Thus, a total sample of 368 farm households were selected and studied. The details on general particular of household contribution in terms of labour, cash and other forms were collected.

## III

## METHODOLOGY

For the purpose of the study, household participation in collective action is defined as action taken by the individual household to manage watersheds in terms of contribution in cash, kind, labour, and participation in Participatory Rural Appraisal (PRA) exercises, watershed development plan meeting, monitoring activities etc.

Though the collective action is defined at the community level, individual household's action referred to as private action is also important (Sakurai, 2002). Private action affecting collective action in watershed management includes participation in PRA exercises, attending watershed development plan meetings, decision making process, adoption of soil and moisture conservation measures in the private lands, contribution towards construction and maintenance of watershed development structures and participation in training and exposure visits.

It is assumed that a household's decision to participate in collective action depends on the expected net benefits of such participation. This in turn is determined by (i) the expected cost of participation and (ii) expected benefits of participation in collective action.

*Cost of Participation in Collective Action*

The cost of households' participation in collective action comprises contribution in terms of cash, human labour, machinery, materials like water, etc. in both during construction and maintenance stage of watershed development, imputed value of labour in attending PRA exercises, watershed development plan meeting, training and exposure visits, monitoring during construction and maintenance activities. The cost of participation of a household is determined by various household-specific characteristics such as wealth position, cropping pattern, resource availability and dependency, educational level, off-farm and non-farm income sources, location of the farm and group level factors like size of the user group, social homogeneity, and type of structure.

*Benefits of Participation in Collective Action*

Private benefits from participation in collective action include the expected present and future benefits from development of watershed structures. The direct benefits include enhanced groundwater recharge, increase in water resources potentials and increase in agricultural production and thereby farm income. The indirect benefits include savings due to reduction in well deepening costs and drilling of new bore wells. The farm households participate in watershed development in order to get maximum benefits in the form of acquiring more information, subsidy benefits and provision of public goods and services to the watershed communities. Thus, the households' private benefits from participation in watershed management lie mainly with the impact on expansion in water resources at the farm level. This may be influenced by various household-specific characteristics, and user group level variables.

*Theoretical Framework*

Let a farm household, "I" participate in watershed management (through attending watershed development plan meetings, PRA exercises, contribution towards construction and maintenance activities, participation in training and exposure visits). Further, the expected benefits from participation in watershed management $EB^P_i$ is determined by the individual household and user group level factors. These include the contribution to watershed development and maintenance, Q, (including construction and maintenance of watershed development structures and opportunity cost of labour in attending meetings, PRA exercises, training and exposure visits), various household-specific characteristics, H, and user group characteristics, G.

$$EB^P_i = f(Q, H, G) \quad \ldots.(1)$$

The expected cost of participation in collective action in watershed management ($EC^P_i$) is determined by the contribution to watershed development and maintenance, Q, various household level characteristics, H, and user group level characteristics G, i.e.,

$$EC^P_i = g(Q, H, G) \quad \ldots.(2)$$

Let Q be the household contribution. It is assumed that there is decreasing marginal benefit and increasing marginal cost of contribution towards watershed management. Following Gebremedhin *et al.,* (2003), the benefit and cost functions, which are assumed to be quadratic, can be written as

$$\begin{aligned} EB^P_i &= a\,Q - b\,Q^2 \\ EC^P_i &= c\,Q + d\,Q^2 \end{aligned} \quad \ldots.(3)$$

where a,b,c and d are positive constants. The optimal level of household contribution Q* is affected by vector of household-specific factors (H), and user group level factors (G). It is assumed that the set of exogenous factors are assumed to shift the marginal benefit and cost curves but do not affect the slope of the curves. By incorporating the effect of these exogenous factors into the cost and benefit functions, we get

$$\begin{aligned} EB^P_i &= (\alpha X + \varepsilon_B)Q - bQ^2 \\ EC^P_i &= (\beta X + \varepsilon_c)Q - dQ^2 \end{aligned} \quad \ldots.(4)$$

Where, $\alpha$ and $\beta$ are coefficients to be estimated and $\varepsilon_B$ and $\varepsilon_C$ are stochastic disturbance terms. X includes the vector of household specific characteristics and user group level factors.

