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Factors for Community Participation in Surface Irrigation Scheme: Experience from Ndanda Irrigation Scheme in Masasi District, Tanzania

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Abstract

Tanzania has a total of 44 million hectares suitable for agriculture. However, only 10.8 million hectares are used for cultivation producing diverse crops. Besides, the country has an irrigation potential of 29.4 million hectares, of which by 2023, only 727,280.6 hectares were under irrigation agriculture, equivalent to 2.5%. In promoting community participation in irrigation agriculture through the surface irrigation scheme to increase the production of crops, the Masasi District Council initiated the Ndanda surface irrigation scheme using the participatory planning methodology of Opportunities and Obstacles to Development (O&OD). Through the O&OD process, the Ndanda surface irrigation scheme was prioritised and established in 2006 as a response to the declining productivity of rain-fed agriculture in the ward. The scheme occupies a total area of 350 hectares and is expected to benefit 23,147 people. However, only 104 hectares are under cultivation through surface irrigation due to a low level of community participation. Therefore, this paper assesses factors influencing community participation in the surface irrigation scheme in Masasi District, taking the Ndanda surface irrigation scheme as a case. A sample of 154 participants was used. The study used a cross-sectional research design that blended qualitative and quantitative methods. Data were collected from primary and secondary sources. The binary logistic regression model was used to analyse participation influencing factors. The qualitative data were analysed through content analysis. The findings from the study indicated that community participation in the Ndanda surface irrigation scheme was significantly associated with the perception of smallholder farmers on the scheme and prevailing economic and institutional factors.

Key Words: Community Participation, Irrigation Scheme, Masasi district, Agriculture

1. Introduction

Agriculture is an important sector in the world since it feeds the population. Agricultural development is one of the most powerful tools to end extreme poverty, boost shared prosperity, and feed a projected 9.7 billion people by 2050 (United Nations, 2019). The world population exceeded 7 billion in 2018 and is projected to reach 9.7 billion by 2050 (FAO, 2018). Agriculture plays a significant role in the global economy, but its production is low because, to a large extent, it depends on rainfall, which is seasonally erratic, unreliable and non-uniformly distributed. Irrigation agriculture is a significant solution to water challenges affecting food production in areas with unreliable rainfall patterns (Li *et al.,* 2020). Irrigation is responsible for nearly 40% of global food production, despite

accounting for only about 20% of the world's cultivated land'' (FAO, 2019). Besides, developing irrigation schemes is one aspect of agricultural intensification that has allowed total production to grow much faster than the cultivated area (FAO, 2022). Similarly, the World Bank recognises the importance of irrigation schemes in achieving sustainable development goals, including poverty reduction and food security. The bank invests in irrigation schemes worldwide to increase agricultural productivity, reduce poverty, and enhance resilience to climate change (World Bank, 2018).

The share of the area equipped for irrigation in agricultural land increased to 7.3 percent in 2020, up 1.4 percentage compared with 2000 (FAO, 2022). The world's total agricultural land is 4.8 billion hectares, one-third of the global land area (Brown, 2019). The world's total land area equipped for irrigation in 2021 was 352 million hectares, or 22% of the total cropland area covering 1.6 billion hectares (FAO, 2021). According to FAO (2022), irrigation development is one aspect of agricultural intensification that has allowed total production to grow much faster than the cultivated area. Crops cultivated using irrigation schemes, ranging from grains and vegetables to fruits and cash crops. Examples are rice, wheat, maize, sugarcane and fruits. Irrigation schemes are a vital aspect of worldwide food production and promoting sustainable livelihoods for millions of people. Irrigation schemes are essential for global food security and contribute significantly to the global economy by enhancing agricultural productivity, increasing farmers' income, generating employment opportunities, and reducing the risk of crop failure due to limited rainfall (FAO, 2022). Irrigation is often considered the engine of agricultural growth, as it plays an important complementary role in crop cultivation. Various studies in the world indicate that irrigation facilities make a significant contribution to the productivity of crop output (Dhawan, 1988 and 1991; Vaidyanathan *et al*., 1994; Vaidyanathan, 1999; Narayanamoorthy and Deshpande, 2005; Narayanamoorthy and Hanjra, 2006).

Currently, agricultural production accounts for 85% of global water consumption (Shiklomanov & Rodda, 2003), and projections indicate that it will double by 2050 (Tilman et al., 2002). Furthermore, Lobell et al. (2008) predict a 1.9 increase in the irrigated area by 2050. Moreover, there was significant variability among regions and sub-regions in terms of areas equipped for irrigation. Asia had the largest absolute value, with nearly 250 million hectares of cropland equipped for irrigation, accounting for 42% of its cropland and 70% of the global cropland equipped for irrigation. In contrast, Africa had the lowest share, with only 6% (about 17 million hectares) of its cropland area that was equipped for irrigation. Europe and Oceania had nearly 10% of their cropland area equipped for irrigation, corresponding to 27 million hectares and 3 million hectares, respectively. The Americas recorded a 15% share, which amounted to 57 million hectares. The significant variability within regions likely reflects different agro-climatic conditions and the variety within agricultural systems. Many regions and

sub-regions have shown an increase in the area equipped for irrigation since 2000, indicating a trend towards greater utilisation of water resources in agriculture over the past decades (Siebert *et al.*, 2010).

In developed countries, irrigation schemes are often managed by well-established and well-funded institutions, such as government agencies or water user associations. These institutions can provide technical assistance, financial resources, and regulatory frameworks that support community participation and ownership of the irrigation scheme (Dinar & Tsur, 2014). In general, powerful institutions, stakeholder engagement, and access to information communication technology tools can all play a key role in developed countries, even though the factors for community participation in irrigation schemes depend on the specific situation. Similarly, middle-income countries rely on irrigation schemes to increase agricultural productivity and ensure food security, with 60% of the world's irrigated land located in India, Brazil, and Mexico. These countries are among the middle-income countries that heavily rely on irrigation and have implemented several irrigation technologies and management practices to improve water use efficiency and crop yields (World Bank, 2023). In middle-income countries, irrigation schemes significantly support the agricultural agribusiness sectors. For example, agriculture accounts for approximately 18% of India's GDP, and irrigation is critical to boosting productivity (World Bank, 2018).

In developing countries, irrigation schemes are diverse in scale and technology, but they all share a common goal of increasing agricultural productivity and supporting livelihoods. For instance, Egypt stands out as the country with the highest share of equipped area for irrigation (98.9 % in 2020), as the agricultural land is concentrated in the Nile Valley and Delta (FAO, 2022). While they bring benefits such as improved food security and higher income for farmers, they face challenges such as high infrastructure costs and water resource conflicts. Developing countries have implemented policies and programmes to promote sustainable irrigation practices and governance to address these challenges and support economic growth (World Bank, 2018). In Pakistan, for example, agriculture entirely depends on irrigation, where the majority of the population directly or indirectly depends on agriculture as a source of livelihood. Water is essential for agriculture and is being provided to farmers through the canal irrigation system in Pakistan. The canal irrigation system of Pakistan is one of the largest in the world (Afzal & Barbhuiya, 2011).

Community participation in irrigation schemes is crucial in developing countries to ensure sustainability and success. The institutional and policy environment is one factor in community participation in irrigation schemes. For example, unclear land tenure systems or lack of government support can hinder community involvement (Berhe et al., 2022). The social capital of the community, including trust and cooperation between community members, can impact participation. Strong social networks can increase

community involvement in irrigation schemes (Asmamawa & Kurunca, 2020).

