**Determinants of Participating in Collective Action: Empirical Evidence from Irrigation Management System of Amhara Region, Ethiopia**

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**ABSTRACT**

Irrigation institutions have a long history of being informal, especially in the Amhara region irrigation systems. However, the qualitative investigation revealed that there is no explicit legislative framework that governs irrigation institutions. Rather, according to the legislative framework for agricultural cooperatives, these organizations are acknowledged as irrigation beneficiaries' cooperatives (IBCs) and/or water users associations (WUAs). The study's objectives were to identify the critical elements driving collective action in irrigation and assess the key irrigation water governance activities. *We used multistage sampling technique to identify study areas and sample respondents. The study was based on a survey of 544 irrigation households in 148 scheme groups from 4 districts of Amhara region. Focus group discussions and semi-structured interviews with key informants were the primary means of collecting data on local institutional arrangements, government interventions and management challenges. In this research both descriptive and econometric methods were employed.* The institutions were characterized by extreme political hegemony and interference from higher officials, low rule enforceability, lack of credit service, lack of committed leaders and members, inadequate or inappropriate legal support for rule and sanction enforcement from government bodies, and non-functional institutional arrangements. Therefore, greater attention has to be paid to outlining the responsibilities and duties of the major irrigation service provider in the delivery of rural public goods, especially concerning encouraging the expansion of community agricultural services. The study also identified variables that influence participation in any irrigation collective actions using the Multivariate Probit (MVP) model. Therefore, appropriate institutional arrangements like sanctioning mechanisms, labor mobilization, strengthening social links, or traditional social contacts within a community through WUA should be established for water use, upkeep, operation, and management of irrigation schemes.

**Keywords**: Collective action, Institutional arrangement, Multivariate probit, Water Users Association (WUA)

**INTRODUCTION**

As a resource belonging to the common pool, irrigation infrastructure faces issues related to "the tragedy of commons," including free riding, unequal distribution of irrigation water, increased conflict and competition among users for water resources, inadequate irrigation system maintenance, improper irrigation system utilization, and other related issues (Ostrom, 1992). In order to ensure the sustainable use of the irrigation scheme and the water supply, as well as to increase output and productivity, it is advised that competent and efficient irrigation management be crucial when irrigation is expanded (Narayanamoorthy & Deshpande, 2004). Because of this, irrigation management became essential for the scheme's sustainable operation and for lowering the environmental harm caused by overuse and inappropriate use of water resources (Bromley et al., 1980).

Common-pool resources, such as irrigation systems, grazing land and forest, are defined by rivalry for consumption and difficulties in exclusion. In situations where restricting access to individual users is difficult or where a large number of people have unrestricted use to irrigation systems, open-access irrigation systems are likely to be overused and eventually exhausted if improperly managed (Takayama et al., 2018a). According to Ostrom (2010), this is a collective-action problem. If every person chooses strategies (like labor and money contribution for irrigation management) based on an estimation that maximizes their own short-term benefits, people will act in a way that results in lower joint outcomes (like the condition of the irrigation canal as a result of everyone's effort) than could have been achieved otherwise. For irrigation management to be effective, farmers must work together in rural communities or water user associations (WUAs) or through collective efforts in irrigation beneficiaries cooperative (IBC).

Various theoretical and empirical works have contended that institutions have a significant impact on economic performance by guaranteeing the efficient and effective use of water resources (Wang et al., 2021; Zang et al., 2021; Bekele et al., 2021). In addition, adopting technology, ensuring food security, reducing poverty, fixing market failures, conserving genetic resources, and managing watersheds all benefit from collective action (Zang et al., 2021;Deneke, 2014; Meinzen-Dick, 2009; Fekadu & Hagedorn, 2006).

