

# Irrigation Schemes and Rural Livelihoods: Assessing Impacts and Challenges in Honde Valley, Zimbabwe

Simbarashe Kembo <sup>1</sup>, Willard Zendera <sup>2</sup>, Friday Nguvayavika Mudondo Kubiku <sup>3</sup>

<sup>1</sup>Africa University, Department of Agriculture and Natural Resources

<sup>2</sup>Manicaland State University of Applied Sciences, Department of Agricultural Engineering and Technology

<sup>3</sup>Manicaland State University of Applied Sciences, Department of Agronomy

DOI: <https://dx.doi.org/10.51584/IJRIAS.2026.110200146>

Received: 01 March 2026; Accepted: 06 March 2026; Published: 21 March 2026

## ABSTRACT

Smallholder irrigation schemes in southern Africa have shown mixed results in improving rural livelihoods and food security. Investigations conducted in Zimbabwe's Honde Valley explored the effects of irrigation projects on the productivity and financial stability of local farmers. A cross-sectional study was conducted across five wards using a mixed-methods approach. A total of 100 irrigating farmers were surveyed via structured questionnaires, with further data gathered from five focus group discussions and eleven key informant interviews. The sample selection utilised a combination of multi-stage purposive and simple random sampling methods. Productivity assessment revealed significant variability across crops and schemes, with banana yields ranging from 7-30 tonnes per hectare and bean yields from 1-3 tonnes per hectare. Sprinkler irrigation systems dominated (90%), reflecting lower capital requirements and adaptability to diverse crops. Improved food security and increased income for farmers were the positive outcomes of irrigation schemes. Crop production contributed 36% of household income, with livestock production adding 27%. Increased household food security was reported by 51% of farmers. Farmers acquired various assets, including livestock (15 % farmers), wheelbarrows (20% farmers), and constructed houses (50% farmers). Key skills developed included farming as a business (50%) and plumbing (30%). High educational attainment among participants (80% secondary education) facilitated technology adoption and business skill development. Major challenges included limited access to capital (30%), poor market access (25%), and seasonal water scarcity (25%). While irrigation schemes have demonstrable positive impacts on rural livelihoods and productivity in Honde Valley, sustainability is threatened by financial constraints, market access limitations, and inadequate infrastructure. Targeted interventions addressing these challenges could significantly enhance scheme effectiveness.

**Keywords:** Food Security, Irrigation Schemes, Rural Livelihoods, Smallholder farming, Zimbabwe

## INTRODUCTION

### Global Context and the Imperative for Smallholder Irrigation

Agriculture remains a main source of income for rural communities in Sub-Saharan Africa, but they still struggle to achieve food security and reduce poverty. The region's agricultural sector, mainly comprising smallholder farming systems, faces increasing pressures from climate unpredictability, population expansion, and restricted access to contemporary technologies (Khatri et al., 2024; Mupaso et al., 2024a). Food security in regions is heavily dependent on small-scale farmers, who are struggling with increasing climate-related challenges that hinder their ability to produce food effectively and maintain resilience (Awazi, 2025; Kapari et al., 2023).

Contemporary research demonstrates that smallholder irrigation expansion could significantly increase agricultural production and reduce food insecurity and poverty levels across the region. A study by Nakawuka et al. (2018) showed that irrigation systems are essential for maintaining food security and reducing drought effects in East Africa, with Idahe & Solomon (2024) highlighting irrigation's key role in addressing water

scarcity issues. These findings underscore the growing recognition of irrigation as a critical adaptation strategy for smallholder farmers facing climate variability.

Small-scale irrigation is increasingly seen as the main approach for creating resilient rural livelihoods, especially considering the irregular and unpredictable rainfall patterns in Sub-Saharan Africa (Harmon et al., 2023; Maru et al., 2023; Mume et al., 2023). This shift toward irrigation-dependent agriculture represents a fundamental transformation in how smallholder farmers adapt to climate change and pursue livelihood security.

### **The Zimbabwean Challenge: Climate, Geography, and Food Insecurity**

In Zimbabwe, agricultural challenges are particularly acute due to geographical and climatic constraints. Around 80% of the country's agricultural land lies in arid or semi-arid areas, where rainfall is insufficient and unreliable, making consistent crop production challenging (Mpala, 2021). This geographical reality positions smallholder irrigation not merely as an agricultural enhancement tool, but as a critical necessity for sustainable production and rural livelihood security.

The urgency of addressing these challenges has intensified with Zimbabwe's deteriorating food security situation. Studies suggest that approximately 1.7 million people, representing 35% of the urban population, are forecast to be food insecure as of 2024 (Sukulao et al., 2025). The situation further deteriorated when the Government of Zimbabwe declared an emergency in April 2024, identifying 7.1 million people at risk of food insecurity (Tawodzera, 2016).

Traditional farming calendars are being disrupted and rainfed agriculture is becoming less reliable due to climate variability and changing precipitation patterns, making irrigation a crucial adaptation strategy (Magrath et al., 2014; Mwadzingeni et al., 2022). Research conducted by Kori et al. (2024) stresses that climate change is causing a rise in both droughts and heavy rainfall events in Zimbabwe, thereby making irrigation essential for minimising production risks.

### **Policy Response and Irrigation Development in Zimbabwe**

Zimbabwe's policy response reflects growing recognition of irrigation's importance for food security and rural development. The Zimbabwe Accelerated Irrigation Rehabilitation and Development Plan aims to cover a cumulative area of 400,000 hectares by 2023, comprising 71,000 hectares of rehabilitation and 183,000 hectares of new irrigation development (Water, 2018). This ambitious target demonstrates government commitment to irrigation-led agricultural transformation.

However, implementation faces significant constraints. Studies by Muhoyi & Mbonigaba (2022) in Chipinge District identified key barriers including limited access to finance, poor market linkages, and inadequate technical support. Recent research conducted by Mhembwe et al. (2019) discovered that, although small-scale rural irrigation schemes make a substantial contribution to food security among smallholder farmers, they continue to face persistent challenges that jeopardize their sustainability.

Adaptation efforts in recent case studies have shown that production can be successfully increased, but also highlight the need for more comprehensive support systems to achieve long-term sustainability. Research conducted by Mupaso et al (2024a) in Mberengwa district discovered that irrigation makes a substantial contribution to household food security, with households that irrigate experiencing superior outcomes compared to those that do not irrigate.

### **Theoretical Framework: Understanding Irrigation within Livelihood Systems**

This study draws on the sustainable livelihoods framework to understand irrigation impacts on rural households. The framework, originally articulated by Scoones (1998), recognizes that rural households deploy multiple strategies combining different capital assets—natural, physical, human, financial, and social—to achieve livelihood objectives.

Recent literature has expanded this framework to better account for climate change adaptation and resilience-building strategies. Harmon (2023) stresses the importance of seeing farmer-led irrigation development as a key component in more comprehensive livelihood diversification plans that allow households to adapt to escalating climate fluctuations. This perspective aligns with (Mupaso et al., 2024a), who note that while studies have documented impacts on food security and productivity, insufficient attention has been given to understanding specific mechanisms through which irrigation contributes to poverty reduction.

Recent studies conducted by Mwadzingeni et al. (2022) confirm that irrigation systems serve purposes beyond just increasing crop yields, also acting as risk mitigation measures that decrease household exposure to climate-related disruptions. Recent Ethiopian research supports this conceptualization, showing that smallholder participation in irrigation systems is crucial for ensuring food security and building resilience (Idahe & Solomon, 2024).

### **Evidence Base: Mixed Results and Knowledge Gaps**

The global literature on smallholder irrigation presents a complex picture of impacts on rural livelihoods and food security. While some studies document significant positive impacts, others reveal mixed or limited results. Research conducted by Mupaso et al. (2024a) highlights that despite several studies detailing impacts on food security, agricultural productivity, and livelihoods, insufficient focus has been placed on understanding the particular mechanisms by which irrigation contributes to poverty reduction.

Recent research in Sub-Saharan Africa has identified specific difficulties associated with institutional capacity, technical know-how, and market growth that hinder the operation of irrigation schemes (Awazi, 2025; Nakawuka et al., 2018). Research by Mhembwe et al. (2019) discovered that irrigation schemes for smallholder farmers play a vital role in maintaining a decent living and providing jobs in rural areas, although their efficiency differs substantially depending on how well water users are performing and the management capabilities of their operations.

Current evidence from East Africa demonstrates that while smallholder irrigation expansion could significantly increase agricultural production and reduce food insecurity, success depends on addressing constraints including limited access to finance, poor market linkages, and inadequate technical support (Nakawuka et al., 2018). These findings align with studies showing that farmer-led irrigation development faces particular challenges related to sustainability and scalability (Harmon et al., 2023).