The marginal benefit and marginal cost of participation in collective action in watershed management can be derived using the eqn (4). The marginal benefit of participation is

$$\frac{\partial(EB^{P}{}_{i})}{\partial Q} = (\alpha X + \varepsilon_B) - 2bQ \qquad \ldots.(5)$$

The marginal cost of participation is

$$\frac{\partial(EC^{P}{}_{i})}{\partial Q} = (\beta X + \varepsilon_C) + 2dQ \qquad \ldots.(6)$$

We know that the necessary condition for profit maximization is MR=MC. Thus, from eqn (5) and (6), the benefit maximizing level of contribution could be derived. The benefit maximising level of contribution Q*, is when

$$\frac{\partial(EB^{P}{}_{i})}{\partial Q} = \frac{\partial(EC^{P}{}_{i})}{\partial Q} \qquad \ldots.(7)$$

i.e., $(\alpha X + \varepsilon_B) - 2bQ = (\beta X + \varepsilon_C) + 2dQ$

Rearranging and solving for Q, we get,

$$Q^{*} = \frac{(\alpha X - \beta X) + U_i}{2(b + d)} \qquad \ldots.(8)$$

From, equation (8), the amount of contribution made by the farm household is determined by various household level and user group level factors.

*Households Participation in Watershed Management*

A key concern for policy makers is the fact of making the farm households participate in watershed development activities. Thus, an important research question is what factors influence households participation in the watershed development activities. For the purpose, the amount of contribution made by the farmers is identified as the key indicator to represent household participation.

An empirical issue that needs to be considered, however, is that few households have not contributed. Thus, the dependent variable takes the value zero for these

households. Given that our dependent variable is censored at zero, a Tobit estimation rather than OLS is appropriate (Madalla, 1989; Tobin, 1958). Thus, the estimated reduced form model with the latent variable is specified as:

$$HC^{*} = X_j b + U_j$$

$$HC = HC^{*} \quad \text{.....if } X_j b + U_j > 0$$

$$= 0 \quad \text{.....if } X_j b + U_j \leq 0$$

$$j = 1 \text{.....n} \qquad \text{....(9)}$$

The error term $U_j$ is independently normally distributed with zero mean and constant covariance $\sigma^2$. In the above functional relationship, the variable HC is endogenous. It is hypothesised that the farm household's decision to participate in collective action in watershed management is influenced by a set of household level factors as well as user group level factors. The exogenous variables viz., FSIZE, EDUCATION, NWORKER, NINCOME, NWELLS, DISTANCE, UGSIZE, CASTE, PERCOLATION and CHECKDAM are expected to influence the household participation.

*A priori*, the relationship between the dependent variable contribution by the households and the factors, which determine is discussed here.

Farm size representing the wealthy position of the farm household and EDUCATION can have two different types of effects on household participation in collective action. They both offer exit options and this is likely to reduce participation (White and Runge, 1994; Lise, 2000). However, the farm households that are wealthy and have educated head can be influential in household's participation in collective action. They may also be able to supplement collective resources with their own. If this happens, then collective action is positively influenced.

It is reasonable to expect that the number of workers (NWORKERS) in the farm household have a positive influence on the collective action. More number of workers enables the household members to participate in the meetings organised, contribute voluntary labour and in the adoption of watershed management technologies (Heltberg, 2001). Income from non-farm sources will reduce the dependency of farm households on crop production on the one hand and enable the households to increase their income level on the other. Thus the variable NINCOME will logically have a negative effect on household's decision to participate in collective action (Lise, 2000).

Resource dependency influences the households to participate in collective action (Lise, 2000; Heltberg, 2001). To capture the effect of resource dependence, the variable NWELLS, or, the number of wells owned by the farm household, is

included. The greater the number of wells, the more important it is for these wells to be re-invigorated and this may lead households to participate in watershed management. Nearness to the rainwater harvesting structure will enable the farm households to get more benefits out of it. Thus, one can expect a negative relationship between the DISTANCE and the household's contribution to watershed development.

It is reasonable to expect that the smaller the user group size of a watershed resource/rain water harvesting structure, the more the collective action will be. This is mainly because when the group size is small, the problem of free riding and conflicts among the group members could be easily overcome (Rasmussen and Meinzen-Dick, 1995; Gebremedhin *et al.,* 2003). Thus it is expected that the variable UGSIZE has an inverse relationship with that of collective action.

The social homogeneity represented by caste is expected to influence household participation in collective tasks positively (Bardhan, 2000; Lise, 2000). Another important factor is the type of watershed technology constructed or maintained. The benefits from watershed development technology critically depend on the functions performed by the structure or technology put in place. And of course the benefits affect the behaviour of the beneficiaries. There are three types of watershed structures that are built or repaired in the study area: percolation ponds, check dams, and tanks that are renovated. Thus, the variables PERCOLATION and CHECKDAM are included in the model as dummy variables to study the influence of the type of watershed structure. These two constructed structures are expected to be perceived as more beneficial than pre-existing tanks. Descriptive statistics of the variables studied are presented in Table 2.