Although user institutions in Ethiopia have long engaged in irrigation management, the field has not received the necessary attention or built a legislative framework to codify the informal institutions of water users (Bekele, 2021; Deneke, 2014). For this reason, irrigation users nationwide formed Irrigation Beneficiaries Cooperatives (IBCs) in accordance with cooperative legislation. The studied areas' irrigation management institutions have a similar background to other regions of the nation. In Ethiopia, irrigation systems such as traditional local water distributors, and water fathers, have long been used as informal traditional organizations. In addition, the official irrigation institutions in the research regions are set up as WUA or IBC. WUAs were founded on the idea of the district office of cooperatives promotion to oversee contemporary small-scale programs. WUAs are sometimes referred to as irrigation cooperatives (ICs) in the Amhara region irrigation schemes, where they are founded with the intention of providing agricultural inputs, operating and maintaining schemes, and marketing their products (Deneke, 2014). Until now, the most common method for establishing decentralized water management systems has been the development of Water User Associations (WUAs) through public funding.

While a glut of international research has been conducted on irrigation institutions and collective action (Zang et al., 2021; Guido et al., 2019; Takayama et al., 2018; Oates et al., 2015), Ethiopian institutional analysis in irrigation system has not received enough attention. In particular, there are few studies that have been published regarding irrigation institutions and collective action (Oates et al., 2020; Deneke, 2014; Deneke et al., 2011; Fekadu & Hagedorn, 2006). The degree of law enforcement by participants or outside parties, as well as the voluntary cooperation of participants, determine the success and effectiveness of collective action. Because of this, the contemporary irrigation beneficiaries' cooperatives of the Koga Irrigation and Watershed Management Project (KIWMP) and Kobo Girana Valley Development Program (KGVDP) are also set up to be actively involved in managing the irrigation system, the production activities and financial behavior of beneficiaries regarding irrigation water use, as well as to boost productivity and output of irrigators by guaranteeing effective resource utilization. Therefore, it is crucial to examine the type, characteristics, role, and function of existing irrigation institutions of the irrigation projects in related to irrigation water management thereby investigate the determinants of participating in any collective action for provision and appropriation in irrigation water.

The next section explains the theoretical and analytical frameworks for the analysis of collective action. The third section deals with the research methods used and briefly describes the case study areas. The fourth section presents the results and discussion. Finally, conclusions and recommendations are drawn from foregoing discussions.

**IRRIGATION COLLECTIVE ACTION AND ITS DETERMINANTS**

***Collective Action and Irrigation Management:*** It is becoming more widely acknowledged how important institutional frameworks are for managing and planning water resources. However, what unites people to take collective action? The process and results of individual decisions to voluntary coordinated conduct are referred to as collective action. In actuality, people band together to do a collective action with the goal of facing the unknowns and looking for answers wherever they can. In the course of group action, the person gains security in addition to an identity. People prefer to meet together to find answers to the many issues they confront because they are impossible for them to solve on their own, and this becomes an urgent necessity rather than a choice.

According to various authors’ descriptions of the meaning, foundation, and characteristics of collective action, including Wade (1987) and Ostrom (2004), the operational definition of collective action is the result of the interaction between three primary elements: the group, its action, and the shared goal. Robert Wade defines "collective action" as an activity taken by several people with the intention of achieving a common objective or satiating a shared interest that is, an objective or interest that cannot be attained by one person acting alone. "Achievement is the provision of a public or collective good" (Wade, 1987). According to Ostrom (2004), collective action is what happens when several farmers work together as a group to accomplish a common goal. A local irrigation system should be maintained, smallholder farmers should purchase agricultural input, plant and harvest collectively, and market their output as a consequence of collective activity. Institutions in the context of irrigation include government laws and regulations, administrative setup for irrigation system management and maintenance, land, labor, and capital usage in irrigation systems, and stakeholder contact in terms of informal institutions (Narayanamoorthy & Deshpande, 2004),

***Determinants of participating in collective action:*** In this section determinants of collective action is reviewed on the contemporary works of different scholars. The majority of research on collective action focused on its determinants. As a result, notable studies on the factors influencing collective action have been conducted globally by various writers. Nonetheless, there are still theoretical enigmas or differences of opinion about the effect of some factors on collective action. This disagreement may arise from the existence of different type of collective actions on different types of common pool resources in diverse socioeconomic, cultural and environmental condition.