### **Gender and Social Dimensions**

Irrigation development has been the focus of growing consideration regarding its gender aspects. Evidence from East Africa indicates that expanding smallholder irrigation can greatly boost agricultural output and alleviate food shortages, but success is contingent upon resolving difficulties such as restricted access to funding, weak market connections, and insufficient technical assistance (Nakawuka et al., 2018). However, contemporary studies reveal contrasting patterns of gender participation across different contexts in Zimbabwe. While some studies document high female participation, others reveal different patterns. Recent research by Mhembwe et al. (2019) found that male respondents constituted 78% of their sample while female respondents were 22%, suggesting that farming work remains male-dominated in some areas. This contrasts with findings from other contexts where women's participation in irrigation schemes is higher.

The role of young people around irrigation schemes has emerged as an important research area. Studies by Parry (2025) examined youth livelihoods around irrigation schemes in Zimbabwe, finding that irrigation development can contribute to local economic diversification and create opportunities for young people who might otherwise migrate to urban areas.

### **Research Problem and Justification**

Despite significant investments in irrigation development in Zimbabwe's Honde Valley, comprehensive empirical evidence of their impact on farmers' livelihoods remains limited. This knowledge gap has several

important implications for evidence-based decision-making by donors, policymakers, and development practitioners.

Current research studies have pointed out comparable knowledge deficiencies across Sub-Saharan Africa, underscoring the necessity for more extensive research that analyses the entire scope of irrigation impacts on rural living conditions (Mupaso et al., 2024a). According to Harmon (2023), farmer-led irrigation development is expanding in the region, yet the institutional and technical factors influencing its success or failure remain poorly understood.

The absence of systematic impact assessment limits understanding of how irrigation contributes to poverty reduction and livelihood improvement. Studies by Lankamo et al. (2025) stress the significance of understanding the effects of irrigation within overall ways of living, whereas Idahe & Solomon (2024) underscore the necessity for research that looks at both technical and social aspects of irrigation development.

### Study Objectives

This study sought to address the identified knowledge gaps in the context of irrigation's significance for rural development in Zimbabwe.

- Evaluate the productivity of smallholder irrigation systems in the Honde Valley.
- Examine skills development and livelihood diversification outcomes from irrigation participation
- Identify key challenges constraining irrigation scheme effectiveness and sustainability

These objectives aim to fill critical knowledge gaps regarding irrigation schemes' contributions to rural livelihood transformation and to identify key factors influencing long-term success or failure.

## METHODOLOGY

### Study Area

The study was conducted in Honde Valley, Mutasa District, Manicaland Province, Zimbabwe in 2023/24 farming season (Figure 1). The valley extends along Zimbabwe's eastern border with Mozambique, forming part of the Eastern Highlands. Located approximately 130 kilometers from Mutare, the valley sits at an average altitude of 900m above sea level, creating favorable conditions for tea, coffee, and banana production.

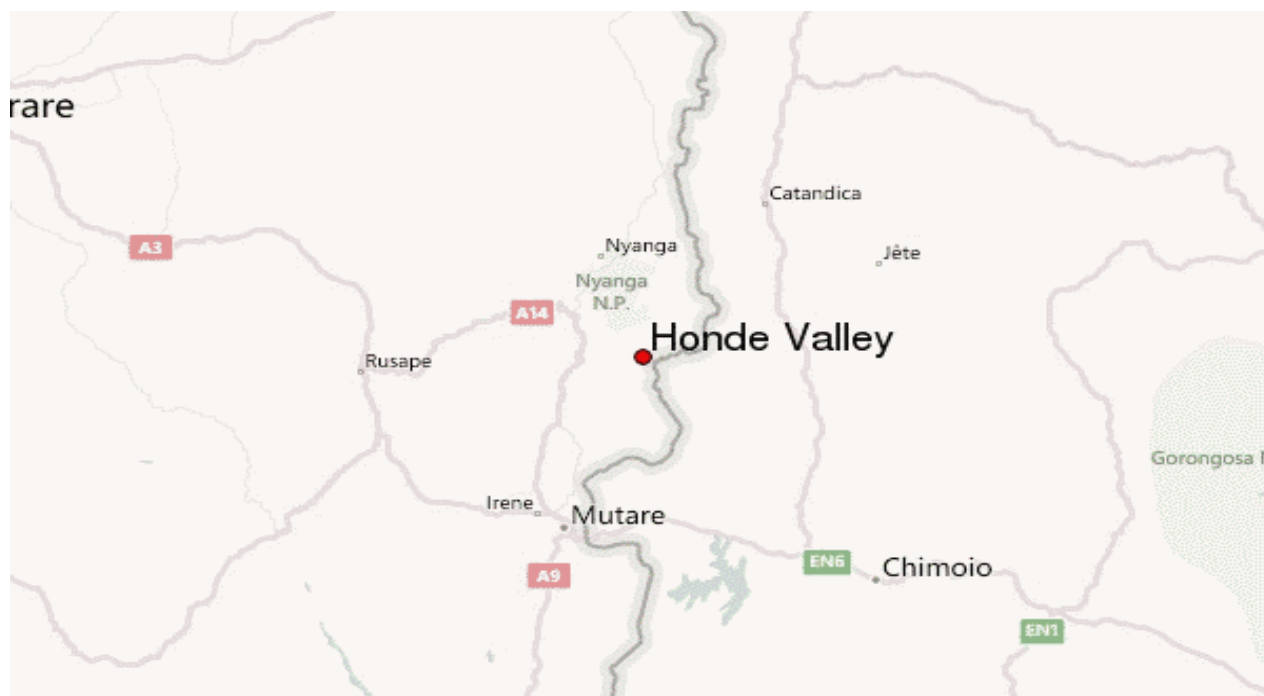


Figure 1: Location of Honde Valley, Manicaland, Zimbabwe (Map data: @OpenStreetMap)

The valley receives Zimbabwe's highest rainfall (annual average >1000mm) but experiences seasonal variability that has prompted irrigation development. The study area encompasses five wards containing community-based irrigation schemes established between 2010-2018.

### Research Design and Sampling

A cross-sectional mixed-methods design was employed, combining quantitative surveys with qualitative data collection methods. This approach enabled comprehensive examination of irrigation impacts while capturing farmers' perspectives and experiences. Multi-stage sampling was implemented across three stages. The first stage involved purposive selection of 10 irrigation schemes from Department of Irrigation records. The second stage utilized purposive selection of 5 community-based schemes based on operational status and accessibility. The third stage employed simple random sampling of 20 farmers per scheme, resulting in a total sample of 100 farmers. Additional respondents included 7 key informants from government agencies and 50 focus group discussion participants.

### Data Collection

Quantitative data were collected through structured questionnaires administered to 100 irrigating farmers, covering household demographics, agricultural production, income sources, asset ownership, and livelihood outcomes. Qualitative data collection involved five focus group discussions with 10 participants each, exploring irrigation impacts and challenges, eleven key informant interviews with extension officers, irrigation engineers, and scheme leaders, and field observations using structured checklists.

### Data Analysis

Quantitative data were analyzed using SPSS version 26, employing descriptive statistics including frequencies, means, and cross-tabulations. Qualitative data were analyzed thematically, identifying key patterns and triangulating with quantitative findings.

### Ethical Considerations

Research clearance was obtained from relevant authorities. Informed consent was secured from all participants, and confidentiality was maintained throughout the study.

## RESULTS

### Socio-Demographic Characteristics

The study sample comprised 65% female and 35% male farmers (Figure 2), reflecting women's significant participation in irrigation agriculture. Most farmers (70%) were aged 20-45 years (Table 1), with high educational attainment: 80% completed secondary education, 15% tertiary education, and 5% primary education only (Figure 3).

