Agric Res J **61** (5): 718-726, *October* 2024
DOI: 10.5958/2395-146X.2024.00086.2

UNPACKING SUCCESS: KEY ATTRIBUTES OF EFFECTIVE SMALL-SCALE COMMUNAL IRRIGATED AGRICULTURE IN ZIMBABWE

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ABSTRACT

This study looks at Zimbabwe's shift from rainfed to irrigated agriculture. Using the Stanmore B Irrigation Scheme, which was named the 'Scheme of the Year' in 2018, as a case study, this study aimed to pinpoint the essential characteristics that make small-scale communal irrigation schemes successful, especially in light of the National Communal Irrigation Competitions, which were started in 2016. The study emphasises success factors like better infrastructure, committed agronomic support, community cohesion, and strategic crop selection through qualitative techniques like focus group discussions (FGDs), semi-structured interviews (SSIs), key informant interviews (KIIs), and observation. Results show that these factors promote socioeconomic advantages for disadvantaged groups in addition to improving crop yields and water management. In order to guarantee long-term agricultural resilience and food security in Zimbabwe, the study ultimately highlights the necessity of sustainable models that incorporate local knowledge, efficient management techniques, and continuous assistance from outside partners. The study recommends that technical assistance and other initiatives meant to build the resilience of plot holders must be offered regularly.

Keywords: Communal small-scale irrigation, Community cohesion, Food security, Internal capacity and resilience, Irrigation scheme, Self-sufficiency score

The global population is projected to rise dramatically, from 7.6 billion in 2021 to approximately 9.7 billion by 2050, while the availability of arable land remains largely static (MIT Joint Program, 2023). This unprecedented population growth, coupled with the adverse effects of climate change, exacerbates food insecurity, particularly in developing nations. Historically, irrigated agriculture has been a critical response to these challenges, gaining traction during the Green Revolution of the 1960s and 1970s, which emphasized modern management techniques and the cultivation of high-yielding crops (Hamdan *et al.*, 2022; Chakwanda *et al.*, 2024). In Zimbabwe, once hailed as the 'breadbasket' of Southern Africa, the reliance on rainfed agriculture proved insufficient by the late 20th century, prompting a strategic pivot toward irrigated agriculture (Scoones, 2022). As the nation moved from agricultural self-sufficiency to reliance on foreign aid, frequently depending on agencies like the World Food Program (WFP) and USAID for sustenance, this transformation was not just a question of choice; it became a necessity. With assistance from outside funders such as the Food and Agricultural Organisation (FAO) and the Zimbabwe/EU Micro-Project Programme, Zimbabwe began concentrating on small-scale communal irrigation projects in response to these difficulties (Ndundu *et al.*, 2010; Scoones, 2022). In 2016, irrigation competitions were added to further encourage these efforts. There are three levels or stages to the irrigation competitions: district, provincial, and national. The top three district-level schemes advance to the province stage, and the top three provincial-level systems qualify for the national stage. As a result, the best three programs from each province compete for recognition in the national competition, which offers financial prizes and agricultural inputs as prizes.

These competitions at all levels involve judges from various stakeholder groups and are monitored to ensure fairness. Competing schemes are judged based on established indicators that evaluate their effectiveness across various dimensions, including repair and maintenance, food security, living standards, management strategies, economic viability, and social acceptance.

These competitions aim to foster environmentally sustainable irrigated agriculture by promoting cooperative schemes that enhance self-sufficiency in food security and improve the living standards of rural communities (Moyo *et al.*, 2016; Chakwanda *et al.*, 2024). Further, this competitive framework enhances community engagement and resource allocation in Zimbabwe's agricultural sector. Despite the irrigation competitions' alignment with the United Nations Sustainable Development Goals (SDGs) related to

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Date of receipt: 26.08.2024, Date of acceptance: 28.10.2024

zero hunger, poverty alleviation, and improved health, there is a critical gap in documented research regarding the attributes and practices that define success within these competitions.

This study sought to address this gap by identifying the key attributes that underpin successful small-scale communal irrigated agriculture in Africa, as informed by national irrigation competitions as well as key stakeholders. By examining the practices and success factors within small-scale communal irrigation schemes, this research seeks to provide a nuanced understanding of what constitutes success in this context, ultimately contributing to the formulation of best practices that can be adopted nationally and regionally.

MATERIALS AND METHODS

Study area description

This study was conducted at Stanmore B Irrigation Scheme, located in Masvingo Province, approximately 17 kilometers east of the city of Masvingo, Zimbabwe (Fig. 1). The scheme is situated in natural agro-ecological region IV, which is characterized by an annual rainfall ranging from 450 mm to 650 mm, severe dry spells during the rainy season, and frequent seasonal droughts (Chingarande and Matondi, 2020; Mbanyele *et al.*, 2022). This site was selected for study due to its recognition as a previous winner (Scheme of Year) of Zimbabwe's National Irrigation Competitions. With this recognition as a model of success, Stanmore B Irrigation Scheme served as a benchmark for future irrigation initiatives, illustrating the characteristics and success factors for an effective irrigation scheme.

