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Farmers' Participation and Its implications for Farms' Economic Viability in Collectively Managed Irrigation Systems: A Case Study in Pakistan

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ABSTRACT

Participatory Irrigation Management (PIM) has emerged as a significant intervention in which farmers are given more control over irrigation management. The primary goal of this study was to identify the factors that influence farmers' participation in PIM activities and compare the economic viability of participation levels. A multi-stage random sampling technique was used to collect the data from 240 farmers of Nasrana and Maduana distributaries located at the tail end of the Lower Chenab Canal (LCC) west circle in district Faisalabad, Punjab, Pakistan, using a structured questionnaire. The factors influencing farmers' participation in PIM activities were identified using an ordered Probit Regression model. The findings revealed that education level (β= 0.12; P=0.00), village leadership (β= 0.97; P= 0.00), and being a beneficiary of a water user association (β=1.20; P= 0.00) all had a significant positive influence on farmers' participation in PIM activities. On the other hand, family size (β= -0.05 P= 0.04), land ownership (β= -0.44; P= 0.05), and off-farm income (β= -0.52; P= 0.01) were found to have a significant negative impact on farmers' participation. Farmers with a high level of participation had higher farm technical efficiency and crop productivity. For these reasons, farming communities must be encouraged to participate in PIM activities in order to achieve a sustainable irrigation system.

Keywords: Irrigated agriculture, Pakistan, Participatory irrigation management system, Technical efficiency.

INTRODUCTION

Water is a critical input for agricultural sustainability and food security around the world, particularly in developing countries like Pakistan (Nasir *et al*., 2021). Water scarcity poses a serious threat to agricultural productivity and a balanced ecosystem. Irrigated agriculture accounts for 20% of total cultivable land in the world and produces 40% of total food production. Irrigated agriculture is more productive and diverse than rain-fed agriculture (World Bank, 2020).

Water availability in Pakistan per capita per year is greater than 1,100 m^3, with less than 1,000 m^3 considered chronic (Riaz and Ashfaq, 2019). Ground water is Pakistan's second largest source of irrigation, accounting for 38%, 79% of the Punjab province, and 28% of the Sind province (Nasir *et al*., 2021). In the north, rainfall is the primary source of irrigation. Seasonal rain fall during the Rabi and Kharif seasons irrigates the entire canal command area with 53 mm and 212 mm, respectively (Razzaq *et*

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al., 2019; Watto and Mugera, 2014).

Water governance refers to a broad range of social, political, economic, and administrative systems for effectively developing and managing water resources for water delivery to society (Güvercin and Boz, 2003; Sinclair *et al*., 2013). Water governance, development, and irrigation management strategies have recently been shifted from government to mutually managed system by government and farmers with World Bank collaboration (Khalkheili and Zamani, 2009; Raza *et al*., 2010). Under PIM, there are 5 Area Water Boards (AWBs) working with 363 Farmer Organizations (FOs) at the distributary level and 18,579 outlets (Baig, 2009).

Participation refers to participants' involvement in policy design, investment, and management decisions that affect local communities as well as ownership (Khalkheili and Zamani, 2009). Participation of all stakeholders in governance, development, and management leads to sustainability, reduced public expenditures, improved water efficiency, water availability, equity, and effective service provision (World Bank, 2020; Hussain *et al*., 2021). The provision and transfer of maintenance responsibilities, the upgrading of irrigation structures, and cost recovery increased water availability and agricultural productivity (Riaz and Ashfaq, 2019; Ahmad *et al*., 2020). Farmers' attitudes toward irrigation structure participation are positively influenced by their level of education, land ownership, and operational land holdings (Khalkheili and Zamani, 2009; Agidew and Singh, 2018).