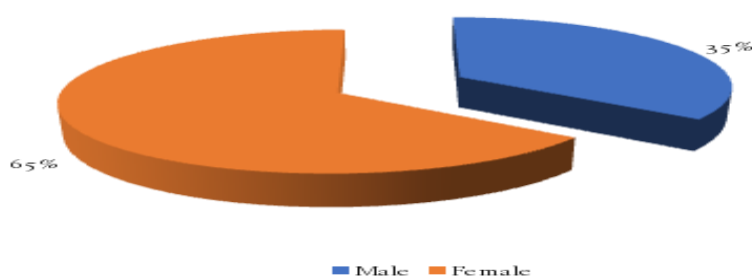


Figure 2: Socio-demographic characteristics

Table 1: Age distribution of smallholder farmers

Age	Distribution
Below 20 years	10%
45 years +	30%
20-45 years	70%

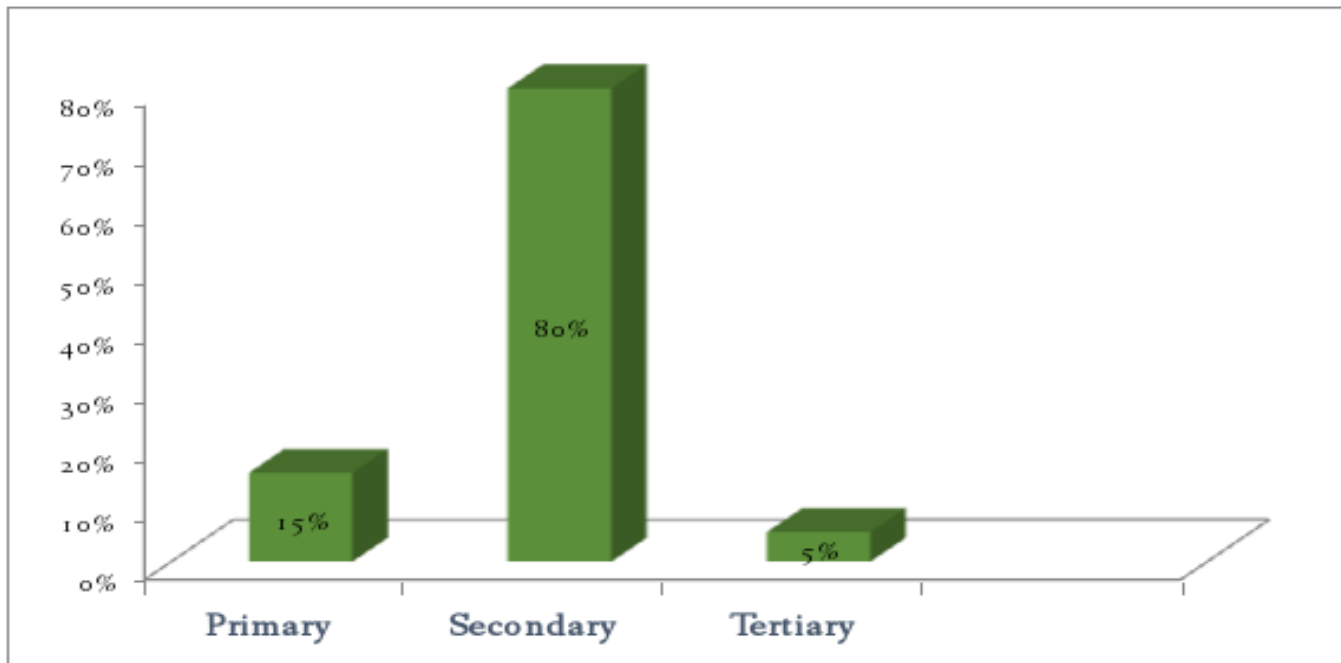


Figure 3: Educational level of smallholder farmers

### Irrigation Systems and Crop Diversity and Production

Sprinkler irrigation dominated among farmers (90%), with drip irrigation used by 10% (Figure 4). The prevalence of sprinkler systems reflected lower capital requirements and suitability for staple crops. Farmers cultivated diverse crops including bananas, beans, coffee, green maize, tomatoes, and ginger (Table 2). Banana production was most widespread across schemes, while high-value crops like tomatoes and ginger were limited to specific locations (Table 2).

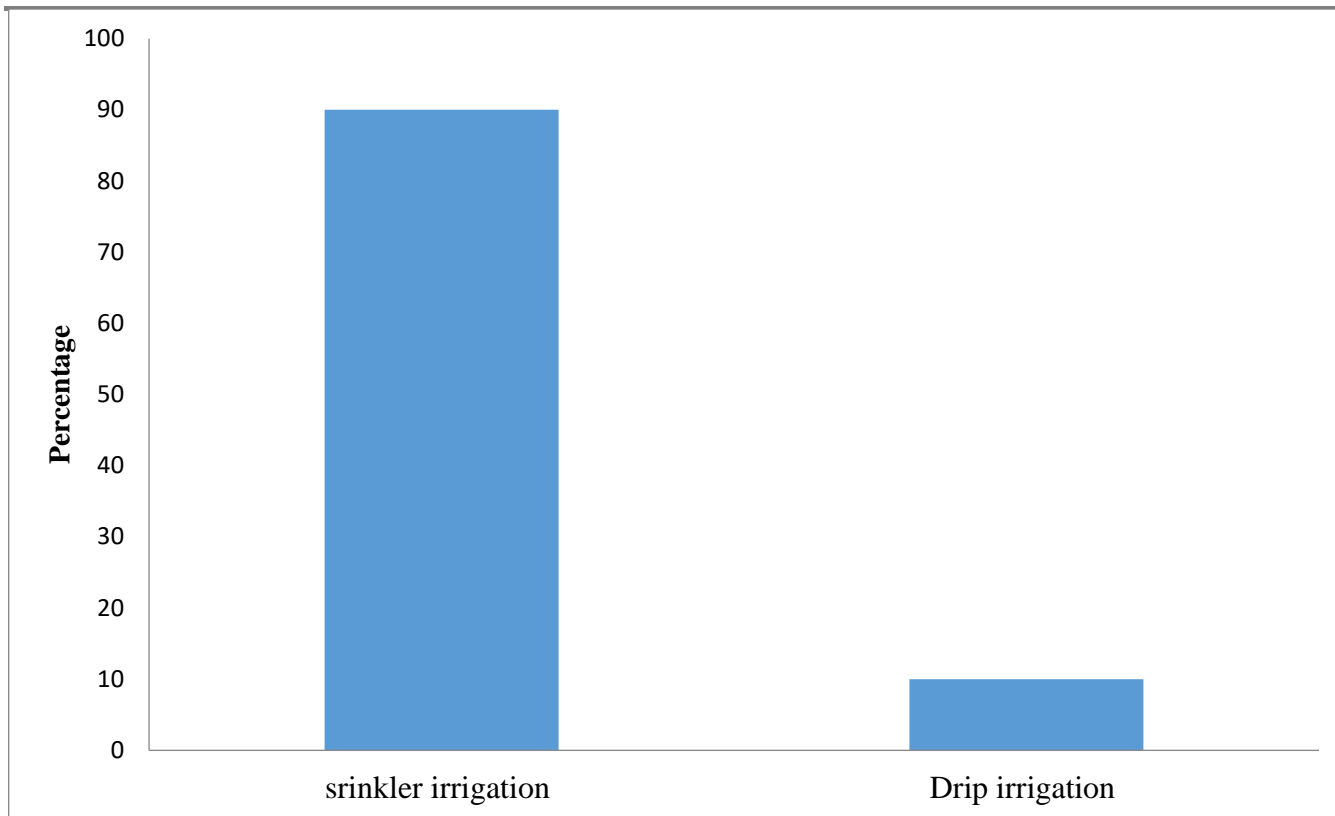


Figure 4: Types of irrigation systems used by smallholder farmers

Table 2: Crop diversity in the Honde Valley Irrigation Schemes

Irrigation scheme	Ward	Main Crops grown	Frequency
Mutarazi	7	Bananas, tomatoes, peas, green mealies beans	20 10 5 20 10
Murara	5	Coffee, Green mealies, beans bananas	5 20 20 20
Chiteme	3	Coffee ginger bananas Beans	10 20 20 20
Rujeko	7	Bananas Beans	20 20
Buwu	5	Coffee beans Bananas	15 20 5

Yield data for the 2018/2019 season showed significant variation across crops and schemes. Banana yields ranged from 7-30 tonnes per hectare across different schemes, while bean yields varied from 1-3 tonnes per hectare (Table 3). Coffee production was consistent at 1 tonne per hectare across the producing areas, and high-value crops, such as tomatoes, achieved yields of 20 tonnes per hectare where grown (Table 3).

Table 3: Crop production performance by irrigation schemes

Area	Crop grown	Area (ha)	Average Yield (t/ha)
Mutazarazi	Bananas	1.00	15
	Green mealies	1.00	6
	Tomatoes	0.20	20
	Peas	0.05	1
	Beans	0.25	1
Murara	Coffee	0.25	1
	Green mealies	0.20	5.8
	Beans	0.50	2.5
	Bananas	1.00	30
Chiteme	Coffee	0.30	1
	Bananas	1.00	10
	Ginger	0.50	2
	Beans	0.50	1.5
Rujeko	Bananas	1.50	9
	Beans	0.80	3
Buwu	Coffee	0.28	1
	Beans	1.00	3
	Bananas	0.20	7

**Livelihood Impacts**

Irrigation-based crop production constituted the primary income source, contributing 36% of household income, followed by livestock production at 27% (Figure 4). Additional income sources included formal employment (9%), manual labor (14%), casual work (5%), and remittances (9%) (Figure 5). Farmers allocated irrigation income strategically, with 40% directed toward food purchases, 30% for education expenses, 15% for agricultural inputs, 10% for clothing, and 5% for asset acquisition (Figure 6).