Various scholars have recognized a vast group of contextual elements as factors influencing collective behavior. Research by (Zang et al., 2021; Guido et al., 2019; Takayama et al., 2018; Deneke, 2014; Meinzen-Dick, 2009; Agrawal, 2001;Agrawal & Ostrom, 2001; E. Ostrom, 2001) outlined the elements from several case studies that have a favorable or negative impact on collective action. The factors can be categorized as follows: (1) the physical and technical attributes of the resource, such as its size and boundaries, the predictability of resource flows, the relative scarcity of the good; (2) technology (the cost of exclusion technology); and (3) the relationship between the resource and user group, which includes the agro-ecological conditions, users' proximity to resource locations and places of residence, their demand, and their knowledge of resources. (4) The group's social and economic characteristics (size, boundaries, relative power of subgroups, heterogeneity, and reliance on the good), as well as the benefits of collective action, level of social capital among users, pre-existing arrangements for discussing shared problems, users' choice to participate or not, users' ability to leave the group, degree of temptation to free ride, degree of mutual obligations among users, and punishment for breaking rules), noticeability (easiness of identifying rule-breaking free riders), and (5) policy and governance factors, such as the scope of formal and informal rules pertaining to resource boundaries and access, monitoring, and sanctioning procedures for resolving conflicts as well as external factors (external arrangements such as property rights, local government decision-making delegation, recognition rights, and environmental and natural regulation), and the degree of connection between formal and informal governance structures.

**RESEARCH METHODS**

**Case Study Area:** The study was carried out at four districts of Amhara National Regional State (ANRS), Ethiopia which have different level of irrigation potential. The Amhara Region is located in the northwestern part of Ethiopia between 8°45' and 13°45' North latitude and 36° 20' and 40° 20' East longitude. Its land area is estimates at about 170,152 km2. According to the Central Statistical Agency of Ethiopia (CSA) the projected total population in 2022 is about 27,618,552 of which 80 percent live in rural areas (CSA, 2013). The study areas are found in North *Wollo* and West *Gojjam* administrative zones of ANRS, *Bahir Dar* town being its capital. The study areas were *Raya* *Kobo* and *Habru* districts of North *Wollo* representing low rainfall, moisture limiting areas of the region moreover the large irrigation schemes of Kobo Girana valley development program (KGVDP) are located. North *Mecha* and South *Achefer* districts of West *Gojjam* representing high rainfall and moisture-surplus areas of the region where Koga river embankment dam and other small-scale irrigation schemes are found (BoA, 2019).

**Sampling Technique:** The study used multistage sampling technique to identify study areas and sample respondents. First, West Gojjam and North Wollo administrative zones were purposively selected based on the accessibility of the irrigation schemes and their representativeness of the high rainfall areas of the north-western and the northeastern low rainfall areas of the region, respectively. In the second stage, two districts from each zone were randomly selected. In the third stage, representative irrigation schemes were randomly selected from each district. Finally, we selected 544 sample farm households using random sampling proportional to the total number of households in each irrigation scheme.

Hence, this study was based on a survey of 544 irrigation households in 148 scheme groups from 4 districts of Amhara region in the period of 2020/21. We have included three group of communities from North *Wollo* representing 108 schemes and two groups of communities West *Gojjam* that represents 40 schemes. The schemes in communities were categorized as those having formal institutions (user or agency managed) and those led by traditional water committees or ‘*water fathers’* in order to compare the existing different local institutional contexts in the management of irrigation infrastructure and also to explore each of them in detail.