Participatory Irrigation Management in Pakistan is facing various challenges to achieve its goals and objectives, support, willingness of government and policy makers. This reform is also facing resistance from the provincial irrigation departments of public sector, which are to be transformed. The reforms process in the country is struggling requiring political will and full support of the stakeholders, especially farmers. This reform leads to conflicts between the concerned stakeholders i.e. FOs (FOs: Farmer Organizations are groups of democratically elected leaders at distributaries level) and publically owned Irrigation Departments due to financial incentives. Ahmad *et al*. (2020), Riaz and Ashfaq (2019), and Gandhi *et al*. (2019) conducted studies on the performance evaluation and function devolution of PIM and its impact on water availability and agricultural productivity. Khalkheili and Zamani (2009) investigated the level of farmers' participation in irrigation management. Dabhi *et al*. (2010) identified financial constraints for irrigation fee payments, damaged irrigation structures, high weed and garbage intensity, and high water losses as major constraints for low farmer participation and effective irrigation management. There is no detailed research being carried out to determine the factors influencing farmers' participation in PIM activities. Therefore, this study was designed to determine the factors influencing farmers' participation level in PIM activities and to compare the economic viability of farms based on farmers' participation level in PIM activities.

MATERIALS AND METHODS

Study Area

Punjab is Pakistan's most populous province, accounting for 60% of the country's GDP. It has fertile land, favorable climatic conditions, and the most extensive canal irrigation system, irrigating 3.35 million hectares of land (Shahbaz *et al*., 2020). The monsoon season (June to August) receives 50 to 70% of the total annual precipitation (Haq *et al*., 2021).

Faisalabad is the second most populous city in central Punjab, with a population of about 7.87 million, contributes 5% of GDP, with agriculture accounting for 21%. (Shahbaz *et al*., 2020). There are a total of five area AWBs, and the Lower Chenab Canal (LCC) is the main source of irrigation in Faisalabad, established in 2007. There are 67 FOs at distributary levels, 175 Khal Panchyats (KPs: Khal Panchyats are groups of farmers that have right to irrigation farms at the water course level) at water courses level, and 2,617 outlets. Faisalabad, where this study was conducted, is located at the middle of the tail reach of LCC (West). The Faisalabad AWB is shown in Figure 1.

Sampling and Sample size

The data were collected from 240 farmers from Maduana and Nasrana distributaries. The sample size was calculated using Cochran's formula, which was also used by Shahbaz *et al*. (2022) for large populations. The formula is given below;

$$n_0 = \frac{Z^2 \times p \times q}{e^2} \quad (1)$$

Where, n_0= Sample size, Z= Confidence level, p= Proportion of population, q= 1-p, and e= Precision level (margin of error).

For this study, 95% level of confidence, 50% population proportion (total variability), and 6% precision level or margin of error was accepted. Using the above values, we calculated a sample size of 240 farmers.

A multi-stage random sampling technique was used to collect the data, using a comprehensive questionnaire through a survey. Punjab has been chosen as the study area in the first stage. Punjab is divided into major Area Water Boards (AWBs) and in the second stage, selected the oldest AWB under Punjab Irrigation and Drainage (PIDA). In the third stage, two tail end distributaries under LCC, named Nasrana and Maduana, were identified. In the fourth stage, 120 farmers from each distributary were selected.

Analytical Procedures

Farm technical efficiency

Productivity and efficiency are not the same thing, but they are often confused with each other (Haq *et al*, 2021). The concept of efficiency was first introduced by Farrell (1957). Technical efficiency refers to whether a farm is making the best use of its available technology for production (Chavas