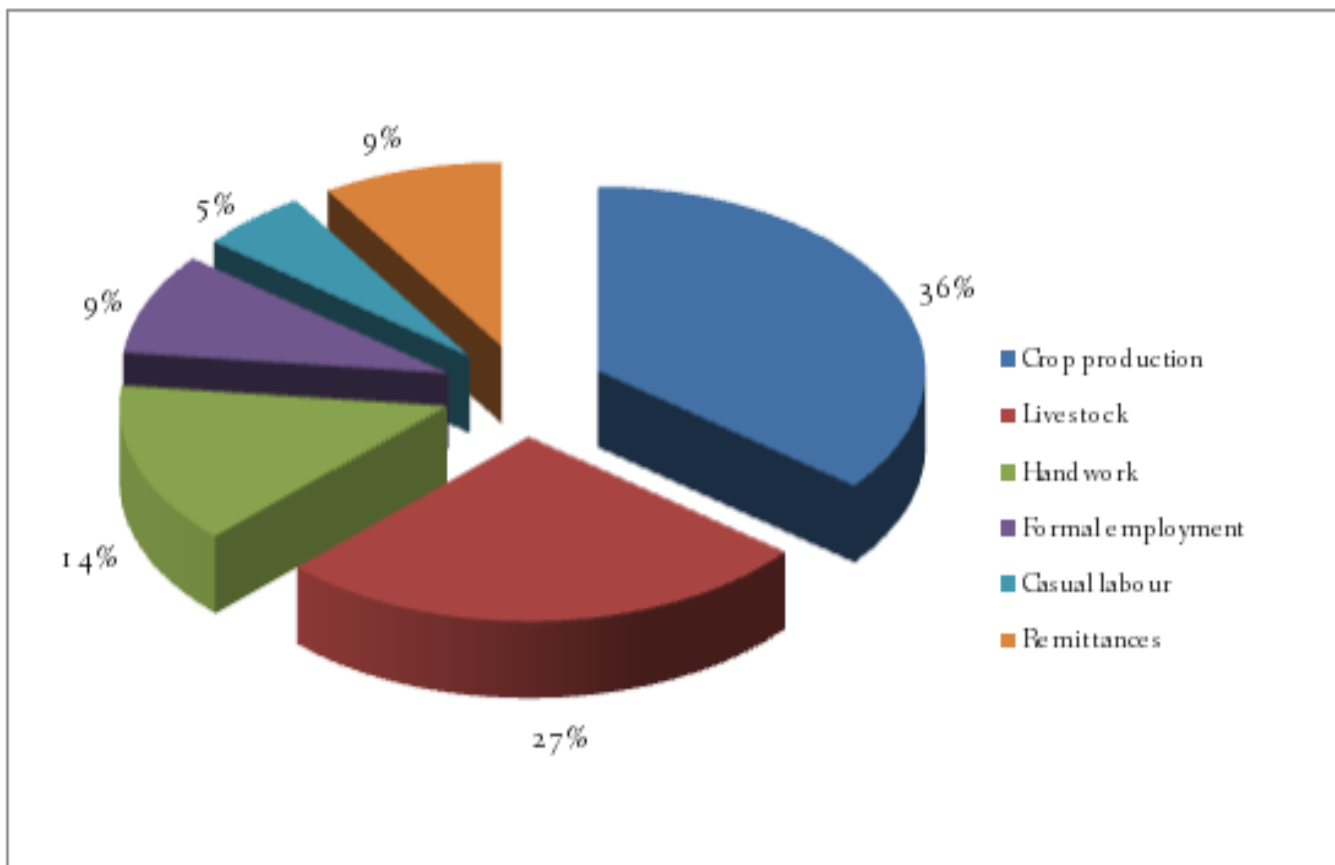


Figure 5: Household income sources and contributions

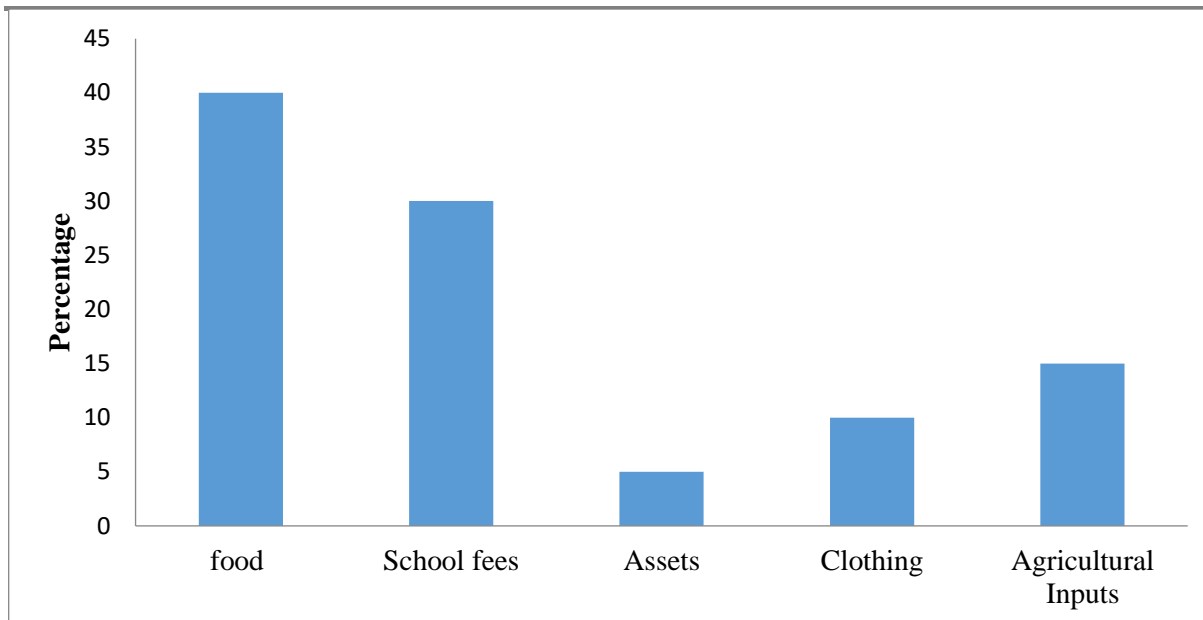


Figure 6: Income use from irrigation-based activities

Fifty-one percent of farmers reported improved household food security following irrigation scheme participation, while 37% reported no change and 12% reported deterioration (Table 4). Irrigation proceeds enabled significant asset accumulation, with all 100 farmers acquiring cell phones, 50 % farmers constructing houses, 20 % farmers purchasing wheelbarrows, 15 % farmers acquiring livestock, 6 % farmers obtaining agricultural equipment, and 1 % farmers purchasing a vehicle (Table 5).

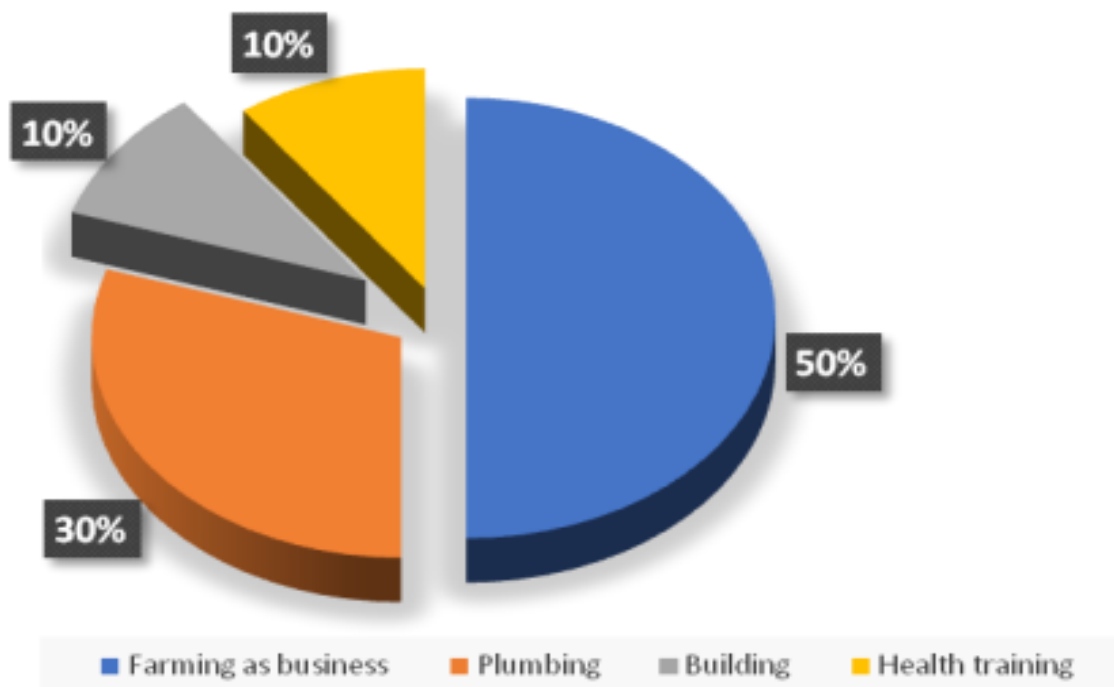
**Table 4: Household food security status following irrigation scheme participation**

