

Full Length Research Paper

Institutional determinants of farmer participation in irrigation development post “fast-track” land reform program in Zimbabwe

K. Nhundu^{1*}, A. Mushunje², L. Zhou¹ and F. Aghdasi¹

¹Risk and Vulnerability Science Centre, University of Fort Hare, Faculty of Science and Agriculture, South Africa.

²Department of Agricultural Economics and Extension, University of Fort Hare, Faculty of Science and Agriculture, South Africa.

Received August, 2009; Accepted 27 April, 2015

Access to reliable irrigation enables farmers to adopt new technologies and intensify agricultural, water and land productivity. The Fast Track Land Reform Programme (FTLRP) of 2000 in Zimbabwe ushered in new, unskilled cadres in the irrigation sector, drastically reducing the area under irrigation from approximately 200,000 ha developed for irrigation to around 120,000 ha. This trend could be explained by lack of knowledge of institutional factors influencing farmers’ decisions to participate in irrigation development. A study was done in Mashonaland East Province to investigate the institutional determinants influencing farmer participation in irrigation development. The empirical results revealed the importance of training, cost recovery, participation in design and implementation, access to extension, and access to credit extension in influencing farmers to participate in irrigation development. The findings suggest that it is important to identify institutional mechanisms of assisting the FTLRP beneficiaries to participate in irrigation development. Thus, policy-makers should put emphasis on increasing farmers’ knowledge and perception of the merits of irrigation development through better access to technical information and extension as this assists them to develop a positive economic assessment of irrigation development.

Key words: Irrigation development, farmer participation, food security, land reform.

INTRODUCTION

Rukuni et al. (2006) posit that irrigation development represents the most important interface between water and land resources. Barau et al. (1999) emphasises on irrigation development as a means of increasing food and raw material production as well as promoting rural development. Similarly, Hussain et al. (undated) points out that irrigation has been regarded as a powerful factor for providing food security, protection against adverse

drought conditions, increased prospects for employment and stable income, and greater opportunity for multiple cropping and crop diversification. Moreover, access to reliable irrigation can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming (Hussain et al. undated). This, in turn, opens up new employment opportunities,

*Corresponding author. E-mail: knhundu@ufh.ac.za. Tel: 27 72 044 8026, +27 40 602 2734.

Author(s) agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

both on-farm and off-farm, and can improve income, livelihoods, and the quality of life in rural areas. Generally, access to irrigation allows poor people to increase their production and income, and enhances opportunities to diversify their income base, reducing vulnerability caused by the seasonality of agricultural production as well as external shocks. This also has the potential to contribute to poverty reduction and the movement of people from ill-being to well-being (Hussain et al. undated).

However, it has been argued that in many countries, institutional weaknesses and performance inefficiencies of public irrigation agencies have led to high costs of development and operation of irrigation schemes (Gyasi et al., 2006). Poor maintenance and lack of effective control over irrigation practices have resulted in the collapse of many irrigation systems. Yet regular training activities can contribute to successful irrigation management by communities. Rao (1993) argues that unless farmers are satisfied with their irrigation systems, there would be no incentives for the farmers to participate in irrigation developmental projects. Moreover, no irrigation technology, regardless of its ecological and economical soundness will have any impact on productivity and income unless it is adopted by a significant proportion of farmers. Against this background, the study, therefore, seeks to investigate the institutional factors that influence farmer participation in irrigation development.

Mlambo and Zitsanza (2001) acknowledged the role that agriculture plays in the development of the Zimbabwean economy through its contribution to the overall economic growth, households' income generation and food security. Further, the majority of Zimbabweans are rural based and derive their livelihood from agriculture. Approximately, over 80% of the rural population lives in Natural regions III, IV and V, where rainfall is erratic, low and unreliable, making dry land cultivation a risky venture (FAO, 2000). In addition, it is estimated that about 70% of Zimbabwe's communal lands lie in region IV and V, characterised by erratic, low and unpredictable rainfall and only suitable for rain-fed agriculture (Food and Agricultural Organisation, FAO, 2006). As a key drought mitigation measure, the Government of Zimbabwe (GoZ, 2000) has recognised the role of irrigation development in these areas (Rukuni et al., 2006). Smallholder irrigation is crucial for the sustenance of rural livelihoods in these semi-arid regions (Samakande et al., 2004). Moreover, as stated by Rukuni et al. (2006) improved supply of water increases water security, thus leading to a more secure and productive farm enterprise.

In light of the above, the government of Zimbabwe, therefore, embarked on land reform programmes to rectify the land imbalances as the majority of Zimbabweans continued to live in rural areas, mostly on small farms in less favoured agro-ecological zones

Mushunje, 2005).

