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*Volume 1 Issue 1* ***2024***

**Rupike Irrigation Scheme: Assessment of opportunities and successes irrigation in Zimbabwe**

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# Abstract

Smallholder irrigation schemes potentially improve the livelihoods of rural communities in developing countries. Rupike Irrigation Scheme has a total of 100 ha with 200 farmers. The crops mainly produced were maize, wheat, sugar beans and vegetables. They were also actively engaged in value addition of produce so as to reach a wider market audience. It was led by an irrigation addition of produce so as to reach a wider market audience. The success of the scheme was attributed to an effective management and functional constitution as well as receiving technical support from relevant stakeholders. Major challenges encountered were a poor road network and unreliable electricity supply. Good scheme management is important for improved livelihoods. The attributes of a good scheme management include a vibrant IMC, functional constitution and technical backstopping from relevant departments. Produce is primarily for home consumption while the surplus is sold to surrounding communities. The farmers were also actively engaged in value addition of produce so as to reach a wider market. The scheme members could take advantage of the dam to venture into other money-making activities such as agri- tourism and fishing. This could widen the revenue base and hedge them against price fluctuations of agriculture produce. The scheme management should continuously engage relevant departments and the local authorities for road maintenance. This would enable them to reach a wider audience in terms of produce marketing and visibility. Investing in other alternative power systems such as wind and solar are key to ensure that cropping cycles are not disrupted resulting in poor produce.

**Key words:** *Farmers,**Irrigation scheme, opportunities, Rupike, success*

# Introduction

Smallholder irrigation schemes are viewed as critical common property resources that significantly play a pivotal role in improving crop water supply and the livelihoods of rural communities in developing countries (Moyo et al. 2017; Mhembwe et al. 2019). In addition, these schemes reduce farmers’ dependency on unreliable precipitation patterns experienced in most African countries due to global warming (Muzerengi and Mapuranga, 2017; Mhembwe et al. 2019). This is true in particular for Zimbabwe where ~80% of agricultural land lies in arid and semi-arid regions of the country (Moyo et al. 2017). Given that rainfall patterns in these regions are unpredictable, irrigation farming is necessary in mitigating droughts and mid-season dry spells thereby facilitating crop production throughout the year and improvement in yields.

Governments and donors across Africa are investing in massive expansion of irrigated agriculture, assuming this will reduce poverty for smallholder farmers and increase food security (Pittock, et al. 2020). Irrigated agriculture may overcome many limitations to food security in Africa by enabling more reliable crop production under climate change and variability. For example, Zimbabwe government invested in massive irrigation schemes and dam construction and rehabilitation since independence (Dube, 2016). The key objective of irrigation development investment was to reduce community dependency on government support, improve household food and nutrition security as well as fostering rural development and alleviating poverty. This initiative has enhanced formation of farmer groups, facilitated collective farming and marketing thereby generating household income, improving food security and community development (Dube, 2016). Zimbabwe has three main types of small-scale irrigation schemes, namely, government, farmers, and communities managed schemes (FAO, 1996; Mhembwe et al., 2019). Over the years, most small-scale irrigation schemes in Zimbabwe experienced many challenges, with more failures being reported relative to successes (Jacobs et al. 2013; Moyo et al. 2017). Previous studies have shown that the under-performance of most small-scale irrigation schemes is elicited by correlated factors such as limited technical capacity, poor institutional arrangements and uncoordinated marketing (Mujere et al. 2013; Jacobs et al. 2013; Moyo et al. 2017). For example, in Zimbabwe, productivity in most small-scale irrigation schemes has been hampered by limited inputs, inaccessible and unreliable markets, inadequate water supply, weak water governance systems, dilapidated infrastructure and lack of capacity to maintain the equipment (Mujere et al. 2013; Jacobs et al. 2013; Moyo et al. 2017; Mhembwe et al. 2019).