Diet Coping	Frequency	Relative frequency
Improved	51	0.51
Stayed	37	0.37
Worsened	12	0.12

**Table 5: Asset acquisition by irrigation participants**

Name of Asset	Number of Assets Bought	Number of Irrigators (%)
Scotch carts	1	1
Wheelbarrow	20	20
Livestock	20	15
Mouldboard plough	5	5
Motor Vehicle	1	1
Constructed houses	50	50
Bought Cell phones	100	100

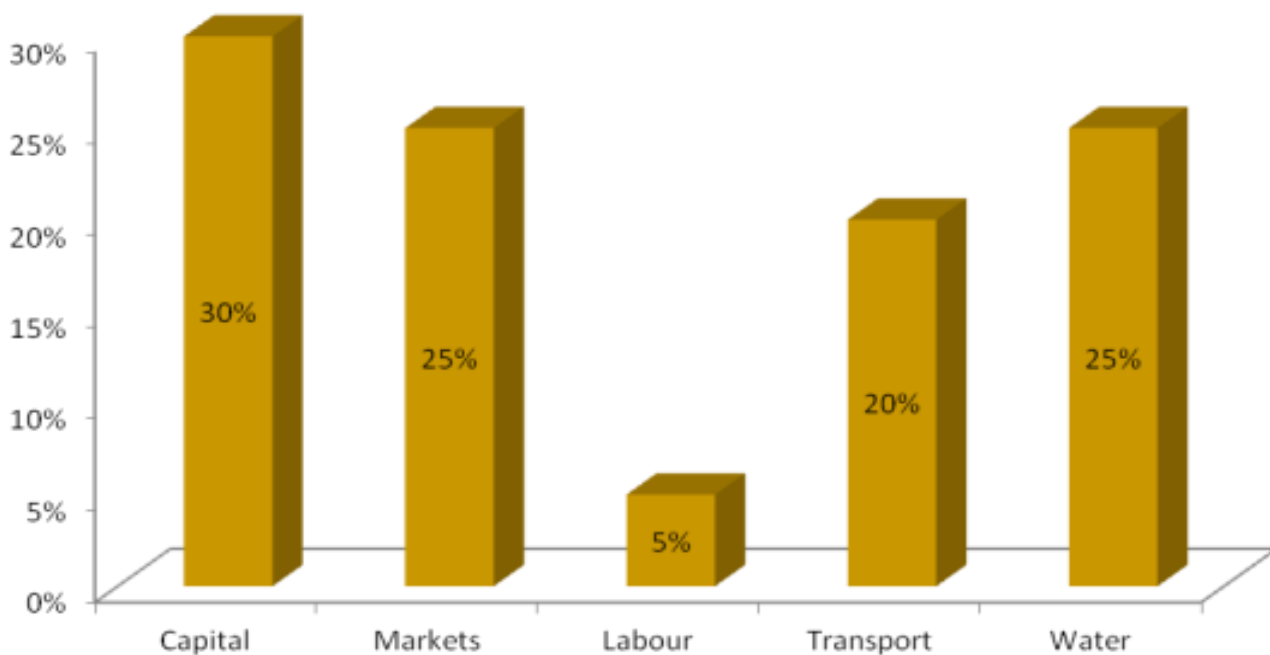
Farmers acquired various skills through irrigation participation, with 50% developing farming as business skills, 30% acquiring plumbing skills, 10% learning construction skills, and 10% developing health-related skills (Figure 7).



**Figure 7: Skills development through irrigation participation**

**Challenges and Constraints**

Major challenges identified included limited access to capital (30% of respondents), poor market access (25%), seasonal water scarcity (25%), transportation difficulties (20%), and labor shortages (5%) (Figure 8). Thirty percent of farmers reported difficulties accessing credit for input purchases, limiting their ability to optimize production. Twenty-five percent identified unreliable markets as major constraints, particularly affecting perishable crop production. Despite year-round irrigation potential, 25% of farmers experienced water shortages during the August-October dry season, requiring rotational irrigation schedules (Figure 8).



---

**Figure 8: Constraints facing irrigation smallholder farmers in the Honde Valley****DISCUSSION****Productivity Analysis and Technology Adoption****Crop Productivity Performance and Variability**

The productivity assessment shows considerable accomplishments accompanied by notable inconsistencies that require a thorough examination. Across all schemes, banana production showed yields varying between 7 and 30 tonnes per hectare, with the highest productivity found at the Murara scheme (30 t/ha) and the lowest at the Buwu scheme (7 t/ha). Significant disparities are implied by the four-fold variation in management practices, soil conditions, water availability, or market incentives among different schemes.

At Murara, yields of 30 tonnes per hectare significantly exceed national averages and are almost comparable to commercial standards, demonstrating the potential of smallholder irrigation when conditions are fully optimal. New studies in East Africa have found that implementing advanced banana cultivation methods resulted in a 64% boost in output, elevating annual yields from 10 metric tons per hectare to 19 metric tons per hectare (CABI, 2022). Low yields at certain schemes, such as 7 tonnes per hectare at Buwu, suggest missed opportunities and imply a need for targeted technical support to address productivity constraints. The observed variability aligns with other African studies, which have demonstrated that technical support and knowledge sharing can substantially increase smallholder banana yields (Murigi et al., 2024).

Bean production exhibited comparable variability, spanning 1-3 tonnes per hectare amongst different schemes. Yields of 3 t/ha at Rujeko and Buwu demonstrate commendable performance in smallholder systems, whereas yields as low as 1 t/ha suggest production challenges that could be addressed through improved agronomic practices or better input availability.

Consistency in coffee production was maintained at 1 tonne per hectare across all production areas, namely Murara, Chiteme, and Buwu, suggesting either optimal management for the local conditions or production constraints limiting yield potential. Given the significant value of coffee as a major export crop, this consistent yet relatively moderate yield level merits examination of ways to improve productivity.

The high-value crop performance, especially tomatoes reaching 20 tonnes per hectare at Mutarazi, illustrates the possibility of intensive horticulture under irrigation. The limited geographic distribution of these crops, found only in Mutarazi, suggests potential barriers to adoption that could include technical skills, access to markets, or restrictions on input availability.

Findings from sub-Saharan Africa confirm that the results of this study align with wider patterns, with irrigated land in the area producing 2.3 times more per hectare than rain-fed agriculture (Mupaso et al., 2023)

The predominance of sprinkler irrigation systems (90% of farmers) represents a pragmatic technology choice reflecting multiple considerations including capital requirements, technical complexity, water efficiency, and crop suitability. Sprinkler systems can be advantageous to smallholder farmers due to their lower initial investment costs compared to drip systems, their adaptability to a variety of crops, and the relatively uncomplicated maintenance they require.

Among farmers, the benefits of water efficiency from drip irrigation are largely negated by its limited use, with only 10% adopting the practice, primarily due to factors like higher capital costs, technical complexity, and its incompatibility with certain crops grown. Studies in sub-Saharan Africa have found that despite the benefits of drip irrigation, there remains a limited extent of effective adoption and use of these technologies in smallholder settings (Serote et al., 2023; Zondo et al., 2024). The prevalence of drip irrigation among a limited group of farmers may suggest that these individuals have successfully overcome obstacles or cultivate crops that warrant the expenditure.

Research out of Zimbabwe indicates that farmers ought to transition away from their existing flood irrigation system and instead adopt more environmentally sustainable methods, such as sprinkler or drip irrigation systems, as a previous study by Dube & Sigauke (2015) also suggests. The practical limitations of this study expose a discrepancy between the technical recommendations and the actual rates at which farmers implement them.

This technology adoption pattern aligns with global trends indicating that sprinkler irrigation usually serves as an optimal intermediate technology for smallholder farmers transitioning from rainfed to irrigated agriculture. The technology selections have significant implications for water use efficiency and the long-term viability of the scheme. Sprinkler systems, though less water-efficient than drip irrigation, have facilitated wider adoption in irrigation agriculture, allowing more farmers to participate and potentially achieve greater overall development outcomes despite their lower technical efficiency.