The agricultural sector in Tanzania plays a critical role in the country's economy and society. Agriculture is the mainstay of Tanzania's economy, contributing to 26.1% of the country's Gross Domestic Product (GDP) in 2020. The sector also accounts for over 65.6% of the total employment (NBS, 2020). Agriculture provides the bulk of the food consumed in Tanzania. The sector is responsible for ensuring that the country's population has access to sufficient, safe and nutritious food (WHO, 2022). Tanzania has a total of 44 million hectares suitable for agriculture. However, only 10.8 million hectares are used for cultivation producing diverse crops. Tanzania has an irrigation potential area of 29.4 million hectares, of which by 2023, only 727,280.6 hectares will be under irrigation agriculture, equivalent to 2.5%. The country has a large number of irrigation schemes of various sizes, such as dams, canals, and large schemes to increase agricultural productivity and promote economic development in rural areas (WHO, 2022).

In recognition of the importance of irrigation schemes in Tanzania as a resilience strategy towards climate change effects, the government has taken various initiatives to develop irrigation frameworks, including the National Irrigation Master Plan of 2002, to guide the development and management of irrigation schemes in the country. The plan aimed to increase the area under irrigation from 460,000 hectares in 2002 to 1.2 million hectares by 2025 (MALF, 2017). The government also established an irrigation development fund in 2006 to provide financial support to farmers and other actors involved in irrigation development by providing loans, grants, and technical assistance to support the development of irrigation schemes (TIR, 2015). The National Irrigation Policy (NIP, 2010) was also established with the main objectives of ensuring sustainable availability of irrigation water and its efficient use for enhanced crop production, empowering beneficiaries for effective participation at all levels in irrigation planning, implementation, operation, management and contributing to food security and poverty reduction (NIP, 2010).

The government of Tanzania, through the Agricultural Sector Development Strategy and Agricultural Sector Development Programme (ASDS and ASDP II), aims at boosting crop production through irrigation development and improvement. Specifically, the ASDP III aims to support a reduction in over-dependence on rain-fed agriculture by rehabilitation and management of low-cost smallholder irrigation schemes, including rainwater harvesting, to reduce fluctuations in production (URT, 2007). The primary reason for irrigation is to improve agricultural productivity in areas where surface soils are naturally drier. Semi-arid regions often have higher agricultural productivity if irrigated. Also, the agricultural sector, aided by technological change, comprehensively impacts poverty alleviation in rural areas. As it reduces poverty in rural areas, it also reduces inequalities (Desai, 2002).

Irrigation schemes play an important role in Tanzania's agriculture sector due

to unreliable rain-fed agriculture (FAO, 2021). Irrigation is essential for increasing agricultural productivity and reducing dependency on rain-fed agriculture, which is often unreliable due to climate change and variability (UNDP, 2020). Irrigation schemes in Tanzania have the potential to increase food security, reduce poverty, and improve livelihoods for smallholder farmers. In collaboration with other development actors, the Tanzania government has undertaken several efforts to promote irrigation schemes in the country. The government has made significant investments in irrigation infrastructure. For example, in the financial year 2022/23, TZs. 361.5 billion were budgeted for the construction of 25 new agricultural irrigation schemes covering an area of 53,234 hectares, the construction of 14 dams with the capacity of harvesting a total of 131,535,000 cubic meters (m3), and the rehabilitation of 30 irrigation schemes covering an area of 41,771 hectares (URT, 2023).

Some of the recently developed irrigation scheme areas in Tanzania include the Malagarasi-Muyobozi irrigation scheme in the Kigoma Region, the Kilombero irrigation scheme in the Morogoro Region, the Lower Moshi irrigation scheme in the Kilimanjaro Region, the Nduruma irrigation scheme in the Singida Region and the Mbarali irrigation scheme located in the Mbarali District in the Mbeya Region. All of these areas cover an area of 4,000 hectares, primarily used for rice cultivation, with plans to expand to other crops such as maize, beans, and vegetables in the future. The project is supported by the Tanzania government and development partners such as the Africa Development Bank (AfDB) and the Japan International Cooperation Agency (JICA) (Mwalyagile & Salanga, 2024). Irrigation schemes play a critical role in developing the agricultural sector, which is a major contributor to Tanzania's economy (Nkonya *et al*., 2022). Irrigation schemes enable farmers to grow a broader range of crops and cultivate them throughout the year, even during dry seasons, thus promoting crop diversification and reducing reliance on rain-fed agriculture (Wamala *et al*., 2021). Irrigation schemes reduce farmers' vulnerability to climate variability, thus enhancing their resilience to the adverse effects of climate change (ASDP II, 2014-2025).

Theoretically, community participation in irrigation schemes is associated with the diffusion of innovation, which is how and why new ideas, products, and practices spread through social systems over time. The diffusion process involves five stages: knowledge, persuasion, decision, implementation, and confirmation (Rogers, 1962). These stages are influenced by various factors, including the characteristics of the innovation, the communication channels used to disseminate the innovation, the social system in which the innovation is being adopted, and the adopters' characteristics. In this case, community participation in the adoption of the newly introduced surface irrigation scheme is influenced by several factors, including the perceived relative advantages of the innovation, its compatibility with existing values and practices, its complexity, and its trial ability and observability (Miller, 1962). Odoemenam and Garba (2017) identify diverse factors

for participation in community-managed irrigation schemes, including limited access to credit, inadequate infrastructure, lack of technical knowledge, and poor management of the schemes. Other factors include investment in infrastructure, technical capacity building, and effective management of community-managed irrigation schemes to improve farmers' participation and sustainability of the schemes. Kikuchi *et al*. (2018) also argue that farmers' participation in collective irrigation management is influenced by various factors such as social networks, perceived benefits, knowledge and information, leadership, and institutional arrangements.

Moreover, community participation in surface irrigation schemes is associated with access to credits, which is one of the most critical economic factors for community participation in surface irrigation schemes. In many cases, farmers who do not have access to credit may not be able to invest in surface irrigation schemes. Kariuki *et al.* (2021) report that farmers with access to credit are likelier to invest in irrigation infrastructure and adopt new technologies that increase their productivity and income than those without access. Panthi *et al.* (2019) in Nepal observed that access to cropping inputs such as seeds, fertilizers, and pesticides was a critical factor influencing farmers' participation in irrigation schemes. Farmers with access to cropping inputs are more likely to participate in irrigation schemes and achieve higher crop yields, while those with limited access to inputs limit farmers' ability to participate effectively. Moreover, extension services can play a vital role in promoting community participation in surface irrigation schemes by providing farmers with the necessary knowledge and skills to manage water resources effectively. Biswas and Bhattarai (2021) assert that extension services are crucial in promoting farmers in Nepal by providing technical knowledge and skills, improving communication, and building trust and collaboration between farmers and irrigation officials. On the other hand, in promoting community participation in surface irrigation schemes, capacity building is a crucial factor as it equips individuals and groups with knowledge, skills, attitudes, institutional structures, processes, and resources to support community development (Yami, 2016).