Fast Track Land Reform Programme (FTLRP)

The Fast Track Land Resettlement Programme (FTLRP) was launched on the 15th July, 2000 (Utete, 2003). The programme was designed to be undertaken in an accelerated manner and with reliance on local resources with the following objectives as stated in policy documents:

1. The immediate identification for compulsory acquisition of not less than 5 million hectares for Phase II of the Resettlement Programme, for the benefit of the landless peasant households
2. The planning, demarcation and settler emplacement on all acquired farms
3. Provision of limited basic infrastructure (such as boreholes, dip tanks and scheme roads) and farmer support services (such as tillage and crop packs) (Utete, 2003)

The FTLRP of 2000 changed Zimbabwe's agrarian structure by rapidly expanding the number of small producers through the model A1 scheme, and small, medium and large scale commercial farmers through the A2 scheme, in addition to the communal areas and the remaining large-scale commercial farms (Manzungu, 2003). Moreover, the Fast Track Land Reform Programme was also characterised by some structural changes regarding access to land and water, as key factors in agricultural production.

Water and land resources inventory

Manzungu (2003) states that actual water resources utilisation was estimated at 60 to 65% and irrigation alone utilising about 80% of the developed water resources. The estimated potential irrigable area in Zimbabwe is 550,000 ha (Manzungu, 2003), of which 200,000 ha has been developed. This area included functional and non-functional irrigation systems, as well as informal irrigation schemes. However, Rukuni et al. (2006) states that Zimbabwe lost 66,190 ha of irrigation land between 1997 and 2003. The loss was due to droughts between 1997 and 2002 and was also due to the land reform which caused conflicts over new farmers' access to irrigation infrastructure, including theft of immovable equipment which reduced the area under irrigation.

LITERATURE REVIEW

Irrigation infrastructure investment

Irrigation development continues to expand; however, the

pace is slowing worldwide (Water Sector Board Report, 2007). This has been attributed to challenges and constraints to irrigation development, especially social and environmental concerns. Moreover, low productivity of many existing schemes has prompted changes in investment policy away from new infrastructure development toward programs that improve performance of existing schemes. Thompson (2001) states that even though irrigation is still one of the core investments activities of the World Bank's Rural Portfolio, the number of irrigation schemes were expected to decrease. Similarly, Jones (1995) states that there has been a sharp decline in World Bank lending for new irrigation development and that funding for new irrigation construction has largely stopped and the emphasis is on the sustainability and efficiency of existing systems. In addition, cost and time overruns in irrigation projects have further eroded the confidence of funding agents. This is despite the fact that irrigation development can provide socio-economic benefits (Nhundu et al., 2010) in terms of increased household incomes and food security level. Denison and Manona (2007) state that infrastructure development alone is unlikely to succeed unless comprehensive strategies that consider all the activities that make up an irrigation enterprise, such as irrigation markets, credit, irrigation inputs, institution-building and crop production information are put in place.

Planning, design and implementation of irrigation projects

The plot-holders need to be at the centre of the planning and implementation process which demands substantial two-way information transfer so that the implications of the decisions can be fully appreciated by intended end users (Denison and Manona, 2007). Furthermore, women are responsible for some 65% of farming activity in the smallholder irrigation sector, yet most of the decisions in meetings are still made by men. This might cause failures of the interventions. In addition, FAO (2001) highlights that failure is also likely to happen if public irrigation development continues without the involvement and participation of the water users in the process. It is only through their involvement from the beginning of a project that farmers can develop a sense of ownership and be likely to care for the system.

Irrigation funding

Irrigation development is expensive and the profitability of irrigated production is critical in justifying both short-term and long-term viability of an enterprise. As such, Rukuni et al. (2006) conclude that effective management is needed to enhance efficiency, cost recovery and be able to sustain the whole system. In Zimbabwe, development costs for small-scale irrigable schemes continued to rise

due to several factors, yet the country is faced with an acute shortage of foreign currency. This has affected the costs of raw materials that are procured from outside the country and consequently, has led to poor irrigation development.

Operation and management

While governments have participated in the expansion of irrigation schemes (Water Sector Board, 2007), the schemes' performance has been sub-optimal. Where there has been sufficient investment and management input from governments, irrigation schemes have contributed to rapid increases in food production, the major public policy goal. However, the supply-led approaches and large-scale irrigation infrastructure that were to fuel growth have resulted in bureaucratic institutions that lack the structure and incentives for efficient management and have resulted in inflexible water-delivery systems not capable of responding to farmers' needs. The study by Gyasi et al. (2006) in Ghana analysed the determinants of the success of community-based institutions for irrigation management. The findings of the study revealed that many schemes severely deteriorated or broke down completely in the past due to insufficient maintenance.

Irrigation viability and cost recovery

A Southern African Development Community report (SADC) (1992) indicated that most new smallholder irrigation schemes in the Southern Africa region will not cover the cost of development and operation and are therefore uneconomic. Furthermore, Mupawose (1984) questioned the economic viability of smallholder irrigation schemes in Zimbabwe and pointed out that certain smallholder schemes have failed and are under-utilised due to poor management, lack of inputs and irrigation experience by farmers. In the same report Mupawose (1984) advocated for the reduction of subsidies on smallholder irrigation and indicated that irrigation development has become expensive and suggested that some form of cost recovery should be employed in these schemes. However, FAO (2002) posit that cost recovery from poor farmers for operation and maintenance of irrigation systems is controversial as subsidising these services and providing irrigation water far below cost is financially unsustainable.