Coffee production at three schemes (Murara, Chiteme, Buwu) reflects the valley's comparative advantage for this export crop. However, the consistent

### **Crop diversification**

The crop diversity demonstrated across these schemes shows that they employ advanced production methods that balance food security, income generation, and risk management goals. Farming both food crops (beans, green maize) and commercial crops (bananas, coffee, tomatoes, ginger) reveals the strategic choices farmers make regarding household needs and potential market opportunities.

Banana production's widespread presence across all schemes underscores its significance as both a food security and income generation crop. Bananas provide benefits such as continuous year-round production capabilities, relatively stable market demand, and cultural recognition. Consistent cultivation across different schemes implies successful knowledge transfer and market development for this crop.

The geographic focus on high-value crops sparks concerns about obstacles to adoption and limitations in expanding their production. The wider adoption of tomato production is confined to the Mutarazi scheme, whereas ginger production is mainly practised in the Chiteme scheme, suggesting the need for specific conditions, knowledge, or market access. Understanding these constraints could inform strategies for scaling high-value crop production. 1 t/ha yields suggest potential for productivity enhancement through improved varieties, processing techniques, or agronomic practices.

### **Educational Attainment and Human Capital Impacts**

#### **Education as an Enabler of Irrigation Success**

It is worth noting that irrigation participants' educational background is quite impressive, with 80% having finished secondary school and 15% holding a tertiary qualification, resulting in a significant finding with profound implications for irrigation program development and assessment. The educational profile in this study far surpasses typical rural averages in Zimbabwe, possibly contributing to the positive findings. Secondary education gives farmers the literacy, numeracy, and analytical skills needed for successful irrigation agriculture. These competencies empower farmers to comprehend technical guidelines, keep track of production records, calculate input expenditures and profits, and interact efficiently with extension services and market participants. A high level of secondary education may be responsible for the substantial business skills acquired by 50% of farmers, as observed in this study. This finding is inconsistent with other research from sub-Saharan Africa, which found that education and extension training have no significant impact on farming technical efficiency (Nguyen-Anh et al., 2022). The discrepancy between education and agricultural productivity implies that the connection between education and agricultural productivity may vary and depend on the type of agricultural system, with irrigation agriculture possibly needing more human capital than rainfed systems.

The 15% of farmers with tertiary education represents an unusually high human capital endowment for rural areas. These farmers may serve as innovation adopters and knowledge brokers within schemes, facilitating technology transfer and best practice dissemination. The presence of these elements may contribute to improvements in overall performance observed across various schemes. The World Bank acknowledges that a

low level of human capital in Africa's agricultural sector is a major obstacle to growth, poverty reduction, and food security (Yu & Osabohien, 2023), thereby making the high educational attainment in this study especially notable.

### **Education-irrigation synergies and development outcomes**

The combination of high educational attainment and irrigation participation creates synergistic effects that amplify development outcomes. Educated farmers are better positioned to adopt new technologies, access market information, develop business relationships, and adapt to changing conditions. This may partially explain the substantial asset accumulation and income generation observed in this study. The strategic allocation of 30% of irrigation income to education expenses demonstrates how irrigation creates positive feedback loops for human capital development. Irrigation income enables families to invest in children's education, potentially creating intergenerational mobility and community development effects that extend beyond immediate participants. This finding has important implications for irrigation program targeting and design. Programs may achieve greater impact by prioritizing areas with higher educational attainment or by combining irrigation development with adult education components to maximize synergistic effects. The available evidence implies that initially, the technology should facilitate higher consumption, asset building, and a decrease in persistent poverty among users, while in the long term, it should result in institutional feedbacks that promote continued economic growth (Burney et al., 2013).

### **Irrigation as a livelihood transformation strategy**

#### **Income generation and household economic security**

This study provides compelling evidence that smallholder irrigation schemes function as effective livelihood transformation mechanisms in Zimbabwe's Honde Valley. The finding that irrigation-based crop production contributes 36% of household income represents a significant livelihood transformation. Participating farmers rely heavily on irrigation as their main source of income, accounting for more than other sources such as livestock production (27%), formal employment (9%), and remittances (9%). This substantial contribution positions irrigation as the primary livelihood strategy rather than a supplementary activity, marking a fundamental shift from subsistence to market-oriented agriculture. Recent comparative studies by Nakawuka et al. (2018) in East Africa report irrigation income contributions ranging from 15-25% of household income, while Mupaso et al. (2024b) found 28% contributions in Zimbabwe's Mberengwa district. The higher contribution observed in Honde Valley may reflect favorable agro-ecological conditions, crop selection strategies emphasizing high-value crops like bananas and coffee, and relatively better market access compared to more remote irrigation schemes.

The strategic allocation of irrigation income - 40% for food purchases, 30% for education, 15% for agricultural inputs—demonstrates sophisticated household financial management that extends benefits beyond immediate consumption. The substantial investment in education (30%) represents human capital development with long-term implications for household welfare trajectories and community development. This allocation pattern suggests that irrigation income provides sufficient surplus to enable strategic investments rather than merely meeting subsistence needs.

#### **Food security improvements and household resilience**

Among participating farmers, a significant achievement has been the improvement in household food security, which stands at 51%, particularly noteworthy in the context of Zimbabwe's food security crisis, affecting 7.1 million people (Tawodzera, 2016). This outcome demonstrates irrigation's potential for building household resilience against climate change. Food security advancements should be viewed in light of Zimbabwe's difficult farming conditions, with 80% of agricultural land located in arid or semi-arid areas that receive inconsistent rainfall (Mpala, 2021). The irrigation schemes' capacity to enhance food security for more than half of the participants, despite these challenging circumstances, supports irrigation's role as a climate adaptation strategy. Recent research by Tadesse et al. (2025) emphasizes that irrigation functions as a risk management strategy, reducing household vulnerability to climate change. The study's findings on food security improvements match this conceptual framework, demonstrating how irrigation systems allow households to maintain access to food despite facing broader environmental and economic challenges. However, the finding that 12% of farmers

reported worsened food security warrants careful analysis. This may reflect households that reallocated land from subsistence crops to cash crops without achieving sufficient income to purchase adequate food, or farmers who experienced production challenges. This finding highlights the importance of supporting farmers in balancing cash crop production with food crop cultivation to ensure food security is maintained while pursuing income generation.

### **Asset accumulation and wealth building**

The substantial asset accumulation seen in this research demonstrates irrigation's role in helping households move up the "asset ladder" from poverty towards more stable living situations. The progression from basic communication tools (100% acquired cell phones) to substantial investments like housing construction (50% of farmers) demonstrates systematic wealth building over time. The asset portfolio acquired by farmers—housing (50%), wheelbarrows (20%), livestock (15%), and agricultural equipment (6%)—reflects both productive and consumptive investments. Housing construction represents the most significant investment, indicating that irrigation income provides sufficient surplus for major capital investments. Livestock acquisition by 15% of farmers demonstrates livelihood diversification into complementary agricultural activities that can provide additional income streams and risk management benefits. This progression from basic to substantial investments shows how irrigation income enables households to move beyond subsistence toward diversified livelihood portfolios, supporting Harmon (2023)'s emphasis on irrigation enabling livelihood diversification strategies for coping with climate variability.

Notably, the universal acquisition of cell phones represents more than simple asset accumulation. Cell phone ownership allows farmers to access market information, coordinate with buyers, and join mobile banking services, thereby increasing their involvement in larger economic systems. This finding aligns with contemporary research emphasizing technology's role in rural livelihood transformation (Awazi, 2025).

### **Skills development and livelihood diversification**

#### **Business Skills and Agricultural Commercialization**

The development of farming as a business skill among 50% of participants represents a fundamental transformation from subsistence to commercial agriculture. This skill acquisition addresses one of the fundamental constraints facing smallholder farmers in Sub-Saharan Africa: the transition from subsistence-oriented to market-oriented production systems. The acquisition of business skills encompasses understanding market dynamics, financial planning, quality control and customer relationships—competencies essential for sustainable agricultural commercialization. Recent research by Idahe & Solomon (2024) emphasizes that successful irrigation requires farmers to develop commercial orientation alongside technical skills. The high prevalence of business skill development in Honde Valley suggests that irrigation participation creates learning environments conducive to skill acquisition. Business skills development may stem from various mechanisms, including exposure to market needs via cash crop production, engagement with buyers and extension agents, involvement in farmers' groups, and learning from experienced peers. These skills have applications beyond irrigation agriculture and can support livelihood diversification into other commercial activities.