The capacity for irrigation to increase crop production depends on a variety of factors such as the water reservoir (i.e. aquifers, underground water and safe water), the specific water availability (i.e. single season, intermittent or full season), the type of irrigation system (i.e. drip, sprinkler or furrow), size of the system (large scale and small scale) access to farm inputs (i.e. land, credit, seeds, fertiliser and labour), the socio-economic characteristics of the household and the administrative laws regulating access to and management of the irrigation systems (Domènech 2015; Oluwasegun et al. 2020; Chidavaenzi et al. 2021). There are five types of irrigation systems in Zimbabwe, namely, sprinkler, centre pivot, furrow, terraced and drip irrigation. The drip irrigation system is favoured in dry regions because of its effective water use capability and the potential to function on any gradient (Adamala 2016; FAO 2016; Lozano et al. 2020). However, the device has large maintenance costs and can operate poorly if users do not have prerequisite experience to perform maintenance procedures that may include filter cleaning (Adamala 2016; Ruban et al. 2020; Chidavaenzi et al. 2021).

While most small-scale irrigation schemes in Zimbabwe reportedly face challenges which hamper crop production, there are some irrigation schemes that have shown positive progress. Among the progressing irrigation schemes, Rupike Irrigation Scheme won the best overall managed scheme and best female managed scheme awards in Masvingo province, Zimbabwe in 2022. In addition, the scheme also won the best irrigation scheme awards in Zimbabwe in the year 2022 again. This is one of the few productive schemes in the country as it reportedly sustains not only Rupike farmers but also serving surrounding communities. In line with this background, this study is therefore premised on understanding factors contributing to the success of the irrigation scheme. The information generated from this study will help other irrigation schemes in the country to adopt the good practices from the scheme thereby enhancing crop production and sustainable irrigation schemes.

# Materials and Methods

**Description of Study Site**

Rupike Irrigation Scheme is located in Masvingo District, Masvingo Province, Zimbabwe in Natural Region IV. Regions IV and V experience low-rainfall patterns ranging from 450 mm – 800 mm to < 450 mm (Chidavaenzi et al. 2021). The scheme was established in 1990 with the assistance of Renco Mine. Renco Mine assisted with dam construction, installing pumps, siting and establishing of irrigation fields. Rupike Irrigation Scheme started in 1990 with 20 hectares only. The irrigated area increased to 100 ha by 1991. At the time of the study, in 2022, there were 200 farmers (124 females and 76 males), meaning that on average each farmer had a plot of 0.5 ha.

 **Data Collection**

The study adopted the qualitative research design approach. To collect data key informant interviews, focus group discussions and observations were used. Data collected were on the reasons behind the schemes’ national success, management, infrastructure operations and maintenance, scheme production and marketing of produce, and challenges faced by the irrigation scheme. Thematic data analysis was done as well as using excel to produce tables and graphs.

***Key Informant Interviews***

Key informants were drawn from Agricultural Advisory and Rural Development Services (AARDS) formerly the Department of Agricultural, Technical and Extension Services (AGRITEX), Agricultural and Rural Development Authority (ARDA), Irrigation Management Committee (IMC) and farmers. These stated departments were identified as the key stakeholders in irrigation farming in Rupike and had a close interaction with farmers and their activities.

***Focus Group Discussions***

Focus Group Discussion (FGDs) were one of the techniques used to collect data. Two FGDs were conducted with a total of 21 participants (15 females and 6 males). The use of FGDs allowed for the encouragement of an intimate group in an accepting environment that enables respondents to share their thoughts, insights and opinions without the fear of judgment. The FGDs give room to discover the perceptions and experiences of different individuals in a particular study. Moreover, it provides the opportunity for the researcher to receive multiple opinions and a group consensus on key issues in a shorter time frame (Satterfield, 2000).

**Data Analysis**

The qualitative approach draws on a triangulation of open ended responses

from the structured questions discussed during data collection on purposively selected participants that include farmers, government departments, experts and external stakeholders to the irrigation scheme.

Thematic analysis was done based on information collected from the semi-structured questionnaires open-ended responses and FGD in order to draw emerging themes on the challenges facing the implementation as well as operations of the drip irrigation scheme. Moreover, possible solutions were concluded on how the scheme could be utilised effectively in increasing food production (Chidavaenzi et al. 2021).

# Results and Discussion

## Scheme management (IMC, farmers, hectarage)

Rupike Irrigation Scheme has 5 blocks (A to E) as indicated in Table 1. Each block has a committee overseeing concerns of that block. Farmers convened block meetings every week. The block committee would meet with the main scheme IMC to deliberate on issues affecting farmers in respective blocks. As such the main committee drew its members from the block sub-committees. The IMC had four females and three males. It comprised the chairperson and vice, secretary and vice as well as the treasurer. The term of office for the IMC was one year. The irrigation had a constitution which was functional and was adhered to. Failure to adhere to set rules and regulations attracted a fine of up to US$5.

**Table 1: Rupike Irrigation Scheme blocks**

|  |  |  |
| --- | --- | --- |
| **Section** | **Area (ha)** | **No. of farmers** |
| A | 9 | 18 |
| B | 26.5 | 53 |
| C | 26 | 52 |
| D | 23 | 46 |
| E | 15.5 | 31 |
| **Total** | **100** | **200** |

**Success story of Rupike Irrigation Scheme**

Rupike Irrigation Scheme won the first prize for at the provincial level in the irrigation scheme competitions held annually from the district level, provincial and national level. The success of the irrigation scheme was attributed to the team spirit that prevailed. Hence farmers and extension workers worked as one entity to achieve set goals. The competition was a motivation for the farmers to work hard as it promoted good irrigation management practices for increased economic activities and improved livelihoods. In addition, the competition ensured improved maintenance of irrigation infrastructure, water management, bill payments and filing of activity reports. Lastly, at the time of the study, the IMC in collaboration with AARDS and ARDA were in the process of setting up a website. The aim of the website was to increase scheme visibility and to widen marketing opportunities.

## Scheme infrastructure operations and maintenance

The sprinkler operating system was the irrigation technique used in Rupike Irrigation Scheme. Irrigation water was drawn from Tugwane Dam on the Tugwane River. The dam was constructed by RioZim with a net capacity of 2,055,000 m3 and a 10% yield of 2,060,000 m3 of water. A 400 mm diameter steel transmission pipe conveyed water from the dam over 200 m distance to a pump house (Mwendera et al, 2013). Gravitational force conveyed water from the dam into the pump house. The pump house contained 4 Ecanorm 80-250 pumps connected to 60 hp motors (Mwendera et al, 2013). Water was delivered at 128 l/s into the piped system by three electric motor driven pumps with a fourth set being on standby. At any given time, three pumps operated and all irrigators were able to irrigate at the same time using a cumulative total of 600 sprinklers. The scheme had a pipeline system consisting of 17 km main line steel pipe ranging from 350 mm diameter to 150 mm diameter and 10 km of Polyvinyl Chloride (PVC) pipes that laterally conveyed water to the irrigated plots. Each plot had three turf hydrants that connected to a 36 m long with a 20 mm diameter garden hose pipe that supplied water to a moveable overhead sprinkler mounted on a tripod. Each farmer was allocated a half hectare plot with three sprinklers.

The final irrigation equipment components consisted of on-farm irrigation infrastructure and was owned and managed by the farmers. The on-farm irrigation infrastructure consisted of field turf hydrants, 20 mm diameter hosepipes, and sprinkler heads mounted on tripods. The main function of the infrastructure was for watering crops as advocated for by good water management and agronomic practices. Irrigation water was available all year round except in drought years, the 1992 drought was cited as one cause of irrigation water shortage. It was gathered that Rupike Irrigation Scheme used the drag hose system. The scheme had 600 sprinklers meaning each that each farmer had three sprinklers and three hydrants per plot.

The study gathered through FGDs that irrigation infrastructure maintenance was done seasonally but the major maintenance for pumps would be done after several years, between four to six years. The bills paid in the scheme included water payment, ZWL$7000 per month per year to ZINWA, the amount was equivalent to US$10.00 per individual. Payment for electricity was ZW$318,000/month (US$454.00) with each farmer contributing ZW$2500/month (US$3.50) towards paying bills. The scheme had no arrears at the time of data collection. The farmers further indicated that they paid an irrigation maintenance fee of US$50.00 per person per annum. The scheme employed three workers (secretary, pump operator and a security guard for the pump house). In order to cater for the payment of the workers, each farmer contributed US$1.00. Land tax was paid to Masvingo RDC as US$15 per farmer per year. Masvingo RDC land tax started billing at US$5 but the amount was increased to US$10. The RDC ploughs back the money in different forms, for example, the local authority bought a weighing scale and a laptop for the irrigation scheme.

## Stakeholder support / services

Irrigation farmers require assistance of specialists in proper agronomic, cropping patterns, soil management practices and irrigation management practices. The services were provided by AARDS and Department of Irrigation (DoI), both public agencies as well as other agencies as listed in Table 2. AARDS supported the farmers by providing technical advice in cropping patterns, crop budgets, sourcing of inputs, and recommended agronomic and irrigation practices. The institutions that are currently working and assisting Rupike Irrigation Scheme were identified as:

**Table 2: Institutions’ responsibilities**

|  |  |
| --- | --- |
| **Institution** | **Cited responsibilities** |
| RioZim (Renco Mine) | Played a key role in the scheme establishment see Section 3.2.Supplied the scheme with electrical technicians that would assist with repairs of the pump, infrastructure rehabilitation and maintenance and prizes for field days. |
| Agricultural Advisory and Rural Development Services (AARDS) | Provision of agricultural extension support and overall scheme management. |
| Department of Irrigation | Provided support to the farmers in appropriate irrigation scheduling, monitor soil salinity, waterlogging, checking sprinkler discharge and operating pressure, and advise farmers on proper specifications and standards of various replaceable parts of irrigation equipment. |
|  |  |
| Seed houses (Zim Super Seeds, Seedco, K2, Pannar, Mukushi, SeedCo, Pioneer and Valley Seeds) | Provision of inputs, seed trials research |
| Zimbabwe Republic Police (ZRP) | Reinforcement of national rules and general maintenance of peace |
| Grain Marketing Board (GMB) | Buyer of grain and provision of inputs through contract farming (command agriculture) |
| Zimbabwe Electricity Supply Authority (ZESA)Agricultural Marketing Authority (AMA) | Power supply for pumping waterMarket linkage |
| Zimbabwe National Water Authority (ZINWA) | Water supply |
| Meteorological Department | Provision of weather data. There was a weather station at the scheme |
| Department of Research and Support Services (DR&SS) | Research support |
|  |  |
| Agricultural and Rural Development Authority (ARDA) | Market linkages and training of farmers on agribusiness activities |
|  |  |
| Agricultural Finance Corporation (AFC) | Provision of loans |

Duplication can be noted on some of the roles by different institutions, for example AARDS and ARDA. Although the water source, Tugwane Dam, was handed over to the scheme by RioZim, it remained the property of the state and as such the proper usage and management of the dam fell under the jurisdiction of the Zimbabwe National Water Authority (ZINWA), a public entity. The other public entity with interest in its usage was the Environmental Management Agency (EMA) which oversaw all environmental issues related to management and usage of water bodies in the country. Duplication by these different institutions tended to confuse the irrigation scheme beneficiaries and also double taxing the farmers. As such farmers were of the opinion that such government and quasi government entities need to come up with a single revenue collection system and a unified response to their grievances. Farmers highlighted that more often there is a lot of discord in what these public entities relay to the farmers.

Trainings conducted by ARDA focused on topics like budgeting, farming as a business, marketing and record keeping. AARDS trainings focused on crop production, specifically, land preparation, crop variety selection, integrated pest management, post-harvest technology. All trainings by the two institutions were conducted through the farmer-field school approach, learning through trial plots. This gave farmers a practical opportunity to learn and give own deductions as they actively participated in the trial plots activities. Such an approach propels scheme production as farmers learn through experience.

The study gathered that there were conflicts experienced in the irrigation scheme. The conflicts arose due to duplication of roles by extension workers from different organisations / departments, farmers encroaching into each other’s plot, misuse of funds and lack of adherence to the cropping calendar. Conflict management was conducted by either block committee, IMC or AARDS. If the matter required local leadership, then it would be referred to the village headman, but such cases were rare as gathered through both FGDs and key informant interviews. The ability to settle disputes at scheme level was another trait that was attributed to the scheme success and could be replicated to other schemes.

## Scheme production and marketing

**Production**

The main crops planted in the scheme were maize (medium to long season), sugar beans, wheat, groundnuts and horticultural crops (leaf vegetables, tomatoes and onions). Table 3 gives information on crop yields in the scheme. Scheme produce was primarily for home consumption while the surplus was sold to surrounding communities.

**Table 3: Scheme yield for the main crops**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **2017** | **2018** | **2019** | **2020** | **2021** |
|  | Area cropped (ha) | Yield (kg/ha) | Area cropped (ha) | Yield (kg/ha) | Area cropped (ha) | Yield (kg/ha) | Area cropped (ha) | Yield (kg/ha) | Area cropped (ha) | Yield (kg/ha) |
| **Maize** | 83 | 5,500 | 83 | 6,500 | 80 | 6,748 | 83 | 7,500 | 83 | 7,500 |
| **Wheat** | 30 | 3,300 | 25 | 3,000 | 25 | 3,000 | 25 | 2,800 | 25 | 3,000 |
| **S/beans** | 75 | 2,100 | 68 | 2,600 | 75 | 2,600 | 75 | 2,500 | 73 | 2,600 |

Crop productivity was enhanced by adequate application of manure and fertilisers, use of pesticides to control pests and diseases, timely weeding as well as adequate and proper land preparation. Factors affecting production were identified as persistent power cuts (especially at critical stages of plant growth like tasselling and flowering), pests and diseases and breakdown of machines. Transport challenges and lack of adherence to timely procedures like fertiliser application and planting as well as the use of retained seed, lack of capital for fertilisers and pesticides were also mentioned as deterrence to crop productivity.

The scheme was under siltation threat from uncontrolled upstream farming activities as well as the rapid multiplication of a water weed that would in future choke aquatic life in the dam.

**Marketing**

Surplus produce from the irrigation scheme were sold to the surrounding communities, GMB, Masvingo (80km), Ngundu (75), Chiredzi (132km) and Renco Mine (12km). Farmers used to rely on collective marketing but the tractor that was used to carry produce to different markets broke down and forced farmers to market their produce individually although this is not sustainable. Prices of produce were determined by market forces thereby farmers were disadvantaged. Though a marketing committee was available, buyers usually determined the price by offering the range that was favourable to them. Farmers had no control over selling prices since prices were determined by market forces. Prices of the inputs (seeds) were cited as listed:

* Maize seed US$40 / kg,
* Tomato Roma US$10 / 20g,
* Onion 2000 seeds at US$30,
* cabbages US$130 / 500g,
* carrots US$6 / 100g

Some of the crops that were grown under contract farming like maize and wheat; were collectively sold to GMB. Horticultural crops were sold individually by farmers. Transportation of produce to markets was expensive due to poor road infrastructure. There was need for farmers to purchase their own truck to transport produce to the market. Contract farming opportunities in the scheme were identified as growing sugar beans with Zimbabwe Super Seed for propagation and cereals with GMB under the presidential input schemes (*popularly known as command agriculture*).

Challenges faced in line with marketing included delayed payment after farmers delivered their produce, for example GMB and Zimbabwe Super Seeds. Suggested ways of addressing the marketing challenges were gathered as diverse cropping systems to widen the crop produce base, engaging in barter trade, avoiding price distortions, collective marketing, contract marketing and road maintenance to improve on accessibility. It was indicated that ARDA was assisting in market search and linkage.

Marketing of the produce and value addition alleviated poverty in the study area by increasing production and income. Value addition activities done were stated as drying of leaf vegetables**,** producing maize popcorn, processing peanut butter, preparing beans mapatti and beans packaging. Value addition is important as it increases income. The findings are corroborated by Bjornlund, Van Rooyen & Stirzaker (2017); Passarelli et al. (2018); Tefera & Cho (2017) who indicate that crop diversification and increased production improve food security and livelihoods.

# Conclusions

Good scheme management is important for improved livelihoods. The attributes of a good scheme management include a vibrant IMC, functional constitution and technical backstopping from relevant departments. Produce was primarily for home consumption while the surplus was sold to surrounding communities. The farmers were also actively engaged in value addition of produce so as to reach a wider market. The scheme members could take advantage of the dam to venture into other money making activities such as agri- tourism and fishing. This could widen the revenue base and hedge them against price fluctuations of agriculture produce

# Data availability

Data from this research can be accessed through the corresponding author.

# Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

# Funding

The research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

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