Some of the physico-chemical attributes of the soils in Stanmore Irrigation Scheme as well as the irrigation water quality used in the scheme are presented in table 1.

Farmers in the scheme have since improved their production levels from subsistence level to small-scale commercial scale. They have diversified their production to include mixed cereals and a variety of horticultural crops, such as cucumbers, carrots, cabbages, rape, onions, peas, and butternuts. Located near the Mutare-Masvingo main road, Stanmore B Irrigation Scheme enjoys easy access to the city of Masvingo, which has a population of approximately 1.64 million (ZIMSTAT, 2022). The city often faces food insecurity, particularly concerning cereals, which are sometimes sourced from as far away as Karoi and Chegutu, where production exceeds local demand. Being just 17 kilometers from Masvingo allows Stanmore B Irrigation Scheme to efficiently grow perishable crops, leveraging its connectivity to access markets. Nearby institutions, including Victoria High School, Riverton College, Mutendi High School, and Kyle College, provide additional markets for perishable products such as tomatoes and vegetables. Furthermore, Mutimurefu Prison and Royi Township, located approximately 5 km and 15 km away, respectively, represent further potential markets for the scheme's produce.

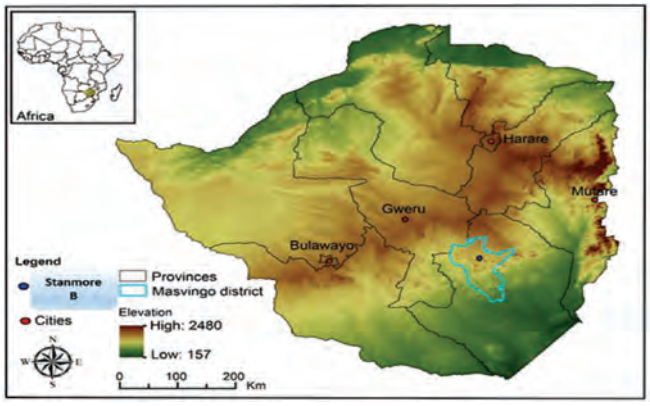

Fig. 1. Map showing the location of Stanmore B irrigation scheme in Zimbabwe

Table 1. Physico-chemical characterization of the soils and irrigation water in Stanmore B irrigation scheme

Property	Value
Soil texture	Clay loam
Bulk density	1.5 g/cm³
Water holding capacity	32%
Soil pH	6.5
Electrical conductivity	0.4 dS/m
Cation exchange capacity	21 cmol/kg
Organic carbon	1.8%
Macro and micro nutrients in the soil	
Nitrogen (N)	19 mg/kg
Phosphorus (P)	9 mg/kg
Potassium (K)	192 mg/kg
Iron (Fe)	8 mg/kg
Zinc (Zn)	1.4 mg/kg
Manganese (Mn)	2.8 mg/kg
Copper (Cu)	0.7 mg/kg
Stanmore B irrigation water quality results	
pH	7.2
Electrical conductivity (EC)	0.7 dS/m
Chemical oxygen demand (COD)	17 mg/L
Total dissolved solids (TDS)	382 mg/L
Nitrate	7.8 mg/L
Phosphates	1.3 mg/L
Microbial contaminants	<100 cfu/100 mL

Data collection tools

This research employed a case study approach, to understand the factors influencing the success of a communal irrigation scheme from the perspectives of Stanmore B small-scale farmers and key informants. The case study approach (Yin, 2018) was chosen for the study for a number of reasons: it allows for a deep dive into a specific phenomenon, providing rich qualitative data that can reveal complexities and nuances often missed in broader quantitative studies; facilitates a comprehensive understanding of the context surrounding the subject of study; and finally for its methodological flexibility.

Data were solicited from the case study (Stanmore B Irrigation Scheme) through four instruments: focus group discussions (FGDs); semi-structured interviews (SSIs); observation; and key informant interviews (KIIs). These methods were employed to triangulate, validate and cross-check the results from each instrument. This approach meant that inconsistencies were identified and clarified thereby enhancing the overall validity and robustness of the findings. Further, data gathered at each session were reviewed with the relevant public extension personnel for validation.