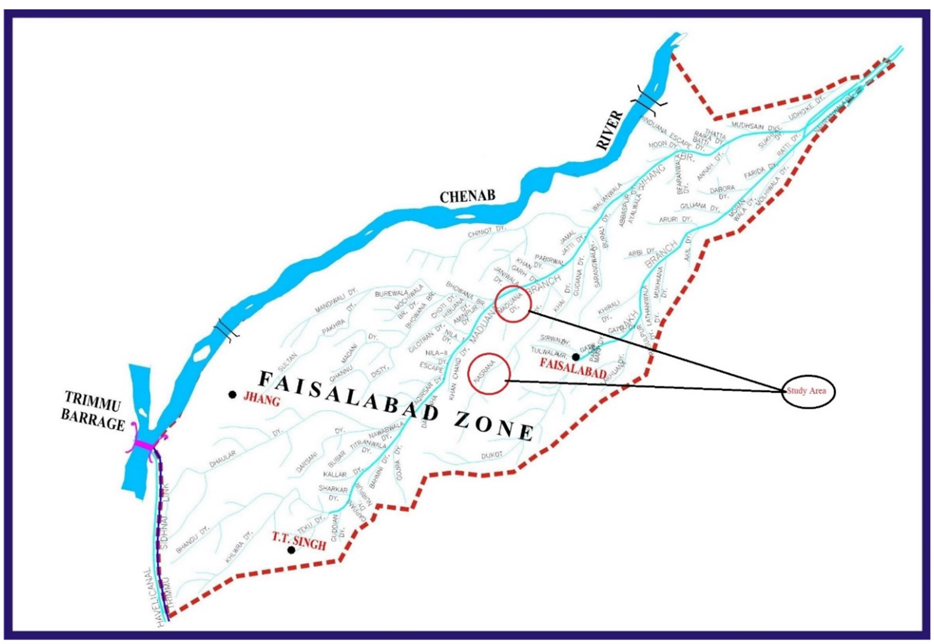

Figure 1. Map of Lower Chenab Canal (West) Circle, Faisalabad (Source: PIDA, 2018).

and Aliber, 1993), while Farrell and Fieldhouse (1962) defined efficiency as the ability of farm inputs to be rescaled without affecting output level. Efficiency is defined as the difference between used and best practice input-output combinations (Ceyhan and Gene, 2014). There are two methods for calculating a farm's efficiency: non-parametric and parametric. The parametric approach is Stochastic Frontier Snalysis (SFA), and the non-parametric approach is Data Envelopment Analysis (DEA). DEA calculates the efficiency relative to efficient Decision Making Units (DMUs) (Razzaq *et al*., 2019). In DEA, efficiency can be calculated in two ways: input-oriented and output-oriented. The output-oriented method refers to a technique in which a farm can produce the highest possible output while using the same set of inputs. An input-oriented method is a technique in which a farm can produce the same level of output while using fewer inputs (Boz *et al*., 2018; Coelli, 1996).

We preferred the input-oriented method to calculate farm technical efficiency using the non-parametric technique DEA and linear programming functions over SFA because it allows for more flexibility in technology functional form selection and requires fewer sample sizes (Ceyhan and Gene, 2014). It also provides farm-specific information such as the source and magnitude of input-output combinations and employs linear programming models (Chavas and Aliber, 1993).

Annual farm revenues (Pakistani Rupee/Year) are used as Yi to calculate farm technical efficiency (output). Inputs included operational holding (acres), labor costs (PKR/Farm), and capital costs (PKR/Farm).

The technical efficiency was estimated using the following equation for the ith farm via linear programming.

$$\text{Minimize}_{\theta,\lambda}\ \theta$$
$$\text{Subject to } -y_i+Y\lambda \geq 0$$
$$\theta x_i - X\lambda \geq 0$$
$$\lambda \geq 0 \qquad (2)$$

If a farm is using A inputs and producing B output then the input and output matrix for N DMUs will be A×N shows input matrix (X) and B×N represents output matrix (Y) in Equation 2. The efficiency values range between 0 and 1, as 1 refers to efficient, and 0 means inefficient farms (Bozoğlu and Ceyhan, 2007).

Estimation of Farmers' Participation Level in PIM Activities

PIM's potential activities for collectively institutionalizing, maintaining, and upgrading irrigation systems were used as strategies to monitor farmer involvement and participation (Table 1). Unfortunately, as shown in Table 1,

Table1. Farmers' participation in different PIM activities.