MATERIALS AND METHODS

Study area

The research was done in Mashonaland East Province. The province lies in Natural Region IIb, III and IV of Zimbabwe. Natural Region II specialises on flue-cured tobacco, maize, cotton, sugar

beans and coffee can be grown. Sorghum, groundnuts, seed maize, barley and various horticultural crops are also grown. Supplementary irrigation is done for winter wheat. Animal husbandry like poultry, cattle for dairy and meat, is also practiced. Natural region III is a semi-intensive farming region. The region is subject to periodic seasonal droughts, prolonged mid-season dry spells and unreliable starts of the rainy season. Irrigation plays an important role in sustaining crop production. Natural regions IV is too dry for successful crop production without irrigation, but communal farmers have no other choice but to grow crops in these areas even without access to irrigation.

Sampling procedure and data analysis

Stratified sampling was done to categorise respondents into two strata; irrigation participants¹ and non-participants². Overall, 120 respondents were selected for interviews (60 farmers from each stratum). A structured questionnaire was administered to respondents through face-to-face interviews.

Statistical Package for Social Scientists (SPSS) program was used to analyse data using descriptive statistics and binary logistic regression model as the main analytical tools. To determine factors that affect the decision to participate in irrigation development a binary regression model was used. The dependent variable in this case was a dummy variable that represented either participation in irrigation development or otherwise. The farmer's decision regarding participation in irrigation development is expressed by the following formulas:

$$\text{Prob(event)} = \text{Prob}(Y, 1 \text{ represents } i\text{th farmer participated, and } 0, \text{ otherwise}) \quad (1)$$

Let X_i represent the set of parameters which influence participation decisions of the i th farmer. For the farmer, Z_i is a direct utility derived from the participation decision, which is a linear function of k explanatory variables (X), and is expressed as:

$$Z_i = \beta_0 + \sum_{i=1}^n (\beta_i X_{ki}) \quad (2)$$

Where; β_0 is the intercept term, $\beta_1, \beta_2, \beta_3, \dots, \beta_i$ are the coefficients associated with each explanatory variable $X_1, X_2, X_3, \dots, X_{ki}$. Gathered in a vector X , these factors explain the irrigation participation decision, or the probability that the i th farmer participates in irrigation development:

$$P_i = \frac{e^{Z_i}}{1 + e^{Z_i}} \quad (3)$$

Where; P_i denotes the probability that the i th farmer's participation decision and $(1 - P_i)$ is the probability that the farmers does not participate. The odds ($Y=1$ versus $Y=0$) to be used can be defined as the ratio of the probability that a farmer participates (P_i) to the probability of non-participation ($1 - P_i$), namely odds = $P_i/(1 - P_i)$. By taking the natural log, we get the prediction equation for an individual farmer (Shaban et al., 2006);

$$L_i = \ln \left(\frac{P_i}{1 - P_i} \right) = Z_i \quad (4)$$

¹ In this paper, an irrigation participant refers to A2-Model farmer who has been allocated an irrigation plot under the FTLRP and is actively participating in rehabilitation and development of an irrigation system.

² In this paper, a non-participant refers to A2-Model farmer who has been allocated an irrigation plot under the FTLRP and is not participating in any irrigation rehabilitation and development activities.

Where $L_i = \log$ of odds ratio; $P_i =$ the probability of participation in irrigation development by the i^{th} household. $1 - P_i =$ the probability of non-participation in irrigation development by the i^{th} household Whereby the value of:

$$P_i = \frac{1}{1 + e^{-Z_i}} \quad (5)$$

And the value of Z_i is also referred to as the log of the odds ratio in favour of participation and is calculated by the following regression equation:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_{11} X_{11} + \mu_i$$

Where; $\beta_0 =$ intercept term, $\beta_1, \dots, \beta_{11} =$ the slope parameters of the model which measures the change in L_i for a unit change in the explanatory variables and μ_i is the error term, and X_1, \dots, X_{11} , are factors explaining the irrigation participation decision, or the probability that the i th farmer participates in irrigation development. These factors and how they are measured is further discussed in Table 1.

RESULTS AND DISCUSSION

Farmer characteristics

The descriptive results based on the farmers' characteristics are presented in Table 2. The average household age of irrigation participants and non-participants were 42 and 51 years, respectively suggesting that younger farmers participate more in irrigation development. Age was negatively related to farm adoption of new technology (Turner et al., 1983). Older farmers are likely to be more risk averse and more resistant to change and, therefore, be reluctant to participate in developmental initiatives. In contrast, findings by Kenkel and Norris (1995) indicated that, as a measure of experience, age has a positive effect on participation as older farmers would want to participate in the projects. Mushunje (2005), citing Bembridge (1987) posits that an individual's age is one of the most important factors pertaining to his personality make-up, since his/her needs and the way in which he/she thinks and behaves are all closely related to the number of years he/she has lived. Furthermore, age may have an impairing effect on physical abilities, which are important on family holdings, and as Bembridge (1987) notes, several studies have indicated little or no mental deterioration at least up to 60 years of age.