Two FGDs were conducted with all the 32 plot holders in the Stanmore B Irrigation Scheme, to gather their perceptions of what constitutes a successful communal irrigation scheme. Similar but more specific information (like average income, assessment of self-sufficiency scores, etc) was collected using SSIs with all the 32 plot holders. Observations were conducted to complement the other data collection tools as a way of verifying some of the physical attributes of the irrigation scheme. A total of eight (8) KIIs were conducted to gather perceptions on success factors for irrigation schemes. The eight key informants were drawn from amongst representatives from the government's primary irrigation agency, Department of Irrigation (DOI), national irrigation competition judges/adjudicators and local extension officers.

Data analysis and presentation

The emergent theme method is used to analyze the qualitative data gathered from respondents. The emergent theme approach is a qualitative research approach that focuses on identifying and analyzing themes that arise directly from the data, rather than applying pre-existing categories (Cloutier, 2024). The approach involved identifying patterns and themes within the qualitative data collected during FGDs, SSIs, KIIs and observations. The themes were arrived at following a rigorous process of coding the gathered data to identify key ideas; grouping codes into categories; examining patterns across categories; reviewing and refining themes to ensure they were representative and accurate. Conversely, some quantitative data gathered on SSIs on attributes like average income generated from irrigation activities income among others were analyzed statistically using one-way ANOVA and other descriptive statistics. Data were presented using tables and bar graphs.

RESULTS AND DISCUSSION

Household head typology

There are a total of 32 plot holders within Stanmore B Irrigation Scheme. Of the 32 plot holders/household heads, 24 were adult males, six were widows and two were children (Table 2).

Using descriptive statistics shown in Table 2, in terms of participation in irrigation scheme activities, the average number of hours worked per week is quite similar across the household types, with father-headed households working the most (41.4 hours/week), widow-headed households slightly less (40.8 hours/week), and child-headed households just marginally less (40.2 hours/week). With an ANOVA *F*-statistics value = *0.6054* and the associated *P*-value = *0.55261*, the study concludes that household head type did not have a significant effect on participation in irrigation activities.

Conversely, on productivity level, the average weekly income from irrigation activities is slightly higher for father-headed families ($22.45) compared to widow-headed ($20.89) and child-headed families ($21.05), though the differences are not large. With an ANOVA *F*-statistics value = *38.65138* and the associated *P*-value = *0*, the study concludes that household head type has

Table 2. Types of household heads within the Stanmore B Irrigation Scheme and their average participation and productivity levels

Household Head type	No. of households	Average no. of hours worked/week)	Standard Deviation	Average weekly income (US$)	Standard Deviation
Father-headed	24	41.38	1.88	22.81	0.2508
Widow-headed	6	40.8	0.98	20.89	1.1321
Child-headed	2	40.2	1.41	21.05	0.4243
Grand Average		41.3		22.07	

a significant effect on productivity level (average weekly income). Similar findings were noted by Negesse *et al*. (2020) in Ethopia and across the African continent (Ndige and Loki, 2024; Zambrano, 2024; Milazzo and van de Walle, 2017).

Key attributes for an effective/successful communal small-scale irrigation scheme

The study found a plethora of factors responsible for the success of small-scale communal irrigation schemes, from the perspectives of the small-scale farmers/plot holders and key informants. These factors/ attributes are discussed in detail as follows.

Regular irrigation infrastructure rehabilitation is vital for success

Regular irrigation infrastructure rehabilitation is a significant factor in improving the operational reliability of irrigation schemes. Findings from FGDs, SSIs and KIIs indicated that irrigation rehabilitation efforts, such as those implemented by FAO in late 2016 resulted in significant positive impacts on irrigation schemes including enhanced water use efficiency and operational reliability. As shown in Figure 2, before rehabilitation there was a lot of wastage of water through leakages, leading to low adherence to the agreed irrigation scheduling and further to reduced crop yields and income. This poor performance of Stanmore B Irrigation Scheme is similar to findings by Moyo *et al.* (2016), Malanco *et al.* (2018), Yohannes *et al.* (2022), Ray and Majumder (2024) and Chakwanda *et al.* (2024) who found most communal irrigation schemes across Africa, to be hampered by inefficient water use, unreliable water supply, and degradation of irrigation infrastructure. Ray and Majumder (2024) stresses that water wastages in most communal irrigation schemes do not only strain water resources but also contribute to other problems like soil erosion, nutrient leaching, and waterlogging, thereby negatively impacting crop growth and yield potential.

After the rehabilitation of the scheme, the amount of water wastages reduced significantly (94.87%), adherence to irrigation scheduled more than doubled (117.78%) and average weekly income per plot holder increased by 77.12%. Similar figures for profitability, water efficiency figures were noted at Exchange Irrigation Scheme, after rehabilitation of the scheme by Ndige and Loki (2024). Thus, the rehabilitation of Stanmore B Irrigation scheme resulted in significant improvements across many facets. As noted by one respondent, 'The rehabilitation efforts by FAO helped the scheme a lot as it resulted in improved reliability in irrigation scheduling, water distribution and adequacy which made the scheme more attractive to many stakeholders (including contractors) who are volunteering to work with the scheme'. This highlights the importance of external support for communal irrigation schemes to remain operational. Further, investments in irrigation scheme infrastructure can lead to improved agricultural outcomes including potential spin-offs and should be prioritized in policy planning.