Farmers' participation in	Mean
Election of WUA	0.83
Water course's cleaning	0.79
Provision of labor for distributary maintenance	0.85
Regularly payment of water fee	0.89
Water theft decision gathering (Panchayat)	0.58
Up-gradation of irrigation infrastructure	0.76
Water fee (abiana) collection	0.24
Regular KP meetings	0.21
Regular FO meetings	0.21
Meetings with government officials	0.21
Campaigns to control the misuse of water	0.25

farmers in the study area were more likely to participate in mandatory activities (voting in elections, paying water charges, maintaining water courses, upgrading irrigation structures, and providing labor) and less likely to participate in non-mandatory activities (meetings with KP, meetings with FO, meetings with government officials, and campaigns to prevent water misuse).

PIM's [PIM= Participatory Irrigation Management (PIM) refers to the involvement of irrigation users in all aspects and all levels of irrigation management] 11 different activities were used to estimate farmer participation. Farmers' responses to each activity were recorded as binary responses 0 (no participation) and 1 (participation). Using K-means cluster analysis, the farmers' scores were totaled and classified into three groups. Farmers who had participated in up to four PIM activities were assigned a low level of participation. Those who participated in up to seven PIM activities were classified as having a medium level of participation. Farmers who participated in more than seven PIM activities were classified as having high participation in PIM activities. In terms of PIM participation, 24.58% of all farmers belonged to the low, 53.75% to the medium, and 21.67% to the high groups.

The factors influencing farmers' participation in PIM activities were identified using an ordered Probit Regression model (Okoye *et al*., 2010). This method assumes that the noise term is normally distributed, allowing partial effects to be recovered (Johnston *et al*., 2020). It is a popular technique for dealing with ordered dependent variables (Okoye *et al*., 2010).

In the Ordered Probit Regression model, the response variable was coded as 0= Farmers in the low level participation group, 1= Farmers in the medium level participation group, and 2=farmers in the high level participation group.

$$y^* = \beta' x_i + \varepsilon, \varepsilon \sim N(0,1) \quad (3)$$

$$y = 0 \; if \; y^* \leq 0$$

$$y = 1 \; if \; 0 < y^* \leq \mu_1$$

$$y = 2 \; if \; \mu_1 < y^* \leq \mu_2$$

Here, y*= Response variable as probability of farmer belonging to participation group, β'= Vector of coefficients, x_i= Vector of respond variables, ε= Vector of normally distributed error terms [0, 1], y= The observed response variable as the probability of farmer having higher participation level in PIM activities, and μ= The cut-off points shows the level of affection of a farmer to have higher participation level in PIM activities.

The marginal effects were measured by using the following formula, used by Boz and Akbay (2005). The marginal effects were used to figure out how much each explanatory variable increased or decreased the probability of a farmer in each of the three categories of the dependent variable.

$$\frac{\partial P(y_i=j)}{\partial x_k} = \left[\Phi\left[\mu_{j-1} - \sum_{k-1}^{k} \beta_k x_k\right] - \Phi\left[\mu_j - \sum_{k-1}^{k} \beta_k x_k\right]\beta_k \right. \quad (4)$$

Where, $\partial P/\partial x_k$ is a partial derivative of probability with respect to the independent variable x_k. The positive value of marginal effect of x_k explains that the probability of a farmer selecting the specific category increases with x_k and vice versa. The sum of the marginal effects should be zero because the responses are exclusive and thus cancel each other out (Nadeem *et al*., 2020).

Table 2 describes the explanatory variables used in the ordered probit model. The first three variables (family size, age, education and farming experience) were related to their socioeconomic characteristics, while the next four variables (operational area, warabandi (number of irrigation turns per farm), and distance from canal) were related to farm specifics and treated as continuous variables. The next two variables were dummy variables related to land ownership and off-farm income sources. The remaining dummy variables were related to PIM.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Sample Farmers

The socioeconomic characteristics of farmers in the study area are described in this section. The results showed that the average age of the sampled farmers was around 47

Table 2. Description of variables used in the model.