More female-headed households (60%) participate in irrigation development compared to male-headed households (40%). A study in Zambia by Thangata et al. (2002) revealed that female-headed households adopt resource technology more than male-headed households, *ceteris paribus*. Again, there were more female-headed households than male-headed households in both categories (60 and 80% for participants and non-participants respectively). Most households in rural areas

Table 1. Description of the variables specified in the empirical binary logistic model.

Acronym	Description	Type of measure	Expected sign
Dependent variable			
PART	Farmer participates in irrigation development	Dummy (1 if yes, 0 if no)	
Explanatory variables			
AGE	Age of household head	Actual number of years	+/-
SEX	Sex of household head	1 = male; 2 = female	+
EDUC	No. of years education of head	Actual number of years	+
FSIZE	Family size	Actual size of family	+
LABFO	Labour force size	Actual members in labour force	+
HHINCO	Household income	Actual household income	+
CONTEXT	Contact with extension	Dummy (1 if yes, 0 if no)	+
TRAINING	Access to training	Dummy (1 if yes, 0 if no)	+
CREDIT	Access to credit	Dummy (1 if yes, 0 if no)	+
DEIMPL	Participate in design and implementation	Dummy (1 if yes, 0 if no)	+
COREC	Participate in cost recovery program	Dummy (1 if yes, 0 if no)	+

Table 2. Farmer characteristics.

Parameter		Participant	Non-participant
Household head age (years)		42	51
Household head sex (%)	Male	40	20
	Female	60	80
Level of education (years)		11.3	4.6
Employment status (%)	Formally employed	35	33
	Full-time farmer	52	27
	Pensioner	13	40
Household size		8.69	5.88
Household labour force	≥ 16 years	6.21 (72%)	4.72 (80%)
	< 16 years	2.48 (28%)	1.16 (20%)

Source: survey data.

are headed by females due to male migration to urban areas (Mushunje, 2005).

Sex of household head is important as it influences the ability of the household to source income (Mushunje, 2005). Headship also influences access to assets such as land and capital that have a direct bearing on agricultural productivity. More female-headed households (60%) participate in irrigation development compared to male-headed households (40%). A study in Zambia by Thangata et al. (2002) revealed that female-headed households adopt resource technology more than male-headed households, *ceteris paribus*.

Education of the household head often influences adoption of technology positively (Hoag et al., 1999). Household heads with more years of schooling would be expected to better visualise the benefits of technology.

On average, irrigation participants attended schooling for 11 years compared to 5 years for non-participants suggesting higher level of education for irrigation participants. Non-participants were found to be 51 years old on average to 42 years for irrigation participants (section 4.1.1) and by virtue of being young, participants may have reached tertiary level, thus attaining more years in school compared to non-participants. Thus, the more educated the farmer is, the higher the probability of participating in irrigation development as they are in a position to acknowledge the benefits and merits of participating. The better educated a household head; the more likely they are to participate in projects (Matsumura, 1997; Beard, 2005). However, in contrast, given the nature of benefits and the time it takes to realise them, the more educated household heads would have a

higher opportunity cost of labour (Pitt and Sumodiningrat, 1991).

Fifty-two percent of irrigation participants were full-time farmers compared to 27% of the non-participants, suggesting why irrigation participants were participating more in irrigation development. Again, 35% of the irrigation participants were in formal employment compared to 33% of the non-participants. As observed in section 4.1.3, irrigation participants have more years of schooling on average (11 years) compared to non-participants (5 years). This could explain why more irrigation participants were formally employed than non-participants. As such, more educated household heads would have a higher opportunity cost of labour (Hoag et al., 1999). Only 13% of the irrigation participants were found to be pensioners compared to 40% of non-participants. Non-participating farmers were on average, older than participating farmers, could explain why most of them are pensioners. These farmers could be getting little income which demotivates them to participate in irrigation development.

On average, participating households were larger in size (8.69) compared to non-participants (5.88), suggesting a larger supply of labour for participating households. A larger family size implies a variety of labour capacity in the form of children, youngsters, adults and elderly members (Parikh et al., 1995). As such, the mix of labour enables the rational household head to assign the right job to the right person. As discussed in previously more irrigation participants were found to be full-time farmers (52%) compared to their non-participants (27%), thus could have been residing at the farm with their families. Human resources are vital to the development process because they are both the targets and instruments of development in Mushunje (2005) (Bembridge, 1987). Furthermore, small-scale farming heavily depends on its family for labour as labour inputs largely replace capital inputs. Although a larger family size puts extra pressure on farm income, it does ensure availability of enough labour for farm operations to be performed citing Parikh et al. (1995) (Mushunje, 2005). Household size has been observed to have a positive relationship to technology adoption (since larger households mean more labour) and that larger households would show more willingness to participate in project activities (Gladwin et al., 2002).

Interestingly, 80% non-participants were in the labour force category compared to 72% for irrigation participants, suggesting an increased labour force base for non-participants. However, Sebotja (1985) in Mushunje (2005) argued that whether or not the *de facto* or *de jure* size of household can influence the efficiency of farming operations, it is not very consistent. This is because some members of the household may not be available during periods of peak demand for labour and this may have a negative effect on farming activities.