Focus group discussions and semi-structured interviews with key informants were the primary means of collecting data on local institutional arrangements, government interventions and management challenges. Interviews were conducted to collect primary data. Secondary data was obtained mainly from official documents. Informal discussions and formal semi-structured interviews were conducted with plot owners/farmers, experts, head of the projects, IBCs and WUA committees in the area. In total 32 semi-structured interviews, 24 key informants interview and 6 focus group discussions were conducted. The data collection was done in person interview using a paper based questionnaire. Either of the household heads [male or female] were interviewed after they provided their oral approval to participate in the survey. The interviews were conducted at farmers’ residences and no minors were involved in the survey.

**Method of Data Analysis:** In this research both descriptive and econometric methods were employed. Hence, the quantitative data has been analyzed using descriptive statistics such as percentages and arithmetic mean. For the econometric part based on the IAD framework of Ostrom (2007), we selected the relevant variables of irrigation collective action in the study areas. The explanatory variables were divided into four types: rules-in-use, biophysical conditions, attributes of community and attributes of household. Moreover, the research objective was to investigate the determinants of participating in irrigation collective actions. Based on the data collected, the different collective actions were grouped into three namely: 1) participating in labor demanding activities, 2) participating in money demanding activities, and 3) participating in the scheme management activities. This leads to the use of polychotomous (multiple-category) response or dependent variables to model the collective action choice behavior (Gujaritati & Porter, 2009).

In this study, irrigation user farmers can participate to more than one type of collective action (alternatives are not mutually exclusive) and the decision to participate to one collective action can be correlated with the decision to participate in other type of collective actions (the error terms can be correlated) which means the unobserved factors affecting the choice of collective action can be correlated. Hence, the MVP is more appropriate and was used to investigate factors affecting irrigation user farmers’ collective action selection decision.

Given that a household, i, has access to a WUA, defined as those households living in a village, r, with at least one WUA member, a household is assumed to participate in collective action, Wir =1, if the utility they receive from joining in collective action, Uir1 , is greater than the utility received from not participating in collective action, Uir0.

That is,

$W=\left\{\begin{array}{c}1 if U\_{ir1}\geq U\_{ir0}\\0 if U\_{ir1}\leq U\_{ir0}\end{array}\right.$ (1)
We assume that utility from participating in collective action, W in {0, 1}, can be expressed as a factor of observable characteristics of the household, XirW , the characteristics of other households in the area that affect collective action, A rW, and a set of unobserved characteristics, εirW . That is,

 $U\_{irW}=X\_{irW}β+A\_{rW}δ+ε\_{irW}$ (2)

Hence, following Greene (2012), a system of simultaneous probit models was constructed for labor demanding activities, money / financial demanding activities, and participating in scheme management committee as follows:

$Y\_{m}^{\*}=X\_{m}^{'}β\_{m}+ϵ\_{m}, Y\_{m}=1 if Y\_{m}^{\*}>0, 0 otherwise, m=1,…M$

$E\left[X\_{1},…,X\_{M}\right]=0$

$Var\left[X\_{1},…,X\_{M}\right]=1$ (3)

$Cov\left[X\_{1},…,X\_{M}\right]=ρ\_{jm}$ ,

$(ϵ\_{1},………ϵ\_{M})\~N\_{M}[0, R]$

Where $Y\_{m}^{\*}$ and$ Y\_{m}$ are the latent dependent variables and actual observations relating to the latent dependent variables, respectively, $X\_{m}^{'}$ is a matrix of covariates, $β\_{m} $is the matrix of unknown parameters to be estimated, $ϵ\_{m}$ are residual error terms distributed as multivariate normal, each with mean 0 and variance-covariance matrix$ R$ with the value of 1 on the leading diagonal and correlation $ρ\_{jm}$ = $ρ\_{mj}$ as the off-diagonal elements that represent the unobserved correlation between the stochastic component of the jth and mth options.