TABLE 2 DESCRIPTIVE STATISTICS OF THE VARIABLES

| Variable (1) | Definition of variables (2) | Number (3) | Mean (4) | Std. Dev. (5) |
|---|---|---|---|---|
| HHCONTBN | Farm household's contribution in watershed management (Rs./year) | 368 | 127.93 | 88.61 |
| EDUCATION | Educational level of the head of the household in years | 368 | 2.97 | 1.47 |
| FSIZE | Farm size in hectares | 368 | 2.08 | 1.34 |
| DISTANCE | Distance between the well and water harvesting structure in meters | 368 | 206.17 | 123.78 |
| NWORKER | Number of workers in the household (in number) | 368 | 2.37 | 0.93 |
| NWELLS | Number of wells owned by the farm household | 368 | 2.30 | 0.98 |
| NINCOME | Participation in non-farm and off-farm income activities ( 1 if participation; 0, Otherwise) | 368 | 0.64 | 0.48 |
| UGSIZE | Size of the User Group (number) | 368 | 8.35 | 3.29 |
| CASTE | Social homogeneity; Dummy, 1 = if more than 75 per cent of UG members belong to the same caste, 0, Otherwise | 368 | 0.56 | 0.49 |
| PERCOLATION | Dummy for the type of watershed structure. 1 if percolation pond, 0, otherwise | 368 | 0.53 | 0.49 |
| CHECKDAM | Dummy for the type of watershed structure. 1 if check dam, 0, otherwise | 368 | 0.21 | 0.40 |

IV

RESULTS AND DISCUSSION

## *General Characteristics of Households*

The average size of holding worked out to 2.20 ha and 1.99 ha, respectively, in completed and on-going watersheds. The cropping intensity worked out to 103.65 per cent and 100.56 per cent respectively, where as the irrigation intensity, accounts for 103.35 per cent in the completed watersheds and 100 per cent in the on-going watersheds (Table 3).

TABLE 3. GENERAL CHARACTERISTICS OF SAMPLE HOUSEHOLDS

| Particulars | Completed watersheds | On-going watersheds |
|---|---|---|
| (1) | (2) | (3) |
| Number of farm households | 189 | 179 |
| Number of workers in the household (Number) | 2.43 | 2.33 |
| Farm size (hectares) | 2.20 | 1.99 |
| Net sown area (hectares) | 1.91 | 1.69 |
| Gross cropped area (Hectares) | 1.96 | 1.69 |
| Cropping intensity (per cent)[a] | 103.65 | 100.56 |
| Net irrigated area (hectares) | 1.84 | 1.60 |
| Gross irrigated area (Hectares) | 1.89 | 1.60 |
| Irrigation intensity (per cent)[b] | 103.35 | 100.00 |
| Status of soil erosion (Index)[c] | 105.57 | 105.76 |
| Fertility status of soil (Index)[d] | 128.09 | 114.40 |
| Number of livestock (Number)[f] | 2.04 | 2.98 |

*Source*: Field survey during 2005-06.

a: Cropping intensity is defined as the ratio of gross cropped area to net sown area and expressed as percentage.

b: irrigation intensity is the ratio of gross irrigated area to net irrigated area and expressed as percentage.

c: Weighted index from different class viz., *1 = Non-detectable , 2 = Slight / moderate, 3 = Severe.*

d: Weighted index from different class viz., *1 =Good, 2 = Medium, 3= Poor.*

e: Livestock include only cattle, sheep and goats.

Maize and sorghum dominate the cropping pattern in the study area. Among the different crops cultivated by sample farmers in both type of watersheds, Maize occupies higher proportion accounting 27.88 per cent in completed watersheds and 23.55 per cent in on-going watersheds (Table 4).

TABLE 4. CROPPING PATTERN FOLLOWED BY SAMPLE FARM HOUSEHOLDS

*(per cent)*

| | Completed watersheds | On-going watersheds |
|---|---|---|
| (1) | (2) | (3) |
| Maize | 27.88 | 23.55 |
| Sorghum | 14.33 | 21.85 |
| Banana | 17.71 | 19.41 |
| Tomato | 12.62 | 12.98 |
| Others | 27.45 | 22.21 |

*Source*: Field survey during 2005-2006

Next to maize, other unirrigated crop sorghum and water consuming crop banana dominate in both the situations. A significant proportion of area under maize and sorghum implies that depleting groundwater table forces the farmers to go for unirrigated rainfed crops to sustain their livelihood thus having cushioning effect.