On one hand, a household with higher incomes would

be more likely to participate in intervention programmes than the one with lower incomes since the farmer would even hire labour if they were constrained in that direction (Thangata et al., 2002). On the other hand, household with higher incomes would have higher opportunity cost of their labour and would not be willing to hire labour for the projects unless the returns were higher than the cost of labour.

On average, irrigation participants had a lower annual income from farm and non-farm activities compared to non-participants with an annual average of US\$2,709.50 and 2,881.70, respectively (Table 3). However, it is interesting to note that irrigation participants still participated in irrigation development. In contrast, Thangata et al. (2002) suggested that household with higher incomes would be more likely to participate in intervention programmes than those with lower incomes.

The highest contributing activity to household income for irrigation participants is hiring out agricultural equipment (24.4%) yet the same activity is the least contributor to household income for non-participants (2.2%). Irrigation participants own tractors which they hired-out and made more money compared to hiring out small equipment, with little returns for the non-participants. The highest contributor to household income for non-participants is remittances, contributing 23.7% and only 10.6% to irrigation participants' household income. A few non-participants were full-time farmers (27%), as such they were engaged in other non-farm activities where they earned more income. Possibly, the fact that non-participants were on average older than irrigation participants, they could be having older children who remitted more money to them.

Institutional policy variables

Extension services

Contact with extension allows farmers greater access to information (Whittome et al., 1995; Atta-Krah and Francis 1987). Having sufficient knowledge about the technology enables farmers to optimise these decision-making processes (Feder et al., 1985). Although other farmers consider fellow farmers to be the most important source of agriculture information, some prefer more specifically trained sources as the complexity of the message increases. The acquisition of knowledge may lead to a change in farmer perceptions about risk and profitability. Thus, farmers who are knowledgeable about profit-enhancing technologies will choose to adopt (Negatu and Parikh, 1999).

Only 18.3% of the irrigation participants had access to extension services compared to 8.3% of non-participants suggesting higher participation amongst irrigation participants (Table 4). Farmers with frequent contacts with extension services and experts and easy access to

Table 3. Sources of income for sample households.

Source of Income	Irrigation participants		Non-participants	
	Average income (p.a.) (US\$)	%aPercentage of total income	Average income (p.a.) (US\$)	Percentage of total income
Agriculture	449.2	16.6	298.3	10.4
Remittances	287.4	10.6	684.0	23.7
Hiring out family labour	63.6	2.3	309.0	10.7
Hiring out agricultural implements	659.9	24.4	63.6	2.2
Sale of livestock	129.8	4.8	259.8	9.0
Building activities	378.0	14.0	506.6	17.6
Beer brewery business	175.4	6.5	200.0	6.9
Cross-border trading business	221.6	8.2	382.6	13.3
Engaged in shop business	344.6	12.7	177.8	6.2
Totals	2,709.5	100	2,881.7	100

Source: Survey data.

Table 4. Access to institutional services.

Access to credit	Irrigation participants (n=60)		Non-participants (n=60)	
	No. of farmers	%Percentage	No. of farmers	Percentage
Access to extension	11	18.3	5	8.3
Access to training	27	45.0	13	21.7
Accessed credit*	37	61.7	11	18.3
Participate in cost recovery	13	22.0	3	5.0
Participate on D & I [#]	13	22.0	-	-

Source: Survey data.*Credit refers to financial assistance for either investment or operational (working capital) purposes; [#]Design and implementation and this facet only captured data from participating household.

information about problems, potentials, and performances of water and irrigation projects, can regularly upgrade their knowledge on development projects (Sidibé, 2005; Forson, 1999). Poor access to extension services could be attributed to the economic challenges experienced in Zimbabwe which affected such services as extension, training among other support services.

Farmer training

Farmers' training for the promotion of agricultural technology is similar to education (Sidibé, 2005; Forson, 1999). As such, farmers who receive regular training had a higher probability of participating. Forty-five percent of the irrigation participants had access to training services compared to only 21.7% non-participants. After the FTLRP, the government prioritised development and rehabilitation of irrigation systems and as such training was geared towards irrigation development. This also suggests why participation is higher among irrigation participants.

Credit accessibility

Access to credit positively influences farmers' decisions to participate in irrigation development. As such, it is therefore expected that higher access to credit increases the probability of farmers participating. The results show that 61.7% of the irrigation participants accessed credit compared to 18.3% of the non-participants. Since the cost of irrigation equipment increased beyond what most farmers afforded (Rukuni et al., 2006), the government moved in to advance loans to irrigation farmers and suggests why irrigation participants were involved in irrigation development activities.

Design and implementation (D & I)

Involving farmers in planning, design and implementation of irrigation systems gives farmers a sense of ownership of the projects. Plot-holders need to be at the centre of the planning, design and implementation process so that the implications of their decisions can be fully appreciated (Denison and Manona, 2007). Most farmers (78%) did

Table 5. Parameter estimates of the binary logistic regression model.