The joint probabilities of the observed events [$y\_{i1},y\_{i2},…y\_{iM}$|$X\_{i1},X\_{i2},…X\_{iM}$], *i*=1, ..., n, that forms the basis for the likelihood function are the M-variate normal probabilities Greene (2012) is given as:

$L\_{i}=Φ\_{M}\left(q\_{i1}X\_{i1}^{'}β\_{1},……,q\_{iM}X\_{iM}^{'}β\_{M},R^{\*}\right),$ (4)

Where,

 $q\_{iM}=2y\_{iM}-1$

$R\_{jM}^{\*}=q\_{ij}q\_{iM}ρ\_{jm}$

Where $ρ\_{jm} $is the correlation between $ϵ\_{j}$ and$ϵ\_{m}$. The distributions are independent if and only if $ρ\_{jm}=0$ . If that is the case, one can use a single probit model for each equation instead of MVP.

**RESULTS AND DISCUSSION**

**Description of activities that need collective action:** With the view of proper irrigation scheme management and reducing conflicts in water use, farmers in the study areas have been broadly participating in different collective irrigation scheme management activities. Table 1 below presents that the majority 87.48 percent of the respondents participate in labor demanding activities of collective actions. The result showed that 46.87 and 16.89 percent of respondents participate in money demanding activities and scheme management committee, respectively. Of the total sample households, 9.87 percent do not participate in all the three specified nature of collective actions.

**Table 1:** Categories of collective action practiced in the study area

|  |  |  |
| --- | --- | --- |
| **Collective action category** | **Frequency** | **Percent** |
| No participation | 52 | 9.87 |
| Participating in labor demanding activities | 461 | 87.48 |
| Participating in money demanding activities | 247 | 46.87 |
| Participating in scheme management committee  | 89 | 16.89 |

Source: Own computation based on survey data, 2020/21

Key collective action activities engaged in by farmers were contribute labor in canal cleaning and maintenance activities (87.5%), collective nursery preparation, disease and pest control ( 70.4%), group sales of outputs (67%), contribute funds (money) for operation and maintenance of the scheme (46.9%), participate in group meeting (35%), group input purchase like seed and fertilizer (27.9%), participate in water controlling and distribution activities (20.1%), participate as scheme management committee member (16.9%) and participate in conflict resolution committee (14.8%) (Table 2).

Participating in labor demanding activities and group sales received very high participation level. Group sales involved farmers aggregating their products in order to be able to sell in bulk to dedicated buyers/brokers. This enabled them to enjoy economy of scale and also reduced the number of transactions since they did not have to move from house to house to buy smaller quantities. Participating in labor demanding activities involved farmers to safely access irrigation water by cleaning the silt trap and grass in the canals on time before planting. Farmers were also involved in group input purchase such as seeds, fertilizers, pesticides and other agricultural inputs.

**Table 2:** Key collective action activities practiced in the study area

|  |  |  |
| --- | --- | --- |
| **Collective action activities** | **Frequency** | **Percent** |
| Contribute labor in canal cleaning, canal and pump repair | 461 | 87.48 |
| Collective nursery preparation, disease and pest control | 371 | 70.39 |
| Group input purchase like seed and fertilizer | 147 | 27.89 |
| Contribute money for operation and maintenance of the scheme  | 247 | 46.87 |
| Participate in water controlling and distribution activities (reporting unlawful diversion of water, reporting theft of irrigation infrastructure, damages and water leakages along the major irrigation infrastructure.) | 106 | 20.11 |
| Participate in conflict resolution committee | 78 | 14.80 |
| Participate in group meeting (attending meetings, lobbying, and contributing ideas in water related issues) | 185 | 35.10 |
| Group sales of output | 353 | 66.98 |
| Participating in scheme management committee (regulation and control) | 89 | 16.89 |

Source: Own computation based on survey data, 2020/21

**Determinants of farmer’s participation in irrigation collective action:** Collective action was found to be an important policy for sustainable management of common pool resources. In line with their arguments, respondents were asked about whether they would participate in collective irrigation activities if a community managed irrigation scheme existed in their localities. Those who supported participation in irrigation scheme management were then asked to choose the nature of participation approaches: these would generate three different outcome variables: (1) households participation decision in labor demanding activities, (2) participation decision in money contribution and (3) participation decision in scheme management committee. The effects of socio-economic and institutional variables on the three outcome variables were analyzed. We employed multivariate probit model to analyze the factors that affect participation in any collective action. A household is considered as participants of collective action if she/he practiced at least in one of the aforementioned activities (Table 3). Combinations of socioeconomic, institutional and resource-related variables influence farmer participation in collective activities.