Presence of dedicated extension agents/ agronomists

Dedicated extension agents/agronomists greatly enhance agricultural practices, particularly in small-scale farming. The presence of a dedicated and well-compensated agronomist played a crucial role in enhancing agricultural practices within Stanmore B Irrigation Scheme. FGD, SSI respondents and key informants (100%) noted that the additional agronomist/ private extension agent provided by FAO offered critical support, leading to improved crop management and yield (Chakwanda *et al.*, 2024; Mungai *et al.*, 2024). Fig. 3 shows the satisfaction level with extension services rendered to them.

The majority (81%) of the small-scale communal irrigators highlighted that they were satisfied with the overall extension services while 16% were very satisfied. There were no respondents who assessed extension services poorly. Reasons given for the high rating of overall extension services included their frequent visits, high quality of advisory services, regular trainings on

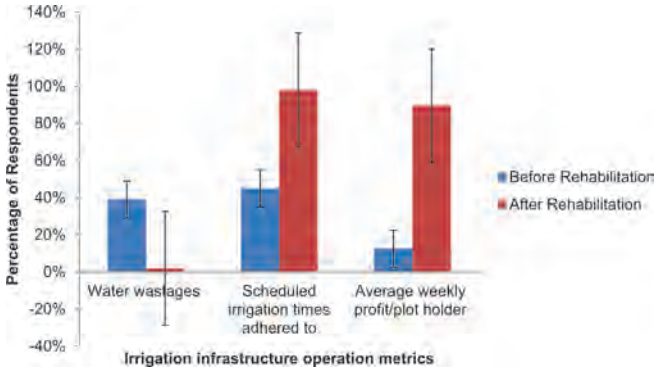

Fig. 2. Relevant operation metrics related to irrigation infrastructure rehabilitation

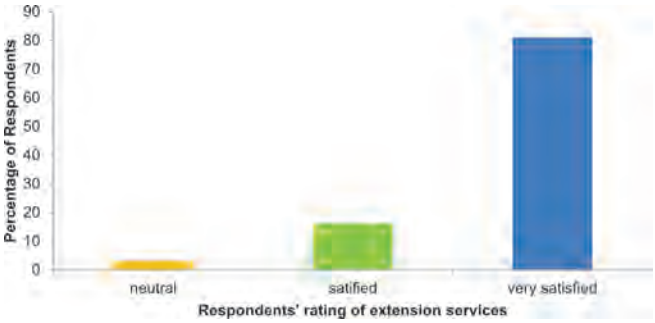

Fig. 3. Plot holders' overall satisfaction with extension services

crop management aspects and improved yields. These findings are consistent with Malanco *et al.* (2018), Masere and Worth (2015, 2021) and Chakwanda *et al.* (2024) who noted the role of dedicated extension services/agents is critical in the success of any small-scale farming operations as they provide technical and advisory support as and when demanded by farmers.

Contract farming has a positive impact on farm productivity

Contract farming significantly enhances financial stability and market access for farmers, thereby increasing productivity. Study respondents at Stanmore B highlighted that programs like K2 and Command Agriculture provide essential inputs such as quality seeds and fertilizers and guarantee markets for their crops. Historically, small-scale farmers have struggled to transition from subsistence to commercial farming due to inadequate input and output markets (Masere, 2023).

All 32 plot holders (100%) participated in contract farming, receiving necessary inputs and advisory services, which align with the need for dedicated extension services. They noted that contractors would purchase all their produce, providing a sense of 'stability' that enables them to focus on production without worrying about market fluctuations. One respondent remarked on government guarantees of a ready maize market, highlighting the positive impact of reliable contracts on motivation and productivity (Ncube, 2020; Hamdan *et al.*, 2022; Chakwanda *et al.*, 2024). Similar studies at Panganai, Mkoba, Mushandike and Kwekwe irrigation schemes indicated that access to essential resources is critical for the success of small-scale farming (Chazovachii, 2012; Moyo *et al.*, 2016; Malanco *et al.*, 2018; Ndige and Loki, 2024). Notably, no plot holders sold less than half of their produce, with only 12.5% selling over 75%, primarily due to household consumption needs.