Variable	β	S.E.	Sig.	Exp(B)
AGE	-0.069	0.041	0.094*	0.934
SEX	0.264	0.401	0.510	1.303
EDUC	0.232	0.133	0.080*	1.262
FSIZE	-0.978	0.959	0.308	0.376
LABFO	1.244	0.398	0.002***	3.471
OFFAI	0.631	0.964	0.513	1.880
HHINCO	-0.829	0.860	0.335	0.437
CONTEX	1.686	0.741	0.023**	5.400
TRAIN	1.767	0.667	0.008***	5.855
CREDIT	1.322	0.729	0.070*	3.750
DEIMPL	2.431	0.836	0.004***	11.375
COREC	2.499	0.853	0.003***	12.169
Constant	-13.625	3.220	0.000	0.000

*, **, ***, Significance at 10, 5 and 1%, respectively.

not participate in design and implementation of irrigation systems. When the FTLRP was launched, new farmers were allocated plots on existing irrigation systems. As a result, farmers did not have the sense of ownership and thus eroded their willingness to participate in irrigation development. As such, they were forced to operate these systems unsustainably, hence, the faster they dilapidated, leading to increased irrigation system failures. Failure of irrigation systems is likely to happen if the public irrigation development continues without the involvement and participation of the water users in the system's operation and management (FAO, 2001).

Cost recovery

Sound cost recovery mechanisms ensure availability of credit to finance irrigation development initiatives. Irrigation development has become expensive and some form of cost recovery should be employed in irrigation schemes to increase efficiency (Mupawose, 1984). This promotes viability and sustainability of irrigation schemes in the long run. This also increases the willingness of farmers to participate in irrigation development due to availability of funds. Cost recovery was more evident within the participants (22%), suggesting they were repaying the loans advanced to them, in comparison 5% of the non-participants. The irrigation participants who were advanced loans were required to pay back the funds on a cost recovery basis, ensuring more funding for irrigation development. This suggests why participants are willing to participate in irrigation development.

Empirical results

Age (AGE) was found to be negatively related to

participation in irrigation development at the 1% level, suggesting a higher probability of participation in irrigation development among younger farmers than older farmers (Table 5). Older farmers are likely to be more risk averse and thus more resistant to change (Turner et al., 1983). In contrast, however, considering the losses incurred by failing to adopt technology, older farmers are likely to adopt technology (Kenkel and Norris, 1995). As discussed previously, irrigation participants were found to be younger, and at this level, it is concluded that younger farmers have a higher probability of participating in irrigation development.

Level of education (EDUC) was positively related to participation at the 10% significant level, implying that more educated farmers had a higher probability of participating in irrigation development. Irrigation participants had more years in schooling, suggesting that they were more educated and thus participated in irrigation development. The better educated a household head; the more likely they are to participate in projects (Matsumura, 1997; Beard, 2005). In contrast Hoag et al. (1999), argues that given the nature of benefits, and the time it takes to realise them, it is expected that more educated household heads would have a higher opportunity cost of labour; hence this variable would be negatively related to participation.

Labour (LABFO) was positively related to participation in irrigation development at the 1% significant level. For every 1 unit increase in labour score, we expect a 3.471 times increase in the log-odds of participation. More labour force means that a variety of labour capacity is available (Parikh et al., 1995). With increasing labour force, there is a tendency of increasing participation in irrigation development. However, participants were found to have less labour force but still participated in irrigation development.

Institutions policy variables

Contact with extension (CONTEXT) had a positive effect on participation in irrigation development at the 5% level, suggesting that farmers who are in contact with extension had a higher probability of participating. Contact with extension allows farmers greater access to information on technology, thus increasing farmers' ability and desire to participate (Atta-Krah and Francis, 1987). In addition, farmers with increased access to extension will be well-appraised on challenges they face and can upgrade their know-how on developmental projects (Sidibé, 2005; Forson, 1999).

Participating in design and implementation of irrigation projects (DEIMPL) was found to be positively related to participation at significant at the 1% level. The odds of a farmer who participated in the design and implementation of the irrigation scheme is 11.375 times the odds of a farmer who did not get involved in the design and implementation of irrigation systems. A farmer involved in the design and implementation of the scheme had a sense of ownership and increased the desire to participate in irrigation development. It is only through involving farmers that a sense of ownership is instilled in them, thus are likely to participate and care for the system (FAO, 2001). In addition, putting plot-holders at the centre of the design and implementation implies their decisions are fully appreciated (Denison and Manona, 2007). However, as noted previously, fewer farmers participated in the design and implementation of irrigation systems.

Training (TRAINING) was positively related to participation at the 1% level. The impact of training on irrigation participation decision is significantly positive, with the likelihood to participate by a trained farmer greatly increased compared relatively to an untrained farmer. For every 1-unit increase in training score, we expect a 5.855 times increase in the log-odds of participating in irrigation development, *ceteris paribus*. As argued by Sidibé (2005) and Forson (1999), farmers' training is similar to education, as such, training farmers increased willingness to participate.

Access to credit (CREDIT) was found to be positively related to participation. The odd of a farmer accessing credit and participating in irrigation development is 3.750 times the odds of a farmer who did not have access to credit. As shown previously, irrigation participants had access to credit more than non-participants. This positively influenced participants to engage in irrigation development, given that the costs of developing irrigation continued to rise beyond the reach of many (Rukuni et al., 2006).