The decision to participate in labor contribution activities (such as disease and pest management, cleaning of canals and maintenance of irrigation infrastructures) was found to be significantly affected by family size in adult equivalent, membership in WUA and access to training (Table 3). Similarly, the decision to participate on money (funds) contribution activities was found to be significantly affected by the variables family size, membership in WUA, land fragmentation index and social capital. Moreover, the decision to participate in committee members was found to be significantly affected by the variables age of the scheme (number of years since the scheme established), total land size, membership in WUA, credit service utilization, membership in agricultural cooperatives, extension contact and social capital.

As family size in adult equivalent increase by 1 unit, the predicted probability of participating in labor contribution activities and contribution of funds in irrigation activities increase by 14.2% and 11.7%, respectively. It is plausible that the size of a household is often used as proxy for household labor endowment. Households with small family size are unable to participate due to workload especially during planting and harvesting time. Thus, households with large family size have more labor to participate to the activities of collective actions than households with few family members. Moreover, the higher the earning capacity of the household. The result is in line with the findings of Muchara et al. (2014) of South Africa and Takayama et al. (2018b) of Japan.

The household being membership in water user association, the predicted probability of participating in labor contributing activities, in fund contributing activities and committee members’ increase by 71.1%, 47.6% and 43.1%, respectively. This result is as expected since the objectives of WUA coordinating collective actions like canal cleaning, removing grass and silt, and nursery bed preparation that demand labor contribution from members, collection of funds and fees from users. The result is in agreement with the findings of Muchara et al. (2014) who found that WUA membership affect participation in irrigation water management in South Africa, Wang et al. (2021) in China and Chattopadhyay et al. (2022) in India also found that the mediated effect of membership in WUA on irrigation collective action.

As the household had access to training, the predicted probability of participating in labor contributing activities increase by 12%. Farmers with some form of training in water/irrigation scheme management participate more in scheme management activities. This highlights the importance of farmer training as being key to improving collective irrigation scheme management. This result is consistent with studies conducted by Muchara et al. (2014) for South Africa and Chattopadhyay et al. (2022) for India.

Age of the scheme shows the strength and the development of irrigation scheme beneficiaries as the years go by affecting contribution as a committee member positively. As age of the scheme increase by 1 year, the predicted probability of participating in committee member increase by 4.6%. This is due to the fact that when they had more experience in irrigation being more likely to participate in collective activities. The finding is consistent with the empirical results of Takayama et al. (2018b) of Japan.