In promoting community participation in the surface irrigation scheme to increase the production of crops, the Masasi District Council initiated the Ndanda surface irrigation scheme using the participatory planning methodology of Opportunities and Obstacles to Development (O&OD). The O&OD process involved collective actions in which the community proactively participated in their development, decision-making, and implementation process. Community priorities were identified as the community needs that were prioritised collectively by the community members based on their perceptions and importance. Through this process, the Ndanda surface irrigation scheme was prioritised and established in 2006 as a response to the declining productivity of rain-fed agriculture in the area, which was attributed to unreliable rainfall patterns and soil degradation (Mushi & Temu,

2018). The total cost for the scheme amounted to TZs. 1,182,998,575.00. The scheme is expected to benefit 23,147 people, of whom 10,195 were men and 1,252 were women. The scheme projection was to increase paddy production from 1.5 tons to 6 tons and other horticultural crops such as maize, vegetables, tomatoes, and cassava (Ndanda Irrigation Report, 2014).

Operationally, the Ndanda surface irrigation scheme receives water from the Ndanda River, which flows from the south of the Makonde plateau spring to the north through the scheme area. The scheme occupies a total area of 350 hectares. However, due to a low level of community participation in the irrigation scheme, only 104 hectares are under cultivation through surface irrigation (Ndanda Surface Irrigation Report, 2014). The scheme is located in Masasi District at Ndanda Ward along the Masasi-Mtwara road. The scheme covered two villages of Njenga and Mpowola, located 40 km east, along the Masasi- Mtwara road. The scheme's main objective is to engage communities in promoting and increasing agricultural production in the area through irrigation. Specifically, the scheme is intended to increase agricultural productivity, enhance food security, reduce poverty, and improve the socio-economic well-being of the local population. The scheme was designed to engage 500 community members, but currently, the level of community participation in the scheme was only 43% registered farmers. Therefore, the study assessed factors influencing community participation in surface irrigation schemes, taking the Ndanda irrigation scheme as a case. The specific objectives of the study were to determine the perception of the community members on the use of surface irrigation schemes in the study area, to examine the influence of institutional factors on community participation in surface irrigation schemes in the study area, and to determine the influence of economic factors on community participation in surface irrigation schemes in the study area.

2. Materials and Methods

The study was conducted in Njenga village, Ndanda ward in Masasi District. Njenga Village was purposively selected because it was the village with a low participation rate of 215 (43%) practising irrigation agriculture through the Ndanda surface irrigation scheme compared to Mpowola with a participation rate of 315 (57%) (Ndanda Irrigation Report, 2014). The study village was selected since the establishment of the Ndanda surface irrigation scheme in 2006 incurred a total cost of TZS. 1,182,998,575.00 was a response to the declining productivity of rain-fed agriculture in the area, which was attributed to unreliable rainfall patterns and soil degradation (Mushi & Temu, 2018). Besides, the scheme was planned to engage 500 community members from two villages; however, the level of community participation in the scheme was only 215 (43%) of registered farmers, much lower than the expected level (Ndanda Irrigation Report, 2014).

The target population for this study was the community members, both irrigators and non-irrigators (smallholder farmers engaging in irrigation schemes and smallholder farmers who are not engaging in surface irrigation schemes)

in Njenga Village, in which an individual smallholder farmer, preferably the head of household, constituted the unit of analysis. Both probability and non-probability sampling techniques were used in selecting participants. In probability sampling, the stratified sampling technique was employed to group irrigators from non-irrigators, and within each stratum, a simple random sampling (lottery) was applied to get respondents for an interview to represent the study population from which primary data were collected. This kind of sampling helped to avoid subjectivity and personal biases. For the nonprobability sampling, the judgemental sampling technique was used in selecting the study village and key informants: The key informants included the manager for the Ndanda surface irrigation scheme, the Ward Executive Officer (WEO), the Village Executive Officer (VEO), and the Ward Executive Officer.

A sampling frame for this study comprised 8,759 smallholder farmers from the Njenga Village from which the sample size was drawn. Based on Yamane's (1967) formula, a sample size of 382 was obtained for both irrigators and non-irrigators. However, due to time and budget constraints, only a sample size of 150 smallholder farmers was used in the study due to the fact that for individual sampling unit of similar characteristics, 10% to 20% of the sampling frame is acceptable for social studies. Hence, the distribution of the sample size was 150 respondents (comprising 75 irrigators and 75 non-irrigators); the four key informants were selected purposively based on their importance, knowledge, and influence in the study area, hence having a total sample size of154 participants, including key informants. Procedurally, the estimation of the sample size using the Yamane's (1967) formula was as follows:

$$n = N/[1 + N (e)^2]$$

Where;

n = Sample size estimate,

N = Population size/sampling frame (total number of smallholder farmers)

1 = Statistical constant,

e = Level of precision (0.05)

$$n = 8{,}759 \div 1 + 8{,}759 (0.05)^2$$

$$n = 382$$

The study adopted a cross-sectional design that blended qualitative and quantitative (mixed) methods. Data for this study were collected from both primary and secondary sources. Primary data were collected through interviews and focus group discussion methods. Secondary data were collected through the documentary review method. The data collected using the questionnaire were edited to detect errors and omissions before being classified and coded to enable them to be analysed using IBM-SPSS Statistics v25.

The qualitative data were analysed through content analysis. The themes and narration of interviews and observational field notes were analysed by identifying the main themes, assigning codes to the main themes, classifying responses under the main themes, and integrating articles and responses into the text. Quantitative data were analysed through descriptive and inferential statistics using IBM-SPSS Statistics v25. More specifically, descriptive statistics (frequency, percentages) were used to analyse the community's perception of using surface irrigation schemes in the

study area. The influence of institutional and economic factors on community participation in surface irrigation schemes was analysed by using a binary logistic regression model. The model for institutional factors was specified as follows:

$(Y_0) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \varepsilon$

Where:

Y_0 = Binary dependent variable defined as 1= if the smallholder farmer participates in the Ndanda surface irrigation scheme 0 = Otherwise

β_0 = constant term

β_1-β_4 = Regression coefficients for each independent variable

X_1= Supportive infrastructures independent binary variable given defined as 1= Provided 0= Not provided)

X_2=Independent binary variable getting sport from institutions (1= Get support 0 = Otherwise).

X_3= Independent binary variable adherence to regulations (1= Adhere to enforced regulations 0 = Otherwise)

X_4= Independent binary variable access to extension services (1 = Access extension serviced 0 = otherwise

The model for economic factors was specified as follows:

$(Y_0) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \varepsilon$

Where:

Y_0 = Binary dependent variable defined as 1= if the smallholder farmer participates in the irrigation scheme 0= Otherwise

β_0 = constant term

β_1-β_4 = Regression coefficients for each independent variable

X_1= Access to farm inputs, binary independent variable given as (1 = Access to farm inputs 0 = otherwise)

X_2= Access to credit, independent binary variable given as (1= having access 0 = Otherwise)

X_3= Access to a reliable source of water, the independent binary variable is given as (1=Having access 0 = Otherwise)

X_4= Independent binary variable land ownership (1 = own the land 0 = otherwise)

3. Results and Discussion

3.1. Demographic characteristics of respondents

The main demographic parameters examined in the inquiry were gender, the age of the respondents, and education level. On the gender of irrigators, 39 (52%) of the respondents were males and 36 (48) were females. The respondents' ages were divided into four categories: 18 -30 years, 42- 52 years, 53-63 years, and above 63 years (Table 1). The majority, 38 (50.6%) of respondents were aged between 42 and 52. This indicates that most community members engaged in irrigation agriculture were adults. On the education level, five categories were used: non-formal education, primary education, secondary education, college and university. The majority of irrigators had primary education, who were 66 and composed 89% of interviewed respondents. This implies that primary school leavers primarily engage in irrigation agriculture compared to secondary, college and university graduates. For non-irrigators, the gender of respondents was 40 (53.3%) males and 35 (46.7%) females. Regarding the age of respondents for non-irrigators, the majority were aged between 42 – 52 with 35 (46.7%) of non-irrigators. On education level, the majority of non-irrigators interviewed

were those who completed primary education, who were 67 (89.3%) of the non-irrigator respondents (Table 1).