*Farm Households Participation in Collective Action*

Membership in formal watershed management institution can be treated as an indicator of household's participation in collective action. The analysis reveals that farm households become member in watershed institutions like Watershed Association, Watershed Committee, User Groups, etc. But it is interesting to note that though the farm households are the members after the closure of the project, most of the watershed institutions become inactive in the post-project periods (Table 5).

TABLE 5. MEMBERSHIP IN FORMAL/INFORMAL ORGANISATIONS AT WATERSHED LEVEL

| Particulars (1) | Completed watersheds | | On-going watersheds (4) |
|---|---|---|---|
| | During programme implementation (2) | Post project period (3) | |
| Membership in different organisation (% of households) | | | |
| Watershed Association | 100.00 | 100.00 | 100.00 |
| Watershed Committee | .. | .. | 3.91 |
| User Group | 100.00 | 100.00 | 100.00 |
| Duration of membership (Years) | 5.56 | .. | 1.58 |

*Source:* Field survey during 2005-2006.

Peoples participation in different stages of watershed implementation indicate that farm households show inclination towards participation in planning, project formulation, attending meetings, training and exposure visits (Table 6). The percentage of farm households participating in forming CBOs is found to be 28 per cent in completed watershed and 43 per cent in on-going watersheds. Similarly, per cent of households participated in training and exposure visits worked out to 5.30 per cent in completed watersheds and 1.11 per cent in on-going watersheds.

It shows that in addition to the presence of PIA, there are other socio-economic and contextual factors responsible for households' participation in watershed management. It is evident that peoples' participation in watershed management activities dramatically reduced after the project period. One reason attributed for this is non-functioning of watershed management institutions in post-project period.

TABLE 6. FARM HOUSEHOLDS PARTICIPATION IN FORMULATION OF WATERSHED DEVELOPMENT PLANS, MEETINGS, TRAININGS AND EXPOSURE VISITS

| Particulars (1) | Completed watersheds | | On-going watersheds (4) |
|---|---|---|---|
| | During programme implementation (2) | Post project period (3) | |
| A.Project planning and formulation | | | |
| Per cent of farm households participated in PRA to identify problems and structures (per cent) | 78.84 | .. | 88.83 |
| Per cent of farm households participated in watershed development plan meetings (per cent) | 19.58 | .. | 16.20 |
| Per cent of farm households participated in forming CBOs (per cent) | 28.04 | .. | 43.02 |
| Per cent of farm households participated in electing office bearers of CBOs (per cent) | 24.34 | .. | 6.15 |
| B.Meetings attended | | | |
| Per cent of farm households attended meeting | | | |
| Watershed Association | 62.43 | 12.17 | 81.01 |
| Watershed Committee | 12.17 | 1.05 | 1.68 |
| User Group | 20.63 | 4.23 | 5.03 |
| C.Training and exposure visits attended per year | | | |
| Per cent of households participated in training and exposure visits | 5.30 | .. | 1.11 |
| Number of training and exposure visits attended (Number/ year/person) | 0.07 | .. | 0.02 |
| Duration of training and exposure visits attended (Days/year/person) | 0.11 | .. | 0.02 |

*Source*: Field survey during 2005-2006.

### *Who Participates More and who Participates Less or Do Not Participate?*

Our interest is to identify the farm households which show inclination towards participation in watershed management. It is commonly observed that households whose farms are located downstream and nearer to the rainwater harvesting structures show much interest in participation by way of contribution to watershed development and maintenance (Table.7). This is mainly because the potential benefits from these structures are relatively much higher than those whose farm is located upstream and far away from the structure.

Similarly, households owning more number of wells show interest in participation as they depend on rainwater harvesting structures for groundwater recharge. Similarly small farmers having land size of 1.2 hectares do participate in collective action. The marginal farmers do not participate much because their opportunity cost of labour through participation in non-farm and off-farm income activities is more when compared to participation in watershed management.

TABLE 7. COLLECTIVE ACTION AND COLLECTIVE INACTION

| Particulars (1) | More Participation (2) | Less/Non-participation (3) |
|---|---|---|
| Potential direct economic benefits | | |
| Location of the farm | | |
| Upstream | | ** |
| Downstream | ** | |
| Distance from rainwater Harvesting structure (Meters) | 60 | |
| Number of wells owned | 2 and >2 | <2 |
| Individual wealth | | |
| Size of land holding (Hectares) | 1.2 | < 1.2 |
| Off-farm and non-farm income sources | | ** |
| Social participation | | |
| Membership in Watershed Organizations | ** | |
| Household specific characteristics | | |
| Educational level of the Head | ** | |
| Number of workers in the Family | 2 and more | <2 |
| Experience in farming | ** | |
| Household's prior adoption of SWC measures | ** | |
| Caste | Homogeneous | Less homogeneity |

## *What Affects Household's Participation in Watershed Management?*

Estimation of the factors that determine the farm households' contribution towards watershed development is presented in Table 8.