**Table 3:** Multivariate probit model result of participating in any type of collective action

|  |  |  |  |
| --- | --- | --- | --- |
| Explanatory variables | Labor contribution | Scheme committee | Financial contribution |
| Coef. (Se) | Coef. (Se) | Coef. (Se) |
| Age | 0.001 (0.007) | 0.005(0.007) | 0.005(0.006) |
| Sex | 0.027 (0.200) | **-** | 0.164 (0.160) |
| Group size | 0.000 (0.001) | -0.001 (0.001) | 0.000 (0.000) |
| Age of the scheme | -0.002 (0.025) | 0.046\*\* (0.022) | -0.003 (0.018) |
| Type of institutional arrangement | -1.184 (0.831) | -0.481 (1.122) | 0.696 (0.817) |
| Command area in ha | -0.001 (0.001) | 0.001 (0.001) | 0.001(0.001) |
| Proportion of female in the group | 0.001(0.017) | 0.006 (0.014) | 0.004(0.012) |
| Total land size in ha | 0.020 (0.115) | 0.204\*\* (0.104) | 0.142 (0.088) |
| Land fragmentation  | -0.121(0.491) | -0.363 (0.553) | 1.302\*\*\*(0.402) |
| WUA member | 0.711\*\*\* 0.180) | 0.431\*\* (0.175) | 0.476\*\*\*(0.138) |
| Credit use | 0.246 (0.172) | -0.382\*\* (0.162) | 0.026 (0.123) |
| Member of government team | -0.234 (0.200) | -0.108 (0.197) | 0.103 (0.150) |
| Member of agri. cooperative | 0.197 (0.280) | 0.608\*\*\* (0.220) | 0.176 (0.205) |
| Family size in adult equivalent | 0.142\*\*\*(0.054) | 0.011 (0.051) | 0.117\*\*\*(0.041) |
| Agro-ecology | -0.053 (0.298) | 0.211 (0.279) | 0.297 (0.220) |
| Social capital | -0.132 (0.169) | 0.349\*\* (0.170) | 0.478\*\*\*(0.137) |
| Training access | 0.120\*\*\*(0.023) | 0.011 (0.017) | 0.017 (0.016) |
| Water distribution method | -0.922 (0.927) | 0.181 (1.199) | 0.829 (0.878) |
| Surface irrigation source | 0.365 (0.449) | -0.428 (0.440) | 0.416 (0.338) |
| Extension contacts | -0.166 0.318) | 0.936\*\*(0.451) | 0.267 (0.221) |
| Formal education level | - | 0.030 (0.022) | - |
| Local administration member | - | 0.093 (0.153) | - |
| \_cons | 7.124 (50.843) | -96.030\*\*(43.62) | 3.532 (35.64) |
| $$ρ\_{21}$$ | 0.551\*\*\*(0.080) |  |
| $$ρ\_{31}$$ | 0.239\*(0.123) |  |
| $$ρ\_{32}$$ | 0.065 (0.087) |  |
| Predicted probability | 87.9% | 47.4%  | 17% |
| Joint probability (success) | 9.4% |
| Joint probability (failure) | 9.8% |
| Number of observations | 544 |

LR test of $ρ\_{21}$ = $ρ\_{31}$= $ρ\_{32}$ = 0: chi2 (3) = 37.447, Prob > chi2 = 0.0000;

Wald chi2 (61) = 130.68; Log likelihood = -729.02; Number of simulations = 100

Note: Standard errors in parentheses; Significant at \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01

Membership in agricultural cooperatives had positive effect on the participation in committee member. Being a member of agricultural cooperative significantly increase the predicted probability of participating in committee member by 60.8%, as a result of social ties imposing indirect recap and ability to be better household in the community. Total cultivated land size has a positive and statistically significant effect on the participation in committee member. The result imply that as the size of farm increases by 1 hectare, the predicted probability of the farmer to participate in committee activities increase by a factor of 20.4%. This could be due to the fact that the larger perceived gains from improved access to irrigation water, markets, inputs, and extension services water users may be more inclined to participate in collective action. This result is aligned with the finding of Muchara et al. (2014) of South Africa but in contrary to the finding of Takayama et al. (2018b) of Japan.

Land fragmentation had a positive and statistically significant effect on the participation in financial contribution. The result imply that as the land fragmentation increase or as the number of plots increase by 1 unit, the predicted probability of the farmer to contribute funds for collective action activities increase by a factor of 130%. This could be due to the fact that land fragmentation increases land circulation because it reduces agricultural production efficiency. Whether the property right is transferred out or transferred in, the purpose of land circulation is to improve efficiency and realize economies of scale in agricultural production. This implies a greater demand for irrigation facilities. Thus, land fragmentation leads to land circulation, which leads to cooperation in irrigation collective action. The result is consistent with the finding of Wang et al. (2020) but disagrees with findings by Zang et al. (2019) and Takayama et al. (2018b) in their study on the effects of land fragmentation on the governance of commons in China and Japan, respectively.