Importance of community cohesion and cooperative dynamics

Community cohesion is essential for operational success in communal irrigation schemes, driving collective efforts and cooperation. The admission of Stanmore B Irrigation Scheme into the irrigation competitions (beginning at district level up to national level) fostered a sense of community cohesion and cooperation among members, driving collective efforts to maintain and improve their plots. As one farmer stated, "We win or lose as a scheme, not individually," emphasizing the communal spirit that was crucial for success. This sentiment of oneness among the farmers was also noted in KIIs particularly, one of the national irrigation competition judges, who adjudicated the competition, the year Stanmore B Irrigation Scheme won. This cohesion continued after the competitions and is now a key feature within the operations of the Stanmore B Irrigation Scheme as shown in Table 3.

Water allocation was discussed by 78.1% of farmers and 21.9% of them regularly. This shows farmers' water management communication, which is crucial for irrigation and collaboration. Most farmers (46.9%) trust each other, and 15.5% trust very much. A significant 37.5% were ambivalent, suggesting that Stanmore Irrigation Scheme plot holders' trust is not universal. This suggests member trust should be improved. The majority (93.8%) of farmers say problems are often resolved. This suggests the irrigation scheme's conflict resolution procedures work well. Only 6.2% of plot holders say disagreements are resolved sometimes, with none saying they are never or rarely resolved, showing great group harmony. Most respondents (56.2%) were very involved in decision-making, while 31.3% were moderate. Only 9.4% are fully active in decision-making. The distribution illustrates that most farmers are involved in decision-making, yet some may feel confined. All farmers (100%) say the group works well together toward common goals, indicating cohesion. This indicates excellent group togetherness and collective effort to attain goals. However, Muchara *et al.* (2014) found that inadequate and unfairly distributed water supply and water-related conflicts negatively affect farmer participation in collective irrigation water management in the Mooi River Irrigation Scheme.

Overall, the data presented in Table 3 suggests a generally high level of cooperation among farmers in the irrigation group, with strong communication, trust, conflict resolution, and group cohesion. However, there is potential for further improvement in areas like trust and more inclusive decision-making. The findings also point to the significance of community cooperation and leadership in driving success. Strong communal ties and effective management can enhance the operational effectiveness of irrigation schemes, suggesting that fostering these dynamics is essential for successful agricultural initiatives.

Manageable plot sizes

Making use of manageable plot sizes in communal irrigation schemes effectively supports resource allocation and reduces the burden on individual farmers. The strategic division of land into smaller plots per farmer (0.25 hectares each/block) allowed for better management of resources and tasks, enabling farmers to synchronize their agricultural activities more effectively. Most plot holders (65.6%) indicated that they were able to perform key tasks (like planting,

Table 3. Community cohesion and cooperative dynamics in Stanmore B

Survey Items	Main question/theme	Frequency for each score
Group Communication	How often do you communicate with other farmers about water allocation and irrigation scheduling?	1 (Very Rarely) - 0 2 (Rarely) - 0 3 (Sometimes) - 0 4 (Frequently) - 78.1% 5 (Always) - 21.9%
Trust among Farmers	How much trust do you have in the other farmers in your irrigation group to respect water-sharing agreements?	1 (Very Low) - 0% 2 (Low) - 0.1% 3 (Neutral) - 37.5% 4 (High) - 46.9% 5 (Very High) - 15.5%
Conflict Resolution	How often are conflicts resolved in a fair and timely manner in your irrigation group?	1 (Never) - 0 2 (Rarely) - 0 3 (Sometimes) - 6.2% 4 (Often) - 93.8% 5 (Always) - 0
Joint Decision -Making	How involved are you in joint decision-making processes for water management and maintenance of the irrigation system?	1 (Not Involved) - 0% 2 (Slightly Involved) - 3.1% 3 (Moderately Involved) - 31.3% 4 (Very Involved) - 56.2% 5 (Completely Involved) - 9.4%
Group Cohesion	How well do the farmers in your irrigation group work together towards common goals?	1 (Not Well) - 0% 2 (Poorly) - 0% 3 (Neutral) - 0% 4 (Well) - 0% 5 (Very Well) - 100%

watering, harvesting) at the same time because of having smaller plots. Despite the relatively small plot sizes, respondents indicated that they were able to improve their crop productivity by utilizing this model (Table 1). This arrangement reduced the burden on individual plot holders, facilitating efficient crop management across the scheme (Heinrichs *et al.*, 2021). Elsewhere, in Nigeria, small-scale farmers who are partaking in a similar farming model (which is also referred to as 'block farming') have realized a 75% increase in productivity, have seen a 103% increase in their income, and increased the cohesiveness of farmers involved (Zambrano, 2024).

Market forces should determine crops to grow

Closely linked to the already discussed contract farming setup, market forces should guide farmers on the choice of crop to grow at any given time if communal irrigation schemes are to succeed. According to FGD respondents, significant postharvest losses (up to 60%) were suffered by plot holders (87.5%) who failed to adapt to the dictates of the market and went on to produce more perishable horticultural crops in a market that had an oversupply of the same, in seasons prior to the rehabilitation (2016) that brought on board of contractors. This scenario reinforces the importance of aligning crop choices with market demands (Musara *et al.*, 2021; Pittock *et al.*, 2020; Chakwanda *et al.*, 2024). Armed with the advisory services and information support provided by contractors about market forces, and postharvest losses suffered in prior years, all plot holders (100%) mentioned that they are now basing their crop choice decision making on market conditions.