Table 1: Distribution of respondents by their demographic characteristics

Variable	Category	Irrigators		Non-irrigators	
		Number	Percent	Number	Percent
Gender	Male	39	52	40	53.3
	Female	36	48	35	46.7
	Total	**75**	**100**	**75**	**100**
Age	18 - 30	8	10.7	7	9.3
	42 - 52	38	50.6	35	46.7
	53 - 63	4	5.3	8	10.7
	63 >	1	1.3	5	6.7
	Total	**75**	**100**	**75**	**100**
Education level	Non-formal education	1	1.2	1	1.2
	Primary education	66	89	67	89.3
	Secondary education	6	7.1	4	5.3
	College	1	1.2	1	1.2
	University	1	1.2	2	2.6
	Total	**75**	**100**	**75**	**100**

3.2. Perception of smallholder farmers in Ndanda surface irrigation scheme

In determining the influence of smallholder farmers' perceptions on the decision to participate in a surface irrigation scheme, the inquiry examined whether the perceptions of smallholder farmers on the Ndanda surface irrigation scheme are associated with their knowledge of the irrigation scheme, attitude, communication channel used to disseminate information, time for adoption, and social culture.

3.2.1. Farmer's knowledge of the Ndanda surface irrigation scheme

The findings from the study revealed that the level of knowledge smallholder farmers acquired through various channels, including meetings, mass media, and interpersonal experience, was crucial in determining the decision towards acceptance of irrigation agriculture through the Ndanda surface irrigation scheme. Findings from the study indicated that the majority of smallholder farmers who engaged in the Ndanda irrigation scheme provided diverse reasons that influenced them to join the scheme and practice irrigation agriculture (the irrigators). About 28 (37.3%) respondents strongly agreed that the decision to join the scheme was associated with familiarity with the benefits of the scheme, 22 (29.3%) their decision was associated with having a good understanding of the scheme, 26 (34.7%) their decision was associated with self-assurance (confidence) that the scheme could yield their expectations while 17 (22.7%) joined the scheme after being well informed about the scheme from their friends (interpersonal experience). Besides, since the mean score was 3.5 and the minimum standard deviation was 1.13, this means that the smallholder farmers' familiarity with the benefits of the scheme largely influenced their positive perception towards the Ndanda surface irrigation scheme compared to other variables (Table 2).

Generally, this finding implies that smallholder farmers' familiarity with the scheme's benefits was the most strongly agreed reason for smallholder farmers' decision to participate in the scheme after getting knowledge from the implementers. Furthermore, the Focus Group Discussion (FGD)revealed that the majority of smallholder farmers joined the Ndanda surface irrigation scheme to exploit the well-articulated benefits of irrigated agriculture. The acquired knowledge raised awareness among smallholder farmers; hence, the improved familiarisation created confidence in the scheme, influencing their decision to join the Ndanda surface irrigation scheme. Generally, the findings imply that whenever community members have a good understanding of the operationalization, benefits, farmer's roles and responsibilities of surface irrigation schemes, they are more likely to have a positive perception and acceptance of the scheme. Similarly, (Dolinska, 2020) declared that whenever a community understands the benefits of surface irrigation schemes, such as increased crop yields, improved water availability, and reduced water logging, they are more likely to have a positive perception and acceptance of the scheme.

Interviews with key informants indicated that capacity building was a crucial factor in promoting community participation in Ndanda surface irrigation schemes as it equipped individuals and groups with knowledge and skills on how water resources from the scheme should be used in conducting irrigation agriculture. The knowledge of the technical aspects of surface irrigation schemes, such as how water is distributed and managed, helped the community appreciate the efforts put in place by the Masasi District Council and influenced their perception and participation in the scheme (Table 2). Besides, the early adopters are the smallholder farmers who decided to participate in irrigation agriculture through the Ndanda irrigation scheme (the irrigators) after getting knowledge. They are expected to influence their followers and have a high degree of influence in the community. In the study context, the early adopters might be the farmers who have seen or expected success with the new technique and were willing to share their experience with others. As time goes on, more and more community members adopt the innovation until it reaches a point where the majority of the community is using the scheme (Rogers, 2014).

Table 2: Knowledge of the community in surface irrigation scheme

2.1 Knowledge of irrigators							
Reason	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std
Good understanding in scheme	5 (6.7%)	10(13.3%)	5 (6.7%)	33(44.0%)	22 (29.3%)	3.7	1.21
Familiar with the benefits of the scheme	4 (5.3%)	3 (4.0%)	19 (25.3%)	21 (28.0%)	28 (37.3%)	3.8	1.13
Confidence in scheme	15 (20.0%)	6 (8.0%)	11 (14.7%)	17 (22.7%)	26 (34.7%)	3.4	1.53
Well-informed about scheme	8 (10.7%)	18 (24.0%)	22 (29.3%)	10 (13.3%)	17 (22.7%)	3.1	1.31
Mean score						**3.5**	
2.2 Knowledge of non-irrigators							
Reason	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Std
Good understanding of the scheme	11 (14.7%)	12 (16.0%)	36 (48.0%)	7(9.3%)	9(12.0%)	2.9	1.15
Familiar with the benefits of the scheme	4 (5.3%)	8(10.7%)	37(49.3%)	17(22.7%)	9(12.0%)	3.3	0.99
Confidence in scheme	17(22.7%)	15(20.0%)	23 (30.7%)	13 (17.3%)	7(9.3%)	2.7	1.26
Well-informed about scheme	8(10.7%)	18(24.0%)	22 (29.3%)	10 (13.3%)	17 (22.7%)	3.1	1.31
Mean score						**2.9**	