TABLE 8. FACTORS DETERMINING THE FARM HOUSEHOLDS' PARTICIPATION IN WATERSHED DEVELOPMENT

| Variables (1) | Regression Coefficient (2) | Elasticity of Index (3) | Elasticity of E (Y) (4) |
|---|---|---|---|
| CONSTANT | 67.012 | | |
| | (2.5176) | | |
| FSIZE | 1.142 | 0.0186 | 0.0172 |
| | (0.2972) | | |
| EDUCATION | -0.78135 | -0.0141 | -0.013 |
| | (-0.14682) | | |
| NWORKER | 9.1505 * | 0.1699 | 0.157 |
| | (1.8409) | | |
| NINCOME | -11.756 | -0.0589 | -0.0544 |
| | (-1.2063) | | |
| NWELLS | 8.134 ** | 0.1890 | 0.1746 |
| | (2.6015) | | |

*(Contd.)*

TABLE 8. *(CONCLD.)*

| Variables (1) | Regression Coefficient (2) | Elasticity of Index (3) | Elasticity of E (Y) (4) |
|---|---|---|---|
| DISTANCE | - 0.15629 *** | - 0.2519 | - 0.2328 |
| | (- 3.9635) | | |
| UGSIZE | -2.3713 | -0.1549 | -0.1431 |
| | (-1.6422) | | |
| CASTE | 25.961 ** | 0.1149 | 0.1062 |
| | (2.599) | | |
| PERCOLATION | 26.104 ** | 0.1093 | 0.1011 |
| | (2.2801) | | |
| CHECKDAM | 39.88 ** | 0.0663 | 0.0613 |
| | (2.905) | | |
| Log-likelihood function | -2052.32 | | |
| Number of observations | 368 | | |
| Dependent variable | HHCONTBN | | |
| Model | TOBIT | | |

*Source*: Field Survey 2004-2005.
*Note*: ***, ** and * significant at 1, 5 and 10 per cent level , respectively.
Figures in parentheses indicate estimated 't' ratios.

It is evident that the household contributions towards watershed development and maintenance are influenced by household level and supra household level factors. The number of workers in the farm family (NWORKER) is found to significantly and positively influence the household's contribution towards watershed development. Larger number of workers in the farm family enables the household to participate in the meetings, contribute labour for watershed development and maintenance activities.

The number of wells owned by the farm households (NWELLS) significantly and positively influences the contribution by the farm households. This implies that more the number of wells in the farm, more will be the contribution made by the households as they depend on rainwater harvesting structures for groundwater recharge. This again confirms the theoretical assertions that resource dependency is a major factor determining collective action. The variable DISTANCE representing the access to the rainwater harvesting structure influences the household's participation on the expected negative line. Nearer to the rain water-harvesting structure implies more the benefits to the household.

The results of the study show that the extent of social homogeneity as represented by caste (CASTE) at group level significantly influences the household's contribution towards construction and maintenance during the project period on the expected positive line. This confirms the fact that social homogeneity enhances collective action as this leads to increased social interaction, understanding, co-operation and cost- and benefit sharing.

The type of watershed development technology is expected to positively influence the household participation in watershed management. Check dams perform many functions such as preventing soil and water erosion and groundwater recharge. Similarly, percolation ponds produce potential benefits in terms of groundwater recharge. The results show that CHECKDAM and PERCOLATION positively and significantly influence household contribution.

## V

## CONCLUSION AND POLICIES

Peoples participation in different stages of watershed implementation indicate that farm households show inclination towards participation in planning and project formulation, attending meetings, training and exposure visits. There are evidences for farm households' participation in watershed management in the post-project period by way contribution of voluntary labour for maintenance activities.

The factors determining households participation in watershed management reveals that the number of workers in the farm family and number of wells owned found to significantly and positively influence the households contribution towards watershed development. The variable DISTANCE representing the access to the rainwater harvesting structure influences the household's participation on the expected negative line. Thus, before implementation of watershed development, there is a need to define the zone of influence for different structures and the construction of structure may be followed based on the zone of influence. This will help in a big way for households to get involved in the watershed management. The supra household factors, namely, size of the user group and social homogeneity are also found to significantly influence the households contribution towards watershed management. Adequate training on watershed development technologies will make them aware of the benefits and that would help sustain the watershed management in the rural areas.

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