Development of internal capacity and resilience among farmers

The inability of irrigation schemes to sustain themselves post-funding reflects a significant challenge in communal agriculture. This was a recurring theme in FGDs and SSIs. Once financial support is withdrawn, many schemes face a decline in maintenance and operational efficiency, ultimately leading to their deterioration. This highlights the importance of developing internal capacity and resilience within these communities to ensure long-term viability. Both small-scale irrigation farmers and key informants mentioned that farmers are continuously learning to better manage their farming operations and develop resilience to ensure sustainability of the irrigation scheme after external funding support elapse. Figure 4 shows the plot holders' perceptions/own assessment of their self-sufficiency score on their perceived ability to maintain irrigation without external funding.

The highly dependent group is characterized by

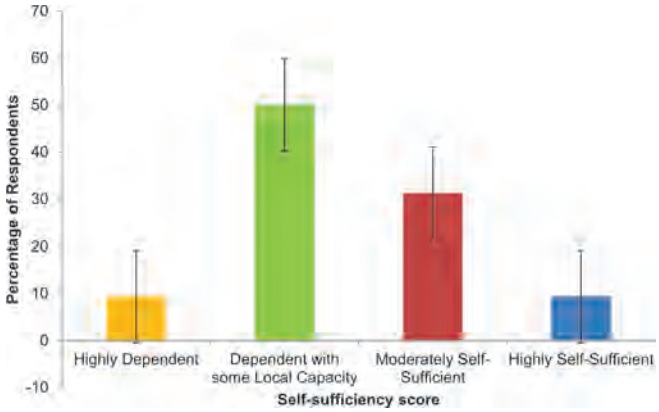

Fig. 4. Respondents' assessment of their self-sufficient scores

Fig. 5. Maintenance sustainability potential of Stanmore B Irrigation Scheme plot holders

little to no capacity to manage the scheme without significant external funding due to lack of technical skills and/or financial mechanisms to sustain operations. The second category (Dependent with Some Local Capacity) refer to those plot holders who are still heavy reliant on external funding for irrigation maintenance but have some local resources or basic skills to manage parts of the system. The Moderately Self-Sufficient group refer to plot holders can maintain the system with some external support but are making strides toward full self-sufficiency. On the other hand, the fourth group (Highly Self-Sufficient) refer to plot holders who are largely self-reliant and can manage most aspects of the scheme independently. They have skills, resources, and financial mechanisms to maintain and operate the system with minimal or no external funding. Finally, the Fully Self-Sufficient group refers to plot holders with skills to operate the system independently and sustainably and does not require external funding.

As shown in Figure 4, 50% of the plot holders assessed themselves to be in the second category (Dependent with some local capacity) while a considerable number (31.25%) perceived themselves to be in the Moderately self-sufficient group (third group). Interestingly, there was not even one plot holder who assessed him/herself to be fully self-sufficient (fifth and final self-sufficient group). Key informant agreed with the self-rating of the plot holders and stressed that while the irrigators have some skills to manage certain aspects of the scheme and are making in-roads towards full self-sufficiency, there is still need for external support including some resources to maintain the scheme. This is consistent with findings by Masere (2023) who reports that small-scale farmers have the capacity to learn and take command of factors that affect their enterprises. Mungai *et al.* (2024) however proposed a more deliberate way of exposing small-scale communal irrigators to regular and focused water management training, through capacity-building programmes run by the government and other initiatives. They argued that their approach is a key step in transferring ownership and management of an irrigation scheme from funder/donor/government management to communities.

In assessing the maintenance sustainability of the irrigation scheme, plot holders indicated different levels of commitment to meeting maintenance and operational costs (Fig. 5). Like with the self-sufficient scores, the first three categories of income pledged (< 10%, 10-20%, and the 30-40% groups) recorded the highest frequencies. The three categories were not statistically different but they were significantly different with the 30 to 40% group (Fig. 5).

Thirty-eight percent of plot holders were willing to allocate between 10 and 20% of their total income on maintenance followed by 28% each for the average group (20-30%) and very low group (less than 10%). Again, no plot holder was willing to spend more than 40% of their total income on maintenance of the irrigation scheme. These findings again illustrate that while small-scale may have some capacity and willingness to manage communal schemes they may still not be ready or be able to do so effectively without outside help and resources.