The cost recovery (COREC) variable was found to be significant at 1% level. The odds of a farmer involved in the cost recovery program participates in irrigation development is 12.169 times the odds of a farmer not involved in program. Irrigation participants were found to

participate in cost recovery programs more than non-participants (although fewer farmers have participated in both cases). Funds generated through a cost recovery system ensure availability of funds for further irrigation development, repair and operation, and maintenance of irrigation systems.

Conclusions

Generally, the findings suggest that any change in each one of the institutional factors under study significantly influence the probability of participating in irrigation development. In light of this, it is thus important to identify mechanisms and strategies of assisting the "new" FTLRP beneficiaries to encourage them to participate more in irrigation development. In trying to come with these mechanisms and strategies, it is important to consider that these new farmers did not have institutional support put in place when they were resettled during the FTLRP. These farmers also are resource-constrained and do not have collateral to support their financial support requirements from financial institutions.

Policy recommendations / insights

To increase and promote the likelihood and probability of farmer participation in irrigation development, policymakers should put emphasis on the following insights:

1. Difficulty in accessing credit appears to be one of the major constraints to participation in irrigation development. There is need for greater financial and institutional input into irrigation development initiatives. The credit system should also take into cognisance that new farmers do not have collateral security for agricultural funding, as such; prerequisites for accessing credit should be conducive and accommodative to these farmers.
2. Mechanisms should be put in place on overcoming credit market failures and promote repayment of loans advanced to farmers on a cost recovery basis.
3. Research and extension arguably should be the fundamental core of government support to agriculture and irrigation farming. Farmers, in particular the new farmers, should be well abreast of changes going on in the global world on agricultural technologies.
4. Training of extension staff should incorporate the needs for younger and new irrigation farmers. The training should also be able to capture the respective and relevant needs of individual farmers, based on location and region.
5. Farmer participation in the design and implementation of irrigation systems should be promoted. This instils a sense of ownership in farmers and as such; promotes

sustainability of agricultural projects.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