On the other hand, the findings revealed that smallholder farmers who did not engage in the irrigation scheme (non-irrigators) had also disparity reasons for their decisions. On whether their decision not to be engaged in the irrigation scheme was associated with a good understanding of the scheme, the findings from the study indicated that about 11 (14.7%) respondents strongly disagreed, 12 (16.0%) disagreed, 36 (48.0%) were neutral, 7(9.3%) agreed, and 9 (12.0%) strongly agreed with the mean of 2.9 and a standard deviation of 1.15. moreover, about whether familiarity with the benefits of the scheme is a reason for smallholder farmers not joining the scheme, about 4 (5.3%) respondents strongly disagree, 8(10.7%) disagree, 37(49.3%) were neutral, 17(22.7%) agreed, and 9(12 %) strongly agree with a mean of 3.3 and a standard deviation of 0.99. On whether the decision not to join the irrigation scheme was influenced by self-assurance (confidence) that the scheme could yield their expectations, about 17 (22.7%) strongly disagreed, 15 (20%) disagreed, 23 (30.7%) were neutral, 13 (17.3%) agreed, 7(9.3%) strongly agreed with a mean of 2.7 and a standard deviation of 1.26. On whether being well-informed about the scheme influenced smallholder farmers' decision not to join the irrigation scheme, the findings from the study indicated that about 8(10.7%)

strongly disagreed, 18(24.0%) disagreed, 22 (29.3%) were neutral, 10 (13.3%) agree, 17 (22.7%) strongly agree with a mean of 3.1 and a standard deviation of 1.31. The finding implies that cumulatively, about 47 (62.6%) of non-irrigators did not participate in irrigation agriculture through the Ndanda irrigation scheme despite having knowledge about the scheme. Since the mean score for the reason for smallholder farmers not engaging in the Ndanda surface irrigation scheme was 2.9, and the value of the standard deviation of 0.99 for those familiar with the benefits of the scheme was relatively closer to the mean score as compared to other reasons (Table 2), this implies that the smallholder farmer's information about the scheme was the strongly agreed reason for the decision of not participating in the scheme. Moreover, in any innovation like the Ndanda irrigation scheme, there will always be a small group of individuals who resist the innovation, either because they are sceptical of its benefits or because they prefer to stick with the old ways (Rogers, 2003).

3.2.2. Farmer's attitude towards Ndanda surface irrigation scheme

Attitude refers to people's overall evaluation of favourability or unaffordability towards an object, idea or action (Rogers, 2003). Theoretically, the perception of community participation in the Ndanda surface irrigation scheme can be influenced by several factors, including the attitudes of individuals towards the innovation.

Table 3: Farmer's attitude towards Ndanda surface irrigation scheme

3.1 Attitude of Irrigators							
Reason	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Mean**	**Std**
The scheme is practical for farming	12(16%)	5(6.7%)	8(10.7%)	38(50.7%)	12(16%)	3.4	1.30
The scheme is too expensive to implement	12 (16%)	12 (16%)	14 (18.7%)	21 (28%)	16(21.3%)	3.2	1.38
The scheme is too complicated to understand	5(6.7%)	12(16%)	36(48%)	16(21.3%)	6(8%)	3.08	1.00
The scheme is necessary for farming	7(9.3%)	9(12%)	19(25.3%)	17(22.7%)	23(30.7%)	3.5	1.30
Scheme increases income	6(8%)	11(14.7%)	37(49.3%)	15(20%)	6(8%)	3.0	0.98
3.2 Attitude of non-irrigators							
Mean score Reason	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**3.2 Mean**	**Std**
The scheme is practical for farming	9 (12.0%)	10 (13.3%)	36 (48.0%)	9 (12.0%)	11 (14.7%)	3.04	1.16
The scheme is too expensive to implement	7 (9.3%)	13 (17.3%)	35 (46.7%)	13 (17.3%)	7 (9.3%)	3	1.05

The scheme is too complicated to understand	5 (6.7%)	12 (16%)	36 (48.0%)	16(21.3%)	6(8%)	3.08	0.98
The scheme is necessary for farming	5(6.7%)	11(14.7%)	36(48%)	18 (24%)	5(6.7%)	3.09	0.96
Scheme increases income	6 (8%)	11 (14.7%)	37 (49.3%)	15 (20%)	6(8%)	3.05	1.00
Mean score						**3.05**	

Thus, in the context of community participation in irrigation agriculture through the Ndanda surface irrigation scheme, the assumption was that if the smallholder farmers had a positive attitude towards the surface irrigation scheme, they would be more likely to participate. On the other hand, if smallholder farmers have a negative attitude toward the surface irrigation scheme, they will slowly participate. Concerning smallholder farmers' attitudes towards the Ndanda surface irrigation scheme, the findings from the study, as indicated in Table 2, revealed that the majority of the smallholder farmers participating in irrigation agriculture through the Ndanda surface irrigation scheme (the irrigators) 12(16%) strongly agree and 38(50.7%) agree that the Ndanda surface irrigation was necessary for surface irrigation and proved to be practical for farming operation in improving crop production while only 12(16%) strongly disagree and 5(6.7%) disagree. On the scheme being too expensive to implement, 6(8%) strongly agree and 21 (28%) agreed, while 12 (16%) strongly disagree and 12 (16%) disagree. The scheme is too complicated to understand 6(8%) strongly agreed, 16(21.3%) agreed while 5 (6.7%) strongly disagreed, and 12 (16%) disagreed. On the scheme that was necessary for farming, 23 (30.7%) strongly agree, 17(22.7%) agree, 7(9.3%) strongly disagree, and 9 (12%) disagree. With regard to the scheme increases income, 6 (8%) strongly agree, 15 (20%) agree, strongly disagree, 11(14.7% and 6 (8%) disagree. Since the mean score for determining the smallholder farmer's attitude towards the Ndanda surface irrigation scheme was 3.2 and the value of the standard deviation being 0.98 for the scheme increases income is relatively closer to the mean score as compared to other sub-variables (Table 3), this implies that smallholder farmers' positive attitude towards the Ndanda surface irrigation scheme was strongly influenced by the expectation that the scheme increases income to farmers.

On the other hand, smallholder farmers who did not participate in irrigation agriculture through the Ndanda surface irrigation scheme, also known as non-irrigators, exhibited a diverse attitude regarding the scheme's practicality for farming. 11 (14.7%) strongly agree, 9 (12.0%) agree, while 9 (12.0%) strongly disagree and 10 (13.3%) disagree. The scheme is too expensive to implement; 7 (9.3%) strongly agree, 13 (17.3%) agree, 7 (9.3%) strongly disagree, and 13 (17.3%) disagree. The scheme is too complicated to understand: 6(8%) strongly agree, 16(21.3%) agree while, 5 (6.7%) strongly disagree and 12 (16%)

disagree. The scheme is necessary for farming, 5(6.7%) strongly agree, 18 (24%) agree, while strongly disagree 5(6.7%) and 11(14.7%) disagree. The scheme increases income; 6 (8%) strongly agree, 15 (20%) agree, 6 (8%) strongly disagree, and 11 (14.7%) strongly disagree. Since the mean score for determining the smallholder farmer's attitude towards the Ndanda surface irrigation scheme for non-irrigators was 3.05 and the standard deviation value is 0.96, it is relatively closer to the mean score than other reasons (Table 1). This implies that despite acknowledging that the scheme was necessary for farming, some smallholder farmers firmly did not accept the Ndanda surface irrigation scheme due to negative attitudes towards it. The findings are similar to Adekunle, *et al.* (2015), who assessed the factors affecting farmers' participation in irrigation schemes of the lower Niger River basin and rural development authority, Kwara state, where it was found that despite the government interventions of promoting community participation in irrigation agriculture factors like lack of interest in farming, poor knowledge on irrigation farming, insufficient water for irrigation during the dry season, high cost of labour, access to the credit facility, poor response to farmers' need by officials, irregular pumping of water and phasing off of sprinkler system jointly affected farmers' participation in the irrigation scheme.