Variables	Description
Family size	Number of family members
Age	Numbers of years of age of farmers
Education	Years of formal schooling of farmers
Farming Experience	Years of involving in farming activities
Operational Area	Acres of operational landholding of farmers
Warabandi	Time of irrigation per turn
Distance from canal	Distance from farm to canal in kilometers
Land Ownership	Value 1 to farmer has ownership of land, otherwise 0
Off-farm income	If a farmer has off-farm income source, value 1, otherwise 0
Village leader	If a farmer is village leader, value 1, otherwise 0
WUA Beneficiary	If the farmer is WUA beneficiary, value 1, otherwise 0
Relationship with WUA	If a farmer has relationship with WUA , value 1, otherwise 0

years, which was more than double the average farming experience. Pakistan has an agricultural economy, where more than 60% of the population earns their livelihoods from agriculture. This may be the reason people are involved in agriculture during their schooling and work with their families at early ages. The sample farmers had an average of eight members per family. The sampled farmers had an average education level of up to middle school. The average operational land holding was approximately 10 acres. In Pakistan, 85% of farmers own less than four hectares (less than 12.5 acres) of land. The family system in the rural areas of Punjab, Pakistan, is a joint system, where people live under the same umbrella and work together. The farming community has a low level of education due to the reasons of early involvement in agriculture and support for their parents. They may have less interest in education just because of their illiterate parents and unfriendly school environment.

The average irrigation time per turn and farm distance from the canal were approximately 23 minutes and 1.32 kilometers, respectively. A third-fourth of the sampled farmers owned land, and more than half had an off-farm income source and a relationship with WUA officials. Table 3 shows that approximately one-fourth of the sampled farmers were village leaders and less than half were WUA beneficiaries in the study area.

Comparison of Economic Viability and Farmers' Participation Level in PIM System

This section compares the economic viability of farmers based on their level of participation in the PIM system. Sugarcane and wheat were the most important field crops in the sampled area. The findings revealed that

Table 3. Socioeconomic characteristics of farmers and farms.

Variables	Mean	Std. Dev.
Family size (No)	8.07	3.76
Age (Years)	47.46	12.07
Education (Years)	7.62	3.65
Farming experience (Years)	24.92	12.32
Operational holding (Acre)	10.07	10.19
Warabandi (Min/Turn)	23.03	10.62
Distance from canal (Km)	1.32	0.77
Land ownership (1= Yes, otherwise 0)	0.74	0.43
Off-farm income (1= Yes, otherwise 0)	0.53	0.5
Village leader (1= Yes, otherwise 0)	0.23	0.42
WUA beneficiary (1= Yes, otherwise 0)	0.45	0.49
Relationship with WUA (1= Yes, otherwise 0)	0.55	0.49

farm technical efficiency differed significantly between farmers with low and medium levels of participation in PIM activities. Farmers with low participation in PIM activities had significantly lower technical efficiency than farmers with high participation in PIM activities. It shows that farmers who participated in fewer PIM activities had a 9% lower TE than participated in more PIM activities. It means that the high-level participation group had 9% more chances to reduce the use of inputs without compromising the output level. Farmers with a high level of participation in PIM activities, on the other hand, had a 15% higher TE than farmers with a low level of participation. It indicates that the low participation group had 15% fewer chances than the high participation group to reduce the use of inputs without compromising the level of output. Arun *et al*. (2012) and Zhou *et al*. (2017) also discovered that the level of farmers' participation in irrigation structure management and upgrading leads to effective water availability and water equity between farms. Farmers with high levels of participation had more water availability than farmers with low levels of participation, resulting in technically more efficient farms.

The sugarcane productivity was significantly different across the levels of farmers' participation in PIM activities. It demonstrates that farmers with a medium level of participation in PIM activities had 1.47 tons/acre higher productivity than farmers with a low level of participation in PIM activities. Farmers with low levels of participation in PIM activities had approximately 4.45 tons/acre lower productivity than farmers with high levels of participation in PIM activities. It also shows that farmers with high levels of participation in PIM activities had approximately 2.98 t acre^{-1} higher productivity than farmers with medium levels of participation.