- Atta-krah AN, Francis PA (1987). The role of on-farm trials in the evaluation of composite technologies: The case of alley farming in Southern Nigeria. *Agric. Syst.* 23:133-152.
- Barau AD, Atala TK, Agbo CI (1999). Factors affecting efficiency of resource use under large scale farming: A case study of dadin kowa irrigation project, Bauchi State. *Nig. J. Rur. Econ. Soc.* 1:1-6.
- Beard VA (2005). Individual determinants of participation in community development in Indonesia. *Environment and Planning C: Government Policy* 23(1):21-39.
- Bembridge TJ (1987). *Agricultural Development Problems in Three Rural Areas of Ciskei*. University of Fort Hare Press.
- Denison J, Manona S (2007). *Smallholder Irrigation*. The Water Wheel. http://www.wrc.org.za/Pages/DisplayItem.aspx?ItemID=6113&FromURL=%2fPages%2fKH_DocumentsList.aspx%3fsu%3d7%26ct%3d2%26ms%3d2%253b63%253b. Accessed 30 March 2014.
- Feder G, Just ER, Zilberman D (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Econ. Develop. Cult. Change* 33:255-298.
- Food And Agriculture Organisation (FAO) (2000). Socio-economic impact of smallholder irrigation development in Zimbabwe: Case studies of ten irrigation schemes. Food and Agriculture Organisation of the United Nations (FAO) Sub-Regional Office for East and Southern Africa (SAFR), Harare, Zimbabwe.
- Food and Agriculture Organisation (FAO) (2001). *International e-mail conference on irrigation management transfer*. INPIM/FAO, FAO Land and Water Digital Media Series No. 17. Rome.
- Food and Agriculture Organisation (FAO) (2002). Water Source of Food Security. E-mail conference organized by Land and Water Development Division, 13 September - 1 November 2002. Rome.
- Food And Agriculture Organisation (FAO) (2006). Fertilizer use by crop in Zimbabwe. Rome, Italy.
- Forson JB (1999). Factors influencing adoption of land-enhancing technology in the Sahel: lessons from a case study in Niger. *Agric. Econ.* 20:231-239.
- Gladwin CH, Peterson JS, Uttaro R (2002). Agroforestry Innovations in Africa: Can They Improve Soil Fertility on Women Farmers' Fields? *African Studies Quarterly* 6: 1&2. Internet site: <http://web.africa.ufl.edu/asq/v6/v6i1a10.htm>. (Accessed 06 March 2014).
- Government of Zimbabwe (GoZ) (2000). The Accelerated Land Reform and Resettlement Implementation Plan (Fast Track). Harare: Ministry of Lands, Agriculture, and Rural Resettlement.
- Gyasi, Engel, Froberg (2006). What determines the success of community-based institutions for irrigation management? ZEF Policy Brief, P. 5, Ghana
- Hoag DL, Ascough JC, Frasier MW (1999). Farm Computer Adoption in the Great Plains". *J. Agric. Appl. Econ.* 31:57-67.
- Hussain I, Mark Giordano M, Munir A (undated). Agricultural Water and Poverty Linkages: Case Studies on Large and Small Systems. http://www.iwmi.cgiar.org/propoor/files/ADBProject/ResearchPapers/Agricultural_water_poverty_linkages.pdf. Accessed 8 March 2014.
- Jones WI (1995). The World Bank and irrigation. A World Bank Operational Evaluation Study. Washington, DC.
- Kenkel PL, Norris PE (1995). "Agricultural Producers' Willingness to Pay for Real-time 21 Mesoscale Weather Information, *J. Agric. Res. Econ.* 20:356-372.
- Manzungu E (2003). Towards Sustainable Water Resources and Irrigation Development in the Post Fast Track Land Reform Era in Zimbabwe, (Utete Report, 2003, pp 57–66.
- Matsumura M (1997). Community Characteristics, Individual Attributes, and Participation in Natural Resource Management among Highlanders in Thailand: A Cross-Village Comparison (Ithaca: Cornell University).
- Mlambo K, Zitsanza N (2001). Economies of scale, capacity utilization and productivity measurement in Zimbabwean commercial agriculture. *African Development Bank Reviews*, 9(2). Accessed at http://www.afdb.org/knowledge/reviews/reviews_vol9_n2.htm [8 March 2014]
- Mupawose RM (1984). Irrigation in Zimbabwe: A broad overview. In: Blackie, M.J. (editor): *African regional symposium on smallholder irrigation*. University of Zimbabwe.
- Mushunje A (2005). Farm Efficiency and Land Reform in Zimbabwe. PhD Thesis, University of Fort Hare, Department of Agricultural Economics and Extension.
- Negatu W, Parikh A (1999). The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district) of Ethiopia. *Agric. Econ.* 21:205-216.
- Nhundu K, Gwata C, Mushunje A (2010). Impacts of Zimbabwe/EU Micro Project Programme (ZIM/EU MPP) Funded Smallholder Irrigation Projects on Food Security and Income Levels. A Case Study of Mopane Irrigation Scheme in Zvishavane, Midlands Province, Zimbabwe. (www.academicjournals.org)
- Parikh A, Ali F, Shar MK (1995). Measurement of Economic Efficiency in Pakistan Agriculture. *Am. J. Agric. Econ.* 77(3):675-685.
- Pitt MK, Sumodiningrat G (1991). Risk Schooling and the Choice of Seed Technology in Developing Countries: A Meta-profit Function Approach. *Int. Econ. Rev.* 32(2):457-453.
- Rao PS (1993). Review of Selected Literature on Indicators of Irrigation Performance. IIMI Research International Irrigation Management Institute: Colombo. P. 13.
- Rukuni M, Eicher CK, Blackie (eds). (2006). *Zimbabwe's Agricultural Revolution, Revisited*, University of Zimbabwe Publications, Harare.
- Southern Africa Development Committee (SADC) (1992). SADC Regional irrigation development strategy: Zimbabwe Country Report. Harare, Zimbabwe.
- Samakande I, Senzanje A, Manzungu E (2004). Sustainable water management in smallholder irrigation schemes: Understanding the impact of field water management on maize productivity on two irrigation schemes in Zimbabwe. *Physics and Chemistry of the Earth*, 29(15-18):1075-1081. Published by Elsevier Ltd.
- Sebotja I (1985). An Evaluation of the Krokokilheuwel Irrigation Scheme, Lebowa. An Honours Dissertation Paper, University of Fort Hare, Alice.
- Shaban A, Doppler AW, Wolff H (2006). Determinants of Farmers' acceptance of Treated wastewater in irrigated agriculture in the northern Gaza strip. *Conference on International Agricultural Research for Development*, University of Bonn.
- Sidibé M (2005) M. Farm-level adoption of soil and water conservation techniques in northern Burkina Faso, *Agric. Water Manage.* 71:211-224.
- Thangata PH, Hindebradt PE, Gladwin CH (2002). Modelling Agroforestry Adoption and Household Decision Making in Malawi. *African Studies Quarterly* 6: no 1&2. Internet site: <http://web.africa.ufl.edu/asq/v6/v6i1a11.htm>. Accessed 8 March 2014
- Thompson RL (2001). The World Bank strategy to rural development with special reference to the role of irrigation and drainage. Keynote address. 1st Asian Regional Conference and Workshop on the Occasion of 52nd IEC meeting of ICID, Seoul. New Delhi, ICID. pp. 2- 17.
- Turner SC, Epperson JE, Fletcher SM (1983). "Producer Attitudes Towards Multicommodity Electronic Marketing, *Am. J. Agric. Econ.* 65:818-826.
- Utete MB (2003). Report of the Presidential Land Review Committee Volume II: *Special Studies under the Chairmanship of Dr Charles MB Utete*, Harare.
- Water Sector Board Discussion Paper Series, Paper no. 10. (2007). Emerging Public-Private Partnerships in Irrigation Development and Management, The World Bank Group.
- Whittome MPB, Spencer DSC, Bayliss-Smith T (1995). IITA and ILCA on-farm alley farming research: Lessons for extension workers. In: Kang B.T., Osiname A.O. and Larbi A. (eds), *Op. cit.*, pp. 423-435.