Establishment of an enabling sustainable partnership/model with external stakeholders

Sustainable partnerships and collaborations with external stakeholders are essential for ensuring continued operational support. The generally poor performance of small-scale communal irrigation schemes in most developing countries stems from complex interplay of factors, including low technical capacity, inadequate institutional arrangements and uncoordinated market linkages (Chazovachii, 2012; Muchara *et al.*, 2014; Moyo *et al.*, 2016; Mungai *et al.*, 2024; Chakwanda *et al.*, 2024). This reality was evident at Stanmore B Irrigation scheme before its

rehabilitation by FAO and its participation in national irrigation competitions. To address these challenges, a more sustainable maintenance and operation framework is proposed, shaped by respondents' insights. Key processes must be initiated, such as developing the capacity of plot holders and irrigators, providing ongoing technical support and training, and securing resources from external stakeholders even after initial funding ends. However, this approach comes with a caveat: it is crucial to guard against donor dependence. Establishing linkages among communal irrigators, extension agents, agro-dealers, and research institutions is vital, as discussed by Pittock *et al.* (2020), Maulu *et al.* (2021), Masere (2023) and Chakwanda *et al.* (2024). In this model, each actor plays a distinct role that complements the others. As Yohanes *et al.* (2022), Mungai *et al.* (2024) and Chakwanda *et al.* (2024), suggest, a gradual withdrawal of support and a careful handover of management and operations to communal irrigators are necessary to ensure long-term viability and sustainability. This measured approach will not only foster independence but also allow the communal irrigators to maximize their learning from water management training provided by technical staff within government and other sectors. As Ray and Majumder (2024) noted water management is vital for the sustenance of irrigation schemes, improved agricultural productivity, ensuring food security, promoting socio-economic development, environmental conservation and resilience to climate change.

Conclusion

According to this study, strong leadership, committed extension and agronomic support, successful market strategies, resilient community engagement, successful contract farming, thorough irrigation infrastructure rehabilitation, and supportive external stakeholders are all necessary for communal small-scale irrigation schemes to be successful. Crop productivity, water management, scheme success, and sustainability all depend on these characteristics. Future initiatives ought to concentrate on sustainable models that preserve access to resources and technical assistance while empowering regional farmers. Incorporating resilience into these initiatives is not just about functioning; it's also about long-term agricultural success and regional food security.

Authors' contribution

Conceptualization and designing of the research work (AM); Execution of field/lab experiments and data collection (AM, TC, TPM); Data Analysis and interpretation (TPM, VSM, AM, TC); Preparation of manuscript (TPM, AM, TC, VSM).

Conflicts of interest

The authors declare that they have no conflicts of interest.

LITERATURE CITED

Chakwanda M A, Chenge P T, Baloyi N, Tamburayi G L, Muchangana M, Jarbah P, Rera A and Sahoo J P 2024. Green revolution: the catalyst for agricultural transformation. *Vigyan Varta* **5**(4): 294-302.

Chazovachii B 2012. The impact of small scale irrigation schemes on rural livelihoods: the case of Panganai irrigation scheme Bikita District Zimbabwe. *J Sustain Dev Afr* **14(**4): 217-31.

Chingarande D and Matondi P 2020. *Zimbabwe Stakeholder Mapping Report: Matabeleland North Province*. Research Technical Assistance Center: Washington, DC.

Cloutier C 2024. Strategies for generating deliberately emergent qualitative research designs. *J Appl Behav Sci* **60**(2): 358-80.

Hamdan M F, Mohd Noor S N, Abd-Aziz N, Pua T L and Tan B C 2022. Green revolution to gene revolution: Technological advances in agriculture to feed the world. *Plants* **11**(10): 1297.

Heinrichs J, Kuhn T, Pahmeyer C and Britz W 2021. Economic effects of plot sizes and farm-plot distances in organic and conventional farming systems: A farm-level analysis for Germany. *Agric Sys* **187**, 102992. https://doi.org/10.1016/j.agsy.2020.102992

Malanco J A, Makurira H, Kaseke E and Gumindoga W 2018. Water management challenges at Mushandike irrigation scheme in Runde catchment, Zimbabwe. *Proc Int Assoc Hydrol Sci* **378**: 73-78. https://doi.org/10.5194/piahs-378-73-2018

Masere T P 2023. A perception-based survey on innovation and technology adoption by small-scale farmers in semi-arid Zimbabwe. *Int J Agric Environ Biotechnol* **8**(1): 82-90. https://dx.doi.org/10.22161/ijeab.81.10

Masere T P and Worth S 2015. Applicability of APSIM in decision-making by small-scale resource-constrained farmers: A case of Lower Gweru Communal Area, Zimbabwe. *J Int Agric Ext Educ* **22**(3): 20-34.

Masere T P and Worth S 2021. Influence of public agricultural extension on technology adoption by small-scale farmers in Zimbabwe. *S Afr J Agric Ext* **49**(2): 25-42.