#### **Technical Skill Acquisition and Capacity Building**

The development of technical skills in areas such as plumbing (30%), construction (10%), and health-related skills (10%) shows that participating in irrigation can lead to skill diversification with various applications. Plumbing skills are particularly relevant given irrigation infrastructure maintenance requirements and have market value for providing services to other farmers and community members. Farmers' participation in irrigation infrastructure development and upkeep may lead to the improvement of their construction skills, and also to the construction of housing. Research currently considers these skills to offer opportunities for generating off-farm income, thereby contributing to diversified livelihood strategies (Awazi, 2025; Idahe & Solomon, 2024). The acquisition of health-related skills, while impacting fewer farmers, may indicate participation in nutrition education programs or community health initiatives associated with enhanced food security. This finding suggests that irrigation schemes can serve as platforms for broader human development interventions.

---

## **Diversified income strategies**

Crop production (accounting for 36%) and livestock production (27%) are the primary sources of income, augmented by formal employment (9%), manual labor (14%), and casual work (5%), which collectively signify successful livelihood diversification. This diversification pattern aligns with the sustainable livelihoods framework's emphasis on multiple capital asset deployment for achieving livelihood objectives (Scoones, 1998).

## **Constraints Analysis and Sustainability Challenges**

### **Financial System Constraints**

The identification of limited capital access as the primary constraint (30% of farmers) reveals a critical bottleneck that threatens scheme sustainability and limits potential impacts. The finding is consistent with a large body of research showing finance as a persistent obstacle for smallholder farming in Sub-Saharan Africa (Muhoyi & Mbonigaba, 2022; Mwadzingeni et al., 2022; Nakawuka et al., 2018). The capital constraint manifests in farmers' inability to purchase optimal input levels, invest in equipment upgrades, or expand cultivated areas. Irrigation infrastructure investments currently cannot be fully leveraged to attain potential productivity improvements by farmers. The constraint is particularly problematic for high-value crops that require substantial input investments but offer significant returns. The persistence of capital constraints despite demonstrated income generation suggests that existing financial systems inadequately serve smallholder irrigators. Traditional banking systems often consider smallholder farmers high-risk clients due to limited collateral, irregular income flows, and high transaction costs. Addressing this constraint requires targeted financial product development and innovative service delivery mechanisms.

### **Market Access and Value Chain Constraints**

Poor market access affecting 25% of farmers represents a fundamental constraint on irrigation scheme sustainability and profitability. The challenge of perishable crops such as tomatoes and vegetables is particularly sharp, especially those that provide higher returns but need reliable access to the market and swift transportation from farm to market. Market access constraints encompass multiple dimensions: physical access (transportation infrastructure), market information (price discovery and buyer identification), quality standards (meeting buyer requirements), and market power (negotiating fair prices). The 25% prevalence suggests that while some farmers have successfully developed market relationships, others struggle with these challenges. The market access constraint is particularly problematic given the crop diversification observed in the study. The consistency of market access constraints across different contexts Awazi (2025) suggests need for coordinated approaches to value chain development. Farmers growing high-value crops like tomatoes, ginger, and coffee require specialized market channels that may be less developed than those for traditional crops. This finding suggests that irrigation development must be accompanied by value chain development to achieve full potential benefits.

### **Water resource management challenges**

The occurrence of seasonal water scarcity affecting 25% of farmers, despite Honde Valley's relatively favorable water endowment, highlights critical water management challenges. This finding is particularly concerning given climate change projections indicating increased variability in precipitation patterns (Kori et al., 2024; Mwadzingeni et al., 2022). The seasonal scarcity during August-October corresponds to the dry season period when irrigation demand is highest but water availability is lowest. The need for rotational irrigation schedules indicates that current water infrastructure and management systems are insufficient to meet peak demand periods. This constraint threatens scheme sustainability and limits expansion potential. Climate change projections suggest that water scarcity challenges will intensify, making comprehensive water resource management increasingly critical for scheme viability. The finding emphasizes the need for irrigation development to incorporate climate resilience considerations from the outset.

### **Gender dynamics and social inclusion**

#### **Women's participation and empowerment**

The predominance of women participants (65%) represents a significant finding with important implications for gender-inclusive development and challenges common assumptions about agricultural participation patterns. This contrasts sharply with research by Mhembwe et al. (2019) showing male dominance (78%) in other Zimbabwean contexts, suggesting that specific conditions in Honde Valley facilitate women's irrigation participation. The high female participation may reflect several factors: cultural norms that encourage women's involvement in horticulture and food production, irrigation infrastructure that reduces labor requirements compared to rainfed agriculture, income opportunities that align with women's livelihood priorities, and supportive community attitudes toward women's agricultural participation. The high female participation validates research by Ndlovu (2025) highlighting how climate-smart agriculture initiatives, including irrigation, can empower women farmers and bridge gender divides. The substantial asset accumulation and skills development outcomes among predominantly female participants demonstrate irrigation's potential for promoting gender-equitable development outcomes. The gender composition has important implications for scheme outcomes. Studies have shown that women usually give top priority to household food security and the well-being of children when deciding how to spend their income, indicating that programmes with a female majority may yield greater improvements in food security and human development. The observed allocation of 40% of irrigation income to food purchases and 30% to education supports this hypothesis.

### **Age Distribution and intergenerational participation**

The age distribution showing 70% of participants aged 20-45 years indicates strong participation by economically active adults, while 10% participation by farmers below 20 years suggests some youth engagement. This pattern has important implications for scheme sustainability and knowledge transfer. The strong participation by prime-age adults (20-45 years) provides a solid foundation for scheme management and development. However, the limited youth participation (10%) may indicate challenges in attracting young people to irrigation agriculture or barriers to their participation such as land access constraints or preference for non-agricultural livelihoods. The age distribution implies the necessity for targeted strategies to enhance youth involvement in irrigation agriculture, considering the significance of knowledge transfer between generations and the potential for young people to adopt innovative technologies and market strategies.

### **Policy and development implications**

The findings from this study have several important implications for irrigation development policy and practice in Zimbabwe and similar contexts. The high variability in crop productivity suggests that blanket approaches to irrigation development may be insufficient. Targeted technical support and capacity building programs that address site-specific constraints could help realize the full potential of irrigation investments. The predominance of sprinkler irrigation systems, while pragmatic, may represent missed opportunities for water efficiency gains. Policy interventions that reduce the barriers to drip irrigation adoption—such as subsidies, technical training, or group purchasing schemes—could enhance the sustainability of irrigation systems while maintaining farmer participation. It appears that a close connection between educational achievement and irrigation success implies that investing in human capital should be viewed as a supplementary component to constructing physical irrigation systems. Programs that integrate irrigation development with adult education or farmer training elements may attain more significant and long-lasting effects. The demonstration of significant income generation, food security improvement, asset accumulation, and skill development validates irrigation's potential as a poverty reduction and rural development strategy. However, the identification of persistent constraints—capital access, market development, and water management—indicates that irrigation infrastructure alone is insufficient. Successful irrigation development requires integrated approaches combining infrastructure with financial services, market development, and institutional capacity building.

## **RECOMMENDATIONS**

Based on the study findings addressing productivity, livelihoods, and sustainability challenges, key recommendations include:

- Implement targeted technical assistance to address yield variability, especially in programmes that have below-average productivity levels, such as in the case of Buwu banana yields of 7 t/ha, which are significantly lower than Murara's 30 t/ha.

- **Financial System Development:** Establish rural credit facilities specifically targeting smallholder irrigators to address the capital constraints affecting 30% of farmers. Recent research emphasizes that access to finance is critical for irrigation success (Idahe & Solomon, 2024; Nakawuka et al., 2018).
- **Market Infrastructure Investment:** Invest in rural infrastructure and develop a value chain to address market access constraints affecting 25% of farmers. Contemporary studies highlight market access as requiring coordinated intervention (Awazi, 2025).
- **Implementing comprehensive water resource management** is crucial to address seasonal water scarcity, which affects 25% of farmers, a matter of great importance in the context of climate change impacts (Mwadzingeni et al., 2022)
- **Technology Support Systems:** Strengthen extension services and provide targeted subsidies for appropriate irrigation technology adoption, building on the technical skills development already observed.
- **Strengthening irrigation management committees and developing farmer organisations for collective marketing** should build on the business skills development that this study has documented.

This cross-sectional design limits causal inferences about irrigation impacts. Future research should employ longitudinal designs to strengthen impact assessment, following recommendations by recent studies (Mupaso et al., 2024b, 2024a). Priority areas for future research include longitudinal impact assessment, economic analysis of different irrigation technologies, gender-differentiated analysis, climate change adaptation investigation, and examination of institutional sustainability factors. These research priorities will contribute to the evidence required for more effective irrigation development policies across Sub-Saharan Africa.