The findings revealed that wheat productivity differed significantly across the levels of participation in PIM activities as shown in Table 4. According to the findings, farmers with high levels of participation in PIM activities had approximately 0.09 t acre^{-1}

Table 4. Comparison of economic viability based on farmers' participation level in PIM system.

Economic viability	Farmers' participation level		Difference
	Low	Medium	
Farm technical efficiency	0.55 (0.25)	0.64 (0.24)	-0.09*
	Low	High	
	0.55 (0.25)	0.70 (0.24)	-0.15*
	Medium	High	
	0.64 (0.24)	0.70(0.24)	-0.06
Sugarcane productivity (t ha^{-1})	Low	Medium	
	10.22 (1.92)	10.01 (1.78)	-0.59**
	Low	High	
	10.22 (1.92)	11.22 (2.93)	-1.80*
	Medium	High	
	10.01 (1.78)	11.22 (2.93)	-1.20*
Wheat productivity (t acre^{-1})	Low	Medium	
	0.647 (0.09)	0.643 (0.16)	0.004
	Low	High	
	0.647 (0.09)	0.684 (0.13)	-0.04***
	Medium	High	
	0.643 (0.16)	0.684 (0.13)	-0.04***

higher productivity than farmers with low levels of participation. Despite this, farmers with a medium level of participation in PIM activities had about 0.1 t acre^{-1} lower productivity than farmers with a high level of participation. Karamjavan (2014) found that farmer participation has a positive impact on the economic viability of their farms. Farmers' participation in PIM activities enhances the water availability across the distributary that ultimately increase the agricultural productivity.

Farmers' participation in PIM activities such as water course cleaning, maintaining and upgrading irrigation structures, and regular payment of water fees, results in low water conveyance loss, less water misuse, and a more effective irrigation system. This efficient irrigation system ensures equitable and timely water distribution that leads to higher production.

Factors Affecting Farmers' Participation in PIM Activities

This section identified the factors influencing the farmers' participation in the PIM system as shown in Table 5. The overall model was significant, with a log-likelihood ratio of chi-square of -154.34 and a probability of chi-square of less than 1%. According to the results, education level, farming experience, village leader, and WUA beneficiary all had a significant positive influence on farmers' participation in PIM (Table 5), while family size, land ownership, and off-farm income had a significant negative impact on farmers' participation in the PIM system.

A one-unit increase in family size in rural households significantly reduces the likelihood of participation in PIM activities. Due to the large family size in rural areas, farmers do not want to participate in irrigation system upgrading and maintenance. The main reason for low participation is a preference for other high-paying off-farm jobs. Dolisca *et al*. (2006) discovered a negative relationship between family size and farmer participation as well. Education is regarded as the most powerful tool for understanding and participating in systems that promote societal well-being. Farmers' participation increases significantly with a one-year increase in education. With the increase in the education level, the farmers' ability to understand, work, increase their level of income, and participate in the systems for the well-being of society increases. Wilson (1997) also established a positive relationship between educational attainment and farmer participation. A one-year increase in farming experience increases the likelihood of participating in PIM activities insignificantly. Farmers with the most experience in any system are the most knowledgeable and have a better understanding of that system. Similarly, farmers' experience provides them with a better understanding and knowledge of the old irrigation system. They are aware of the fundamental issues and devise better solutions to address them. Experienced individuals were included to improve knowledge, experience, and understanding of the irrigation system. Dolisca *et al*. (2006) and Khalkheili and Zamani (2009) found that farmers' level of participation was strongly related to how long they had been involved in farming.