3.2.3. Time for Adoption of Ndanda Surface Irrigation Scheme

Time is a significant factor for community participation in any innovation persuaded in a particular locality. Principally, different groups of people in a community may adopt the innovation at different times (Rogers, 2003). In the context of Ndanda surface irrigation schemes, the adopters are the smallholder farmers who are willing to practice irrigation agriculture using new irrigation techniques introduced in their locality by the district council. Concerning time use for the adoption of irrigation agriculture through the Ndanda irrigation scheme, results from the study, as presented in Table 4, revealed that 18(10.7%) of irrigators were earlier adopters who adopted the Ndanda surface irrigation scheme within a year, while 8(24%) adopted the scheme in two years, 34 (45.3%) adopted it in three years' time. However, contrary to the project expectations, the majority of smallholder farmers, 69 (92%), adopted the Ndanda surface irrigation scheme more than three years after the establishment of the scheme. This implies that most of the smallholder farmers were the latter majority who were uncertain about the benefits of the innovation (the Ndanda surface irrigation scheme) and waited until most of their peers adopted the innovation. Although they were sceptical about the innovation and its outcomes, economic necessity and peer pressure influenced them to adopt the Ndanda surface irrigation scheme. The early adopters were more likely to hold leadership roles in the social system; other smallholder farmers came to them to get advice or information about the Ndanda surface irrigation scheme. This indicates that the early adopters played a central role at virtually every stage of the innovation process, from initiation to implementation. As time goes on, more and more community members will

adopt the innovation until it reaches a point where the majority of the community is using the scheme. However, a small group of individuals will resist the innovation, either because they are sceptical of its benefits or prefer to stick with the old ways (Rogers, 2003). The findings are similar to the diffusion of innovation theory that argues that time plays a crucial role in adoption; innovators adopt quickly while the majority takes more time to evaluate benefits and risks, early adopters and later adopters based on their willingness to embrace the new ideas (Rogers, 2003).

Table 4: Time for Adoption of Ndanda Surface Irrigation Scheme

Time for Adoption	Irrigators (75)	
	n	Percent(%)
One year	8	10.7
Two years	18	24.0
Three years	34	45.3
More than three years	69	92.0

2.3.4. Communication channels for the Ndanda surface irrigation scheme

The diffusion of the Ndanda surface irrigation scheme to the community is a function of the communication channel processes. The study determined and examined how participants created and shared information about the Ndanda irrigation scheme to reach a mutual understanding. The findings revealed that community members accessed information about the Ndanda surface irrigation scheme through five communication channels: friends, extension officers, media, public meetings, and local leaders.

For the irrigators, the most dominant communication channel with significant responses was through public meetings at 88%, friends at 79.3%, extension officers at 37.9%, followed by local leaders at 58.9%, and media at 31%. For non-irrigators, the findings indicated that the dominant communication channels with large responses were public meetings 96%, friends 73.3%, local leaders 54.9%, media 37.5%, and extension officers 35.8%. The findings imply that public meetings and friends were the leading communication channels that smallholder farmers used to access information about the Ndanda surface irrigation scheme. Besides, the findings also imply that the innovation adoption decision process is an information-seeking process, where an individual community member is motivated to reduce uncertainty about the advantages and disadvantages of innovation through interpersonal communication channels of public meetings and friends that are more persuasive towards participation in the Ndanda surface irrigation scheme.

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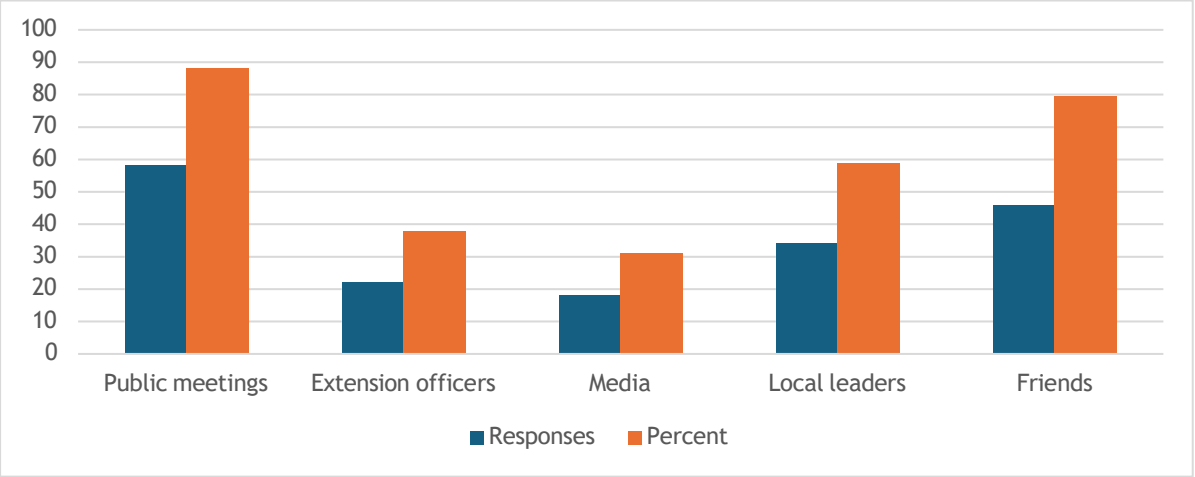

Figure 1: Responses on communication channels used by smallholder farmers

3.3. Institutional Factors Influencing Community Participation in Surface Irrigation Scheme

An institutional system that describes a set of interrelated units engaged in joint problem-solving to accomplish a common goal is crucial for community engagement in surface irrigation. Since the diffusion of innovations takes place in the social system, it is influenced by the social structure of the social system and the extent to which the Ndanda surface irrigation scheme is institutionally organised. During the study, the nature of institutional factors that affect the community's decision to participate in the Ndanda surface irrigation was examined using four variables: institutional set-up, supportive infrastructures, regulations, and access to extension services provided to smallholder farmers.

The supportive infrastructures in the scheme results in Table 5 show that there was a significant association between supportive infrastructures and community participation in the Ndanda surface irrigation scheme. The findings revealed that supportive infrastructures with a ßeta coefficient of 0.299 and Sig. 0.024 significantly ($p<0.05$) influenced smallholder farmers' participation in the Ndanda surface irrigation scheme. According to the odds ratio of 1.349, there is over a 100% increase in the likelihood of smallholder farmers' engagement in the Ndanda surface irrigation scheme for every unit of supportive infrastructures in raising their level of engagement. This implies that the presence of supportive infrastructures was directly related to an increased involvement of smallholder farmers in the scheme. This is one of the reasons that influenced some smallholder farmers in the study area to be reluctant to adopt the surface irrigation scheme. The findings are similar to those of Nakawuka (2017), who identified the constraints to participation in community-managed irrigation schemes, including limited access to credit, inadequate infrastructure, lack of technical knowledge, and poor management of the schemes.

Table 5: Institutional factors influencing community participation in surface irrigation scheme

Factors for engagement in scheme smallholder farmers	B	S.E.	Wald	df	Sig.	Exp(B)
Supportive infrastructures	.299	.847	.125	1	.024*	1.349
Institutional support	-.319	1.045	.093	1	.030*	.727
Enforcement of regulations	.291	.638	.208	1	.648	1.338
Access to extension services	1.357	.696	3.804	1	.041*	3.885
Constant	-5.870	3.645	2.594	1	.107	.003

* = Significant

The findings on institutional setup show a significant relationship between institutional setup and community participation in the Ndanda surface irrigation scheme. The results revealed that the institutional set-up had a ßeta coefficient of -0.319, and the sig. 0 .030 statistically significant ($p<0.05$). According to the odds ratio of 0.727, there is approximately a 72.7% increase in the likelihood of smallholder farmers' engagement in the Ndanda surface irrigation scheme for every unit of institutional setup in raising their level of engagement. This implies that the presence of a well-structured scheme management team contributes to smallholder farmers' participation in the surface irrigation scheme.