## CONCLUSION

This study provides comprehensive evidence that smallholder irrigation schemes in Zimbabwe's Honde Valley function as an effective livelihood transformation mechanisms while revealing critical constraints that threaten sustainability. The productivity assessment demonstrates significant potential alongside concerning variability, with banana yields ranging from 7-30 tonnes per hectare and crop diversification strategies balancing food security with income generation objectives. The predominance of sprinkler irrigation systems (90%) reflects pragmatic technology choices that balance efficiency with affordability and management capacity. The substantial livelihood impacts—including 36% household income contribution from irrigation, improved food security for 51% of farmers, and significant asset accumulation—validate irrigation's potential as a poverty reduction strategy. The high educational attainment among participants (80% secondary education) emerges as a critical success factor, facilitating technology adoption, business skill development, and market engagement. Skills development outcomes, particularly farming as business skills (50%) and technical skills (30% plumbing), demonstrate irrigation's role in human capital development beyond agricultural production. However, persistent constraints threaten scheme sustainability and limit impact potential. Limited capital access (30%), poor market access (25%), and seasonal water scarcity (25%) represent systemic challenges requiring coordinated intervention. The productivity variability across schemes suggests unrealized potential that could be addressed through targeted technical support and resource optimization. The high female participation (65%) validates irrigation's potential for gender-inclusive development, while the strategic income allocation—40% for food, 30% for education—demonstrates sophisticated household financial management that extends benefits beyond immediate consumption. These findings support the increasing body of evidence that smallholder irrigation can achieve several development objectives at once when implemented using comprehensive approaches that cover production, finance, markets, and institutional capacity.

## ACKNOWLEDGEMENT

We acknowledge Irrigation farmers and Agritex extension officers in Honde Valley, Mutare district for the support and implementation of the research.

## REFERENCES

1. Awazi, N. P. (2025). Livelihood Resilience in Agriculture-Dependent Communities in the Global South in the Face of Climate Change. In *Building Resilience: Climate Change and Livelihoods in the Global South* (pp. 117–145). Springer.
2. Burney, J. A., Naylor, R. L., & Postel, S. L. (2013). The case for distributed irrigation as a development priority in sub-Saharan Africa. *Proceedings of the National Academy of Sciences*, 110(31), 12513–12517.
3. Dube, K., & Sigauke, E. (2015). Irrigation Technology for smallholder farmers: A strategy for achieving household food security in Lower Gweru Zimbabwe. *South African Journal of Agricultural Extension*, 43(1), 1–11.
4. Harmon, G., Jepson, W., & Lefore, N. (2023). Farmer-led irrigation development in sub-Saharan Africa. *Wiley Interdisciplinary Reviews: Water*, 10(2), e1631.
5. Idahe, D., & Solomon, Z. (2024). Smallholder farmers' participation in small-scale irrigation system: Insight from Lume district, Ethiopia. *Heliyon*, 10(20).
6. Kapari, M., Hlophe-Ginindza, S., Nhamo, L., & Mpandeli, S. (2023). Contribution of smallholder farmers to food security and opportunities for resilient farming systems. *Frontiers in Sustainable Food Systems*, 7, 1149854.
7. Khatri, P., Kumar, P., Shakya, K. S., Kirlas, M. C., & Tiwari, K. K. (2024). Understanding the intertwined nature of rising multiple risks in modern agriculture and food system. *Environment, Development and Sustainability*, 26(9), 24107–24150.
8. Kori, D. S., Kelso, C., & Musakwa, W. (2024). Climate change adaptation by smallholder farmers in Southern Africa: A bibliometric analysis and systematic review. *Environmental Research Communications*, 6(3), 032002.
9. Lankamo, A. A., Ramalingam, D., Bati, B. E., & Dira, S. J. (2025). Towards Sustainable Future: Adoption Dynamics of Climate-Smart Agriculture by Smallholder Farmers in the Sidaama Region, Ethiopia. *SAGE Open*, 15(2), 21582440251343674.
10. Magrath, J., Tshabangu, L., & Mativenga, S. (2014). Irrigation Schemes and Weather Extremes: The challenge for Zimbabwe.
11. Maru, H., Hailelassie, A., & Zeleke, T. (2023). Impacts of small-scale irrigation on farmers' livelihood: Evidence from the drought prone areas of upper Awash sub-basin, Ethiopia. *Heliyon*, 9(5).
12. Mhembwe, S., Chiunya, N., & Dube, E. (2019). The contribution of small-scale rural irrigation schemes towards food security of smallholder farmers in Zimbabwe. *Jàmá: Journal of Disaster Risk Studies*, 11(1), 1–11.
13. Mpala, T. A. (2021). Perspectives on Adaptation to Water Scarcity and Drought of Small-Scale Farmers in Masvingo, Zimbabwe.
14. Muhoyi, E., & Mbonigaba, J. (2022). Stakeholder consultations on small-scale irrigation schemes' constraints in Zimbabwe. *Environment, Development and Sustainability*, 24(11), 13198–13217.
15. Mume, I. D., Mohammed, J. H., & Ogeto, M. A. (2023). Impact of small-scale irrigation on the livelihood and resilience of smallholder farmers against climate change stresses: Evidence from Kersa district, eastern Oromia, Ethiopia. *Heliyon*, 9(8).
16. Mupaso, N., Makombe, G., & Mugandani, R. (2023). Smallholder irrigation and poverty reduction in developing countries: A review. *Heliyon*, 9(2).
17. Mupaso, N., Makombe, G., Mugandani, R., & Mafongoya, P. L. (2024a). Assessing the contribution of smallholder irrigation to household food security in Zimbabwe. *Agriculture*, 14(4), 617.
18. Mupaso, N., Makombe, G., Mugandani, R., & Mafongoya, P. L. (2024b). Socioeconomic determinants of poverty reduction among irrigating farmers in Mberengwa District, Zimbabwe. *Sustainability*, 16(9), 3580.
19. Murigi, M., Ngui, D., & Ogada, M. J. (2024). Impact of smallholder banana contract farming on farm productivity and income in Kenya. *Cogent Economics & Finance*, 12(1), 2364353.
20. Mwadzingeni, L., Mugandani, R., & Mafongoya, P. (2022). Risks of climate change on future water supply in smallholder irrigation schemes in Zimbabwe. *Water*, 14(11), 1682.
21. Nakawuka, P., Langan, S., Schmitter, P., & Barron, J. (2018). A review of trends, constraints and opportunities of smallholder irrigation in East Africa. *Global Food Security*, 17, 196–212.

22. Ndlovu, E. (2025). Government Safety Nets as Catalysts for Climate Adaptation and Women's Empowerment in Agriculture: Insights from Mbire District, Zimbabwe.
23. Nguyen-Anh, T., Hoang-Duc, C., Tiet, T., Nguyen-Van, P., & To-The, N. (2022). Composite effects of human, natural and social capitals on sustainable food-crop farming in Sub-Saharan Africa. *Food Policy*, 113, 102284.
24. Parry, K. (2025). Youth living around irrigation schemes in Zimbabwe: Their livelihoods and role in the local economy. *International Journal of Water Resources Development*, 41(2), 402–427.
25. Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis.
26. Serote, B., Mokgehle, S., Senyolo, G., du Plooy, C., Hlophe-Ginindza, S., Mpandeli, S., Nhamo, L., & Araya, H. (2023). Exploring the barriers to the adoption of climate-smart irrigation technologies for sustainable crop productivity by smallholder farmers: Evidence from South Africa. *Agriculture*, 13(2), 246.
27. Sukulao, T., Kurevakwesu, W., Tshugulu, A. N., Matanga, A. A., & Muridzo, N. G. (2025). Perceived causes and consequences of food insecurity in rural Zimbabwe: Using a decolonised methodology. *Journal of Social Development in Africa*, 40(1), 27–61.
28. Tadesse, S., Mekuriaw, A., & Assen, M. (2025). Farmers' perception and choices of adaptation strategies to climate change in the upper Gelana watershed, northeastern highlands of Ethiopia. *Theoretical and Applied Climatology*, 156(7), 386.
29. Tawodzera, G. (2016). Food insecurity in a state in crisis. In *Rapid Urbanisation, Urban Food Deserts and Food Security in Africa* (pp. 85–95). Springer.
30. Water, U. (2018). Sustainable Development Goal 6 synthesis report on water and sanitation. Published by the United Nations New York, New York, 10017.
31. Zondo, W. N. S., Ndoro, J. T., & Mlambo, V. (2024). The Adoption and Impact of Climate-Smart Water Management Technologies in Smallholder Farming Systems of Sub-Saharan Africa: A Systematic Literature Review. *Water*, 16(19), 2787.