The main beneficiaries of irrigation structures in farming communities are the head-reach farmers, who have much better access to irrigation water and experience lower water losses compared to the middle and tail reach farmers. A one-kilometer increase in distance between the canal and the farm significantly increases the likelihood of farmer participation. It implies that the tail reach farmers are more willing to participate in PIM activities for greater and effective water availability at their farms compared to the head- and middle-reach farmers. Water losses and water misuse in irrigation upgrades always affect the tail-reach water users. They are always prepared and have a high participation rate in improving the irrigation system and water equity. Farmers are distinguished from others by land ownership and multiple sources of income. Farmers with large land holdings and multiple income sources hold a prestigious position in Pakistan's rural community. They are always reluctant and seek to prevent any laborious activities. According to the findings, having land ownership and off-farm income significantly reduces farmers' chances of participating in the PIM system compared to tenants and farming as only one source of income. Dolisca *et al*. (2006) discovered a negative correlation between farmer participation and land ownership.

Relationships with officials in any system distinguish members of society from others in Pakistan's rural areas. Farmers who have a relationship with WUA officials have a significantly higher chance of getting involved in PIM activities than farmers who do not have a relationship with WUA. The PIM system is a democratic system in which farmers elect their leader and work collaboratively to improve the system. They cooperate with WUA officials by accepting obligatory responsibility and benefiting from it.

The marginal effects results show that increasing the size of a rural household's family by one person reduces the likelihood of farmers being in the medium and high participation groups by 0.14 and 0.86%, respectively, while one person increase in family-size increases the likelihood of being in the low participation group by 0.10%. Farmers with a one-year increase in education are 0.33 and 2.1% more likely to be in the medium and high participation groups, respectively. A one-year increase in education level, on the other hand, reduces their likelihood of being in the low participation group by 2.3%. A one-year increase in farming experience increases their chances of being in the medium and high participation groups by 0.06 and 0.4%,

Table 5. Results of ordered pro-bit regression model.

Farmers' participation level	Co-ef	St Err	P-value	Marginal effects		
				Low	Medium	High
Family size (No)	-0.05**	0.03	0.04	0.0101	-0.0014	-0.0086
Age (Years)	0.02	0.01	0.11	-0.0039	0.0005	0.0034
Education (Years)	0.12***	0.03	0.00	-0.0233	0.0033	0.0201
Farming Experience (Years)	0.02*	0.01	0.06	-0.0046	0.0006	0.0040
Operational Area (Acre)	-0.02	0.01	0.15	0.0028	-0.0004	-0.0024
Warabandi (Min/Turn)	-0.01	0.01	0.42	0.0014	-0.0002	-0.0012
Distance from canal (Km)	0.37***	0.13	0.01	-0.0729	0.0103	0.0626
Land Ownership (1= Yes, otherwise 0)	-0.44*	0.23	0.05	0.0774	0.0089	-0.086
Off-farm income(1= Yes, otherwise 0)	-0.52***	0.17	0.01	0.9182	-0.0102	-0.908
Village leader (1= Yes, otherwise 0)	0.97***	0.27	0.00	-0.1427	-0.0838	0.2265
WUA Beneficiary (1= Yes, otherwise 0)	1.20***	0.22	0.00	-0.2297	0.0006	0.2291
Relationship with WUA (1= Yes, otherwise 0)	-0.03	0.17	0.86	0.0059	-0.0008	-0.0051
Constant	1.14	0.59	.b			
Constant	3.61	0.64	.b			
Log-likelihood	-154.34					
Pseudo r-squared	0.36		Number of obs	240		
Chi-square	176.12		Prob> Chi^2	0.000		
Akaike crit (AIC)	336.67		Bayesian Cric (BIC)	385.40		

*** P< 0.01, ** P< 0.05, * P< 0.1

respectively. Farmers with one year of farming experience are 0.46% less likely to be in the low participation group. The results showed that increasing the distance between the canal and the farm by one kilometer increases their likelihood of being in the medium and high participation level groups by 1.03 and 6.26%, respectively. However, when the canal is one kilometer farther from the farm, the chances of farmers' being in the low participation group go down by 7.29%.