Credit service utilization had a negative and statistically significant effect on the participation in committee member. The result imply that as the household get credit service, the predicted probability of the farmer to participate in committee activities decrease by a factor of 38.2%. Similarly, extension contact had a positive and statistically significant effect on the participation in committee member. The result imply that as the household get extension service, the predicted probability of the farmer to participate in committee activities increase by a factor of 93.6%. Social capital had positive and significant effect on collective action. The household having good social ties and networks, the predicted probability of participating in fund contributing activities and committee members’ increase by 47.8% and 34.9%, respectively. The predicted probability of participating in labor demanding activities, contributing funds and participating in committee members were 87.9%, 47.4% and 17%, respectively. The joint probability of participating in all types of collective action was 9.4%. Whilst, the probability of not participating in any of the collective action activities was 9.8%.

**CONCLUSION AND RECOMMENDATIONS**

**Conclusion:** The key collective action activities in which irrigation user farmers engaged in the study areas were canal cleaning and maintenance activities, collective nursery preparation, disease and pest control, group sales of outputs, contribute funds (money) for operation and maintenance of the scheme, participate in group meeting, group input purchase like seed and fertilizer, participate in water controlling and distribution activities, participate as scheme management committee member and participate in conflict resolution committee. The study has also identified factors that affect the various types of irrigation collective actions. The MVP model result revealed that participation in labor demanding collective action activities was significantly influenced by family size in adult equivalent, membership in WUA and access to training. The decision to participate on money (funds) contribution activities was found to be significantly affected by the variables family size, membership in WUA, land fragmentation index and social capital. Moreover, the model result demonstrate the decision to participate in committee members was found to be significantly affected by the variables age of the scheme (number of years since the scheme established), total land size, membership in WUA, credit service utilization, membership in agricultural cooperatives, extension contact and social capital.

**Recommendations:** The farmers’ reason for participation in the irrigation system is the interest in growing more crops. They are willing to try new crops if irrigation water is available. WUA should capitalize on this aspect in order to bring more farmers’ participation within its system. According to the farmers’ opinion and our discussion with the different groups during the field study, it was observed that farmers/users give priority to WUA members in river irrigation system because it is richer in fertilizing elements whereas the ground water is devoid of them. In order to make farmers’ participation more forthcoming WUA scheme management should encourage farmers/users to diversify their crops by giving different incentives such as allowing the use of water for crops other than cereals in the study areas, distribution of improved seeds, and small farming consultancy which would teach farmers improved agricultural practices. The increasing trend of payment of cash fines is not favorable to the user management system. The majority of the farmers are in favor of labor contributions. If the cash contribution practice is encouraged, the user management system may come to the same fate as that of agency or state managed is neither to collect water charges nor to involve the farmer users in the collective action of operating and maintenance activities. Irrigators who joined the local WUA revealed higher participation in any collective activities compared to non-members, this suggests a need to increase farmer participation in formalized institutions that also expose them to water management training, through capacity-building programs run by the government and other non-government stakeholder initiatives. Knowledge exchange and experience sharing among the members of better performing and underperforming WUAs could ensure greater replication of best practices. Hence, provision of trainings for irrigation beneficiary farmers, their executive committees and irrigation experts at each level will improve the efficiency and sustainable use of irrigation schemes. Therefore, strengthening social links via WUA and cooperatives or traditional social contacts within a community in order to accumulate social capital is one of the approaches meant to suppress the worsening collective action for irrigation management.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

Informed consent

All survey procedures for experiments were approved by the supervisors were approved by the Haramaya University of Post Graduate Directorate. There are ethical protocols that was followed by the researchers. Either of the household heads [male or female] were interviewed after they provided their oral approval or consent to participate in the survey.

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