On the existence of regulations guiding the Ndanda surface irrigation scheme, results show that there was no significant relationship between joining requirements and community participation in the Ndanda surface irrigation scheme. The findings revealed that the regulations with regard to the requirements for joining the scheme had a ßeta coefficient of 0.291, and the sig. 0.648, which is statistically insignificant ($p>0.05$). According to the odds ratio of 1.338, there is over a 100% increase in the likelihood of smallholder farmers' engagement in the Ndanda surface irrigation scheme for every unit of regulations enforcement in raising their level of engagement. This implies that joining requirements in the Ndanda surface irrigation scheme were not directly related to the involvement of smallholder farmers, though joining requirements for membership are one of the factors in other schemes. For example, Tusiime *et al.* (2023) found that establishing clear rules and guidelines, establishing water user associations, water allocation, and water pricing policies can help to increase transparency and accountability in irrigation management, which can ultimately lead to more effective participation and sustainable use of water resources.

The findings show that there was a significant relationship between access to extension services and community participation in the Ndanda surface irrigation scheme. The results revealed that the institutional set-up had a ßeta coefficient of 1.357, and the sig. 0.041 statistically significant ($p<0.05$). According to the odds ratio of 3.885, there is over a 300% increase in the likelihood of smallholder farmers'

engagement in the Ndanda surface irrigation scheme for every unit of access to extension services in raising their level of engagement. This testifies that the availability of extension services in the scheme contributes to community participation in the scheme. This study result is similar to that of Dhital (2017) in Nepal, where the researchers found that extension services play a crucial role in promoting farmers by providing technical knowledge and skills, improving communication, and building trust and collaboration between farmers and irrigation officials.

3.4. Economic Factors on Community Involvement in Surface Irrigation Scheme

As presented in Table 6, results from the study were analysed using a binary logistic regression model of the selected factors as independent variables or predictor variables that include access to farm inputs, access to credits, access to water resources, and land ownership. These independent variables, or predictor variables, were tested to determine whether a statistically significant association exists between a dependent variable and the independent variables or predictor variables. Based on the results of the binary logistic regression model performed, the findings revealed that access to farm inputs had a ßeta coefficient of -3.612 and the sig. 0.049 statistically significant at ($p<0.05$), access to credits had a ßeta coefficient of -.161 and the sig. 0.901 statistically insignificant at ($p>0.05$), access to reliable water had a ßeta coefficient of 5.272 and the sig. 0.00 statistically significant ($p<0.05$), and land ownership had a ßeta coefficient of -3.314 and the sig. 0.046 statistically significant ($p<0.05$).

Table 6: Economic factors for smallholder farmer's involvement in surface irrigation scheme

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Access to farm inputs	-3.612	1.831	3.892	1	.049*	.027
Access to credits	-.161	1.299	.015	1	.901	.851
Access to reliable sources of water	5.272	1.306	16.288	1	.000***	194.792
Land ownership	-3.314	2.129	4.19	1	.046*	.029
Constant	-4.309	3.852	1.251	1	.263	.013

* = Significant; *** = Very High Significant

Besides, Rahman *et al.* (2022) found that high costs associated with inputs such as seeds, fertilizers, and pesticides can limit the ability of smallholder farmers to participate in schemes. The researcher concluded that reducing the costs of cropping inputs through subsidies or other means could increase community participation in surface irrigation schemes and promote agricultural productivity and income. According to Yohannes *et al.* (2017), the factors that positively influence farmers' participation in small-scale irrigation schemes include the availability of water, the size of land cultivated, farmers' experience in irrigation, farmers' access to information, and the quality of the irrigation infrastructure.

4. Conclusion

Based on the study's findings, in promoting community participation in surface irrigation schemes for increasing agricultural productivity and reducing dependency on rain-fed agriculture, the Masasi district council established the Ndanda surface irrigation scheme in 2006 as a response to declining productivity of rain-fed agriculture in the area. The scheme is expected to benefit 23,147 people through the projection of increasing production of paddy from 1.5 tons to 6 tons and other horticultural crops such as maize, vegetables, tomatoes, and cassava. The scheme occupies a total area of 350 hectares. However, due to the low level of community participation in irrigation agriculture through the scheme, only 104 hectares are cultivated through surface irrigation. Based on the analysis of results through the binary logistic regression model, the findings from the study indicated that community participation in the Ndanda surface irrigation scheme was significantly associated with economic factors of access to farm inputs, access to credits, access to water sources, and land ownership among smallholder farmers. On the other hand, institutional factors were also associated with community engagement in surface irrigation schemes through the institutional setup, supportive infrastructures, regulations, and extension services. Finally, the level of community participation in the scheme was also associated with the perception of smallholder farmers on the Ndanda irrigation scheme that was influenced by farmers' knowledge of the irrigation scheme, farmers' attitudes towards the irrigation scheme, time for adoption, and communication channels.

References

Adekunle, O. A., Oladipo, F. O., & Busari, I. Z. (2015). Factors affecting farmers' participation in irrigation schemes of the lower Niger River basin and rural development authority, Kwara state, Nigeria. *South African Journal of Agricultural Extension*, *43*(2), 42-51.

Afzal, M., & Barbhuiya, S. (2011). Effects of extreme weather events in Pakistan and their impacts on sustainable development. *University of the West of Scotland, UK*.

Asmamawa, M., & Kurunca, A. (2020). The impacts of improving water management of smallholder agriculture in Ethiopia. *International Journal of Innovative Science and Research Technology*, *5*(6), 2456-2165.

Berhe, G. T., Baartman, J. E., Veldwisch, G. J., Grum, B., and Ritsema, C. J. (2022). Irrigation development and management practices in Ethiopia: a systematic review on existing problems, sustainability issues and future directions. *Agricultural Water Management*, *274*, 107959.

Brown, L. R. (2019). The worldwide loss of cropland. *In Future Dimensions of World Food and Population* (pp. 57–96). CRC Press.

Cheng, J. (2020). Access to credit and agricultural productivity: Evidence from rural China. *Agricultural Economics, 51(1), 29-43[https://doi.org/10.1111/agec.12588].*

Deshpande, T. (2017). State of agriculture in India. *PRS Legislative Research*, *53*(8), 6-7.

Dhawan, B. D. (1986). Irrigation and water management in India: Perception of problems and their resolution. *Indian Journal of Agricultural Economics*, *41*(3), 271-281.

Dhital, P. R. (2017). Agricultural extension in Nepal: experiences and issues. *Journal of Advances in Agriculture*, *7*(3), 1071-1082.

Dinar, A., Tsur, Y. (2014). Water scarcity and water institutions. *In Routledge Handbook of Water Economics and Institutions* (pp. 218-235). Routledge.

Dolinska, A., Oates, N., Ludi, E., Habtu, S., Rougier, J. E., Sanchez-Reparaz, M., and d'Aquino, P. (2020). Engaging farmers in a research project. Lessons learned from implementing the Community of Practice Concept in innovation platforms in irrigated schemes in Tunisia, Mozambique and Ethiopia. *Irrigation and Drainage*, *69*, 38-48.