An owner farmer is 0.89 and 7.7% more likely to belong to the medium and high participation groups compared to tenant farmers, respectively. Instead, a tenant farmer is 8.6% less likely to belong to a high participation group compared to a land-owned farmer. A farmer with off-farm income is less likely to be in the medium or high participation group by 1.02 and 90.8%, respectively, than a farmer with only farming as an income source. A farmer with off-farm income, on the other hand, increases their likelihood of being in the low participation group by 91.82% when compared to farmers with only farm income. A farmer having the position of village leader decreases their likelihood by 8.38% and 14.27% of being in medium and low participation groups compared to the local farmers, respectively. When compared to local farmers, a farmer in a leadership position increases their likelihood of being in high participation groups by 22.65%. A WUA beneficiary farmer is 0.06 and 22.91% more likely to belong to medium and high participation groups, compared to a non-WUA beneficiary. Nonetheless, a farmer who is a WUA beneficiary reduces their chances of being in the low participation group by 22.97% when compared to a farmer who is not a WUA beneficiary.

CONCLUSIONS

It has been concluded that education, distance from canal to farm, village leadership, and being a WUA beneficiary all positively influenced farmers' participation in PIM activities. Family size, land ownership, and off-farm income sources all had a negative impact on farmers' participation levels. Farmers with high-level participation had high technical efficiency and crop productivity. The participation level in the collectively managed irrigation system leads to a low level of water loss, proper use of water, and timely maintenance and up-gradation of irrigation structures. Farmers' participation improves water availability, which leads to increased productivity and income. As a result, high levels of farmers' involvement and participation are required for an effective irrigation system. To improve the irrigation system, agriculture, and the economy as a whole, farming communities need to be encouraged by providing financial incentives and higher water share to take part in PIM activities.

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مشارکت کشاورزان و پیامدهای آن برای پایداری اقتصادی مزارع در سامانه‌های آبیاری مدیریت شده جمعی: مطالعه موردی در پاکستان

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چکیده

مدیریت مشارکتی آبیاری (PIM) به عنوان یک مداخله مهم مطرح شده است که در آن به کشاورزان کنترل بیشتری بر مدیریت آبیاری داده می شود. هدف اصلی این پژوهش شناسایی عوامل مؤثر بر مشارکت کشاورزان در فعالیت‌های PIM و مقایسه میزان پایداری اقتصادی سطح مشارکت بود. برای نمونه‌گیری، از روش تصادفی

چند مرحله‌ای برای جمع‌آوری داده‌ها از ۲۴۰ کشاورز کانال‌های توزیع‌آب در مناطق Nasrana و Maduana واقع در انتهای کانال غربی چناب پایین (LCC) در ناحیه فیصل آباد، در پنجاب پاکستان، و با استفاده از یک پرسشنامه ساختاریافته (Structured) استفاده شد. با استفاده از مدل رگرسیون پروبیت مرتب (Probit Regression model)، عوامل مؤثر بر مشارکت کشاورزان در فعالیت‌های PIM شناسایی شدند. یافته ها نشان داد که سطح تحصیلات (β=0.12، P= 0.00)، رهبری روستا (β=0.97، P= 0.00)، و عضو بودن در انجمن مصرف کنندگان آب (β=1.20, P= 0.00) همگی تأثیر مثبت معناداری بر مشارکت کشاورزان در فعالیت های PIM داشت. از سوی دیگر، اندازه خانواده (β=-0.05، P= 0.04)، مالکیت زمین (β=-0.44 P= 0.05) و درآمد خارج از مزرعه (β=-0.52، P= 0.01) تاثیر منفی معنی‌داری بر مشارکت کشاورزان داشت. کشاورزان با سطح مشارکت بالا از کارایی فنی مزرعه و بهره وری بالاتری برخوردار بودند. از این رو، جوامع کشاورزان باید برای مشارکت در فعالیت های PIM تشویق شوند تا به یک سامانه آبیاری پایدار دست یافت.