Maulu S, Hasimuna O J, Mutale B, Mphande J, Siankwilimba E and Yildiz F 2021. Enhancing the role of rural agricultural extension programs in poverty alleviation: A review. *Cogent Food Agric* **7(**1). https://doi.org/10.1080/23311932.2021.1886663

Mbanyele V, Mtambanengwe F, Nezomba H, Rurinda J and Mapfumo P 2022. Conservation agriculture in semi-arid Zimbabwe: A promising practice to improve finger millet (*Eleusine coracana* Gaertn.) productivity and soil water availability in the short term. *Agriculuture* **12**(5): 622.

Milazzo A and van de Walle D 2017. Women left behind? Poverty and headship in Africa. *Demography* **54**: 1119-45. https://doi.org/10.1007/s13524-017-0561-7

MIT Joint Program 2023. *The 2023 global outlook: Charting the earth's future; energy, managed resources, climate, policy prospects*. Retrieved from https://globalchange.mit.edu/publications/signature/2023-global-change-outlook

Moyo M, van Rooyen A, Moyo M, Chivenge P and Bjornlund H 2016. Irrigation development in Zimbabwe: Understanding productivity barriers and opportunities at Mkoba and Silalatshani irrigation schemes. *Int J Water Resour Dev* **33**(5): 740-54. https://doi.org/10.1080/07900627.2016.1175339

Muchara B, Ortmann G, Wale E and Mudhara M 2014. Collective action and participation in irrigation water management: A case study of Mooi river irrigation scheme in KwaZulu-Natal Province, South Africa. *Water SA* **40**: 699-708.

Mungai L M, Messina J P, Zulu L C, Chikowo R and Snapp S S 2024. The role of agricultural extension services in promoting agricultural sustainability: A Central Malawi case study. *Cogent Food Agric* **10(**1). https://doi.org/10.1080/23311932.2024.2423249

Musara J P, Watetepa K, Bandason W, Munyati V T, Zivenge E, Musemwa L and Mafuse N 2021. Constrained crop enterprise choices by smallholder farmers in semi-arid Zimbabwe. *Cogent Soc Sci* **7**(1). 1984657. DOI: 10.1080/23311886.2021.1984657

Ncube D 2020. The importance of contract farming to small-scale farmers in Africa and the implications for policy: A review scenario. *Open Agric J* **14**: 59-86.

Ndige T and Loki O 2024. Impact of smallholder irrigation revitalisation programme on the Exchange Irrigation Scheme in Kwekwe District, Zimbabwe. *S Afr J Agric Ext* **52**(5): 53-72. https://doi.org/10.17159/2413-3221/2024/v52n5a15510

Ndundu K, Gwata C and Mushunje A 2010. Impacts of Zimbabwe European Union Micro-Project Programme (ZIM/EU MPP) in funding smallholder irrigation projects on food security and income levels: A case study of Mopane Irrigation Scheme in Zvishavane, Midlands Province, Zimbabwe. *Afr J Agric Res* **5**(14):1759-71.

Negesse A, Jara D, Temesgen H, Dessie G, Getaneh T, Mulugeta H, Abebaw Z, Taddege T, Wagnew F and Negesse Y 2020. The impact of being of the female gender for household head on the prevalence of food insecurity in Ethiopia: A systematic-review and meta-analysis. *Public Health Rev* **5**: 41: 15. doi: 10.1186/s40985-020-00131-8

Pittock J, Bjornlund H and van Rooyen A 2020. Transforming failing smallholder irrigation schemes in Africa: A theory of change. *Int J Water Resour Dev* **36**(1): S1–S19. https://doi.org/10.1080/07900627.2020.1819776

Ray S and Majumder S 2024. Water management in agriculture: Innovations for efficient irrigation. **In**: Sil P, Chhetri P, Majumder S and Santosh D T (Eds.) 2024. *Modern Agronomy*, Datish Serial Publishing House: Dehli, India.

Scoones I 2022. *Researching land reform in Zimbabwe*. Brighton: Institute of Development Studies.

Yin R K 2018. *Case study research and applications: Design and Methods*. Sage Publications.

Yohannes G S, Belay S, Engidawork A and Amare H 2022. Polycentric irrigation water governance: Irrigation water users associations service delivery in Ketar subbasin, Ethiopia. *Afr J Agric Res* **18**(10): 783-91.

Zambrano J C I 2024. Block farming: A new farming approach to improve the performance of companies and smallholder farmers. Retrieved from https://farmfitinsightshub.org/resources/block-farming-a-new-farming-approach-to-improve-the-performance-of-companies-and-smallholder-farmers

ZIMSTAT 2022. *Population and housing census*. Retrieved from https://zimbabwe.opendataforafrica.org/anjlptc/2022-population-housing-census