Food and Agricultural Organization of the United Nations. (2018). Irrigation in Africa in Figures*:* AQUASSTAT survey-2018*. Food and Agriculture Organization of the United Nations [http://www.fao.org/3/19535EN/i9535en] site visited on February 2024.*

Food and Agricultural Organization of the United Nations. (2021). AQUASTAT Tanzania country profile. *[http://www.fao.org/aquastat/en/countries-a-to-z/country-profiles/caf-tza/] site visited on April 2024.*

Food and Agricultural Organization of the United Nations. (2022). World Food and Agriculture Statistical Yearbook.

Gumbo, B. and Muyambo, F. (2016). Factors affecting the sustainability of community-based irrigation schemes in Zimbabwe: Physics and Chemistry of the Earth, PartsA/B/C, 93, 64-70. *[https://doi.org/10.1111/1468-5973.12204] visited on March, 2024*

Komba, C. (2018). Ndanda Irrigation Scheme in Tanzania: An Assessment of Performance and Challenges.

Li, J., Fei, L., Li, S., Xue, C., Shi, Z., & Hinkelmann, R. (2020). Development of "water-suitable" agriculture based on a statistical analysis of factors affecting irrigation water demand. *Science of The Total Environment*, *744*, 140986.

Miller, R. L. (2018). Rogers' innovation diffusion theory (1962, 1995). In *Technology adoption and social issues: Concepts, methodologies, tools, and applications* (pp. 1558-1571). IGI Global.

Ministry of Agriculture, Livestock, and Fisheries. (2017). National Irrigation Development Strategy 2017-2022: *Government of Tanzania.*

Mushi, C. A. (2018). Gender issues in irrigated agriculture in Tanzania: A case study of the Lower Moshi scheme. *Social Justice Perspectives (SJP). Retrieved from http://hdl. handle. net/2105/46591*.

Mwalyagile, N., Jeckoniah, J. N., & Salanga, R. J. (2024). Gender differences in rice production participation

among smallholder farmers in small-scale irrigation schemes in mbarali district, Tanzania. *Journal of Agriculture and Food Research*, *18*, 101390.

Nakawuka, P., Langan, S., Schmitter, P., and Barron, J. (2018). A review of trends, constraints and opportunities of smallholder irrigation in East Africa. *Global food security*, *17*, 196-212.

Narayanamoorthy, A. (2004). Impact assessment of drip irrigation in India: the case of sugarcane. *Development Policy Review*, *22*(4), 443-462.

NBS. (2020). Basic demographic and socio-economic profile report: Tanzania Mainland. *[https://www.nbs.go.tz/nbs/takwimu/census2012/Basic-Demographic and Socio-Economic-Profile-Report-2020-Mainland-Tanzania] visited on April 2024.*

Nkonya, E. M., Magalhaes, M., Kato, E., Diaby, M., & Kalifa, T. (2022). Pathways from irrigation to prosperity, nutrition and resilience: The case of smallholder irrigation in Mali (Vol. 2129). Intl Food Policy Res Inst.

Rahman, M. M., & Connor, J. D. (2022). Impact of agricultural extension services on fertilizer use and farmers' welfare: Evidence from Bangladesh. *Sustainability*, *14*(15), 9385.

Rogers, E. M. (1962). Seminal work on the Diffusion of Innovations theory and the key concept and stages of the adoption process: *New York Free Press.*

Rogers, E. M. (2003). Diffusion of innovations *(5th ed.) New York: Free Press.*

Rogers, E. M. (2014). Diffusion of innovations. *In An integrated approach to communication theory and research* (pp. 432-448). Routledge.

Shiklomanov, I. A., & Rodda, J. C. (Eds.). (2003). World water resources at the beginning of the twenty-first century. *Cambridge University Press.*

Siebert, S., Burke, J., Faures, J. M., Frenken, K., Hoogeveen, J., Döll, P., & Portmann, F. T. (2010). Groundwater use for irrigation–a global inventory. *Hydrology and earth system sciences*, *14*(10), 1863-1880.

Tanzania Ministry of Water and Irrigation. (2017). National Irrigation Master Plan (NIMP) for Tanzania Mainland: *[https://www.maji.go.tz/storage/app/public/ irrigation/national]* site visited on March 2024.

Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature*, *418*(6898), 671-677.

Tusiime, M., and Juarez, R. A.T.(2023). Characterising agricultural holdings in Uganda: Inputs to improving policy formulation. *Journal of Development and Agricultural Economics*, *15*(1), 11-25.

United Nations (2019). Population Prospects 2019, the United Nations Department of Economic and Social Affairs, Population Division. *World: Data Booklet. ST/ESA/SER. A/424*.

United Nations Development Programme (2020). Tanzania: Climate and disaster resilience. *[https.//www.undp.org/content/undp/en/home/librarypage/en resilience.html]* site visited in May, 2024.

United Republic of Tanzania (2015). Agricultural Sector Development Programme II (ASDP) 2015/16 – 2024/25*[https://www.tz/fileadmin/documents/dpg- internal/dpg-working-groups-clusters-2/agricultural-sector/Key-Sector Documents/ASDP-II-2015-2025.pdf]* site visited on December 2024.

United Republic of Tanzania. (2023). Budget Speech: Ministry of Agriculture. *https://www.kilimo.go.tz/. Visited on July 2023.*

Vaidyanathan, A. (1999), Water Resource Management: Institutions and Irrigation Development in India, *Oxford University Press, New Delhi.(pp. xi+-260).*

Vaidyanathan, A., Krishnakumar, A., Rajagopal, A., & Varatharajan, D. (1994). Impact of irrigation on productivity of land. *Journal of Indian School of Political Economy*, *6*(4), 601-645.

Wamala, F., Gidudu, A., Wanyama, J., Nakawuka, P., Bwambale, E., and Chukalla, A. D. (2023). Assessment of irrigation water distribution using remotely sensed indicators: a case study of Doho Rice Irrigation Scheme, Uganda. *Smart Agricultural Technology*, *4*, 100184.

World Bank (2018). World development report 2018: Agriculture for development. *Washington, DC: World Bank. https://doi.org/10.30875/e89f8212-en.* The site was visited in May 2024.

World Bank (2023). World development report 2023: Agriculture for development. *Washington, DC: World Bank. https://doi.org/10.30875/e89f8212-en.* The site was visited in May 2024.

World Health Organization. (2021). The State of Food Security and Nutrition in the World 2021: Transforming food systems for food security, improved nutrition and affordable healthy diets for all *(Vol. 2021). Food & Agriculture Org.*

WHO. (2022). The state of food security and nutrition in the world 2022: Repurposing food and agricultural policies to make healthy diets more affordable (Vol. 2022). Food and Agriculture Org..

Yami, M. (2016). Irrigation projects in Ethiopia: what can be done to enhance effectiveness under 'challenging contexts'?. *International Journal of Sustainable Development & World Ecology*, *23*(2), 132-142.

Yohannes, D. F., Ritsema, C. J., Solomon, H., Froebrich, J., and Van Dam, J. C. (2017). Irrigation water management: Farmers' practices, perceptions and adaptations at Gumselassa irrigation scheme, North Ethiopia. *Agricultural Water Management*, *191*, 16-28.