ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

PREDISPOSING FACTORS TOWARDS ADOPTION OF IRRIGATION IN ALLEVIATING FOOD INSECURITY IN BUBANZA PROVINCE, BURUNDI

Authors: Jean Pierre Mbonyiyeze[1], Cliff Ooga Obwogi[2] and Stephen Mailu[3]

[1,2&3]National Defence University-Kenya
P. O. Box 24381- 00502, Nairobi, Kenya

Abstract

Food insecurity is a pressing issue across the globe that needs urgent solutions. The rapidly growing population is also an indicator that demand for food will increase in the future, thus effective solutions are critical. Irrigation is one of the solutions able to promote higher production levels in the agricultural sector. This study focused on assessment of the predisposing factors towards adoption of irrigation in alleviating food insecurity in Bubanza Province, Burundi. The Sustainable Livelihoods Framework guided this study because it is a suitable lens for understanding the relationship between irrigation systems and food insecurity. The study followed a descriptive research design. The research employed a mixed methods approach. The targeted population included 3,380 irrigating households along River Kajeke in Mpanda commune, Bubanza Province, community leaders and personnel from the Ministry of Environment, Agriculture, and Livestock, from which the sample size is 97 was achieved. Both simple random sampling and purposive sampling were applied during this research. For the irrigating households and community leaders, the researcher used the simple random sampling. On the other hand, when selecting the personnel from the government ministry of agriculture, purposive sampling was sufficient. Primary data was collected through questionnaire and interviews. Statistical Package and Social Sciences which is a powerful, reliable and user-friendly statistical software that efficiently analysed primary while secondary data was analysed using Nvivo thereby producing accurate results through a wide range of descriptive and inferential statistical techniques. The study found out that climate unpredictability in Bubanza Province was a significant motivator to farmers adopting irrigated agriculture. The study established that rainfall unpredictability and climate variability are the primary predisposing factors influencing farmers to adopt irrigation. The study also realized that several of the policy elements such as provision of adequate infrastructure, extension services, and financing have not been met by the government. However, the study realized that significant benefits are being reaped by the irrigating households in terms of food adequacy within their households, even though surplus for supplying markets remains minimal.

Key words: *Food Insecurity, Bubanza Province, Irrigation Systems, Climate Unpredictability, Irrigated Agriculture, Irrigating Households*

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

INTRODUCTION

Despite the efforts that many countries across the world have taken to alleviate food insecurity, it remains a serious issue. There is shared recognition across the globe that all people, regardless of their gender, or age have a right to live free from hunger. This perspective grew more wide spread following the World Food Conference that took place in 1974 in Rome. It is during this event that nations adopted the declaration on eradicating hunger and malnutrition (UN, 2020). This represented an urgent call for nations to take action against the growing problems of food insecurity. Even today, this issue persists, but with greater intensity. According to the Food and Agriculture Organization (FAO, 2023), approximately 735 million people experienced hunger in 2022, primarily in developing countries. Contrary to popular opinion, the challenges of food insecurity affect both the developed and underdeveloped regions across the globe.

Climate change, coupled with rapid population growth, makes it difficult for nations to meet adequate food demand. The growing population is an important factor of consideration because this population is projected to reach 9.7 billion by 2050 (Hussain et al., 2025). This will alter the patterns of consumption significantly across the world. While this is happening, the weather condition is getting worse as a result of climate change. Floods and droughts are growing more common, hindering households' ability to produce adequate food. According to Pawlak & Kołodziejczak (2020), food insecurity among people across the globe will grow worse in the future if appropriate interventions are not applied. The resolution by nations across the globe to end hunger is evident following the adoption of the UN's Sustainable Development Goals (SDGs).

The second SDG is zero hunger. The surge in food insecurity in recent years demands coordinated efforts by nations across the globe to alleviate it. Nations now have to up to 2030, and within this period, they are expected to maintain the momentum of their initiatives against food insecurity (WHO, 2025). This SDG provides a unique opportunity to strengthen and coordinate global and national efforts by aligning programs, initiatives and measures to achieve lasting food security.
To translate this commitment into tangible outcomes, the global community must confront the challenge of climate change that significantly undermines the efforts of alleviating food insecurity. One of the proven strategies to enhance food production and minimize vulnerability to climatic shocks is the adoption of irrigation. Irrigated agriculture contributes over 40% of the world's food supply on only 20% of cultivated land (World Bank, 2025), demonstrating its efficiency in boosting productivity and ensuring year-round food availability. As such, governments and development organizations have increasingly prioritized irrigation as a key pillar in food security strategies.

The growing concern of food insecurity across the world has resulted in the increased adoption of irrigated agriculture under various programs and partnerships seeking to increase yield within the agricultural sector. Based on data that was drawn from 70,000 households across 26 countries across Middle East, Latin America, Africa, and Asian, the United Nations University (2025) established that expanding irrigated agriculture leads to higher dietary diversity, which is important

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

for micro-nutrient sufficiency. Taking on a global perspective, the United States of America is one of countries in the West that has invested heavily in irrigated agriculture. The extensive irrigation networks in this country have therefore contributed significantly to enhancing productivity in agriculture and protecting the greater majority of its population from hunger. Nebraska is one of states in USA with extensive irrigation system, with approximately 53.1 million of irrigated acres according to a survey report released in 2023 (USDA, 2024).

Nebraska is a perfect example that proves that irrigation is the tool that can promote food stability. The agricultural economy in this state includes modern irrigation systems that allows farmers to water their crops based on the crop needs and soil moisture data, which helps to optimize quality and yield while minimizing water waste. The commonly used forms of irrigation in Nebraska include furrow irrigation, surface drip irrigation and center pivot irrigation. These methods help farmers maintain optimal crop growth even during the drought spells resulting in higher production efficiency than relying on dryland production (USDA, 2024).

Regionally, irrigated agriculture is an important part of Egypt's history. Irrigated agriculture has played a key role in Egypt's food security and national economy (Gebeltova et al., 2024). In a country with over 100 million inhabitants, domestic production is critical, hence the focus on irrigated agriculture. Between 2000 and 2018 the size of irrigated area in Egypt increased from 3.07 million hectares to 6.52 million hectares. The average growth per annum is 2.06% (Sayed & Wadie, 2022). Through irrigation, farmers in this country are able to maximize the potential of the available cropland, thereby enhancing the availability and supply of food. The government has been a key player and has transformed acres of desert area into productive farmland using smart irrigation technology. Using underground water in these areas to irrigate these acres' land, it has boosted agricultural production in this country by 80 percent in the last few years, while many other countries have been experiencing a drop in production levels because of climate change.

In the Sub-Saharan Africa, the conversation surrounding adoption of irrigated agriculture and food security is different. The countries in this region hold great agricultural potential that is yet to be realized. The high dependence on rain-fed agriculture has left them grappling with food insecurity that threatens the lives of inhabitants and the nations' economies. The level of agricultural productivity in these regions continue to decline because of worsening climatic conditions. Extreme weather conditions, such as droughts and floods have grown more frequent in recent years and they consistently undermine crop yields and household food availability. According to the African Development Bank (2022), 70% of the population in the Sub-Saharan Africa rely on agriculture for sustenance, but only 6% of the arable land in this region is irrigated. This means that under current conditions, the production levels cannot meet the food demand. This has prompted several East African nations, including Kenya, Ethiopia, and Rwanda, to initiate national irrigation master plans that are aimed at promoting sustainable agriculture and boost yield.

The efforts to boost production through irrigated agriculture by some of the countries in East Africa hold great promise of stabilizing food production, which in turn can boost household incomes.

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

This endeavor however requires significant level of resources, proving to be a major hindrance to the expansion of irrigated agriculture. It remains constrained by inadequate infrastructure, limited access to irrigation technologies, and institutional challenges that disproportionately affect smallholder farmers. Recognizing these barriers, regional and international development agendas such as the African Union's agricultural strategy, the EU's Agenda for Change, and the Comprehensive Africa Agricultural Development Programme (CAADP) have emphasized the need for sustainable agriculture and investment in smallholder irrigation (Namara et al., 2023).

The African Development Bank's Feed Africa Strategy, alongside policy commitments by several Southern African Development Community (SADC) member states, supports the scaling-up of irrigation as a pillar of agricultural transformation. National initiatives in countries like Malawi and Tanzania have aligned with this vision through the establishment of agricultural greenbelts and growth corridors. Additionally, global institutions such as the World Bank have renewed their focus on agricultural water management, viewing it as a cornerstone for achieving food security, economic growth, and climate resilience across the continent. The World Bank describes irrigated agriculture as the most powerful climate adoption method. It is an insurance policy for the food systems across the globe that shields against extreme climatic condition, thereby ensuring that food supply is steady (Namara et al., 2023).

In this study, food insecurity is therefore a phenomenon that describes a situation where there is lack of stability or uncertainty in food supply, the distribution, the availability of food in the household is unequal, and there is lack of control on the food situation (Alaimo et al., 2020). In summary, food insecurity is a mark of human suffering. According to Alaimo et al. (2020), food insecurity limits consistent access to sufficient, safe, and nutritious food, which often leads to various forms of malnutrition, including undernutrition and micronutrient deficiencies. These conditions are major contributors to poor health outcomes, particularly among children under the age of five, who are the most vulnerable. Even when recovery occurs, the long-term impacts on cognitive function and physical growth are often irreversible, thus, there is a critical need to address food insecurity.

Burundi is among the countries in the Sub-Saharan Africa that face significant food security challenge. Over 90% of the people in this landlocked country depend on agriculture. Burundi has not been spared by the effects of climate change which have exacerbated food insecurity. This country's agricultural sector is highly vulnerable due to unpredictable weather patterns, land fragmentation, soil erosion, and poor access to water resources. It has been reported by the Integrated Food Security Phase Classification in that between August and September 2025, at least 1.17 million Burundians were experiencing acute food insecurity (IPC, 2022). Also, according to this report, between June 2021 and May 2025, about 484,000 children between the ages of 6-59 months were facing acute malnutrition, which was double the number recorded in 2022 (IPC, 2025). The high reliance on rain-fed subsistence farming, coupled with high population density, has put immense pressure on available agricultural land and water resources.

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

In response, the Government of Burundi, with support from partners such as the FAO and the World Bank, has initiated irrigation development projects aimed at transforming agricultural productivity. One such interventions are the irrigation along the River Kajeke in Bubanza Province, which aims to improve water access, extend the growing season, and increase crop yields for local communities (IPC, 2025). The impact of the irrigation projects along the River Kajeke to food security in Bubanza is underexplored, inspired this study. The contribution of the irrigation projects to the availability of adequate food in Bubanza, or a lack of it were determined in this study. The findings provide crucial insights for policy formulation and contribute to the sustainable transformation of agriculture in Burundi. Therefore, achieving food security is a priority for all countries irrespective of their socioeconomic conditions. The study therefore sought to examine the predisposing factors influencing the adoption of irrigation as a strategy for alleviating food insecurity in Bubanza Province, Burundi

Theoretical Basis

Sustainable Livelihoods Framework (SLF) Theory

This study was guided by the Sustainable Livelihoods Framework (SLF). SLF originated from the pioneering work of Robert Chambers in the mid-1980s. Chambers proposed the concept of "Sustainable Livelihoods" after realizing that traditional development models failed to address the root causes of poverty and inequality. His work formed the foundation for the Sustainable Livelihoods Approach (SLA) later formalized by the UK Department for International Development (DFID) in 1997 (Kollmair & Juli, 2002). The adoption of this framework aimed to enhance development cooperation and guide poverty reduction efforts through people-centered strategies. The SLF defines a livelihood as the capabilities, assets, and activities required for a means of living, which is sustainable when it can cope with and recover from shocks while maintaining or enhancing assets and the natural resource base. The framework emphasizes several key principles: it is people-centered, focusing on individuals' strengths and adaptive capacities; holistic, considering all aspects influencing livelihoods; dynamic, recognizing the changing nature of livelihood systems; and sustainability-oriented, ensuring long-term environmental and economic resilience. It also stresses macro-micro linkages, connecting local realities to broader policy and institutional contexts.

It is a relevant framework in this study because it provides a suitable lens for understanding the relationship between irrigation systems and food insecurity. Through this lens, the study explores how irrigation initiatives along the River Kajeke strengthen farmers' capacity to cope with environmental stresses such as drought and land degradation through irrigation to improve access to adequate food. It will also facilitate understanding of how macro-level policies influence farmers' micro-level livelihood outcomes. It highlights whether policy interventions effectively improve access to irrigation technology needed to sustain food security. The framework also provides a basis for assessing the sustainability of the irrigation projects in term of long-term access to water and understanding practices that build sustainable livelihoods. It allows analysis of how irrigation systems enhance productivity, reduce vulnerability to climate variability, and

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

improve food availability and dietary quality. Therefore, the SLF's people-centeredness and sustainability outlook makes it a suitable framework for linking irrigation practices, policy effectiveness, and food security outcomes in Burundi's rural context.

METHODOLOGY

Research Design

This study adopted a cross-sectional survey research design and a mixed methods approach. Cross-sectional survey design was determined suitable for this study because it is useful in reporting the actual status of the matter being studied by analysing data at a specific point in time without considering the historical timeframe.

Study Area

The location of study is Bubanza Province in Burundi. It is one of the 18 provinces in this country. Bubanza Province sits the northwestern side of Burundi bordering the Democratic Republic of Congo. This location is popular for its beautiful landscapes and the whole province extends over 1,089 square kilometers. The population is estimated at about 338,023 people. Inside this province, there are 5 communes or districts, and each is led by a local government.

Target Population

The study targeted different stakeholders within the agriculture sector. The report from the Ministry of Environment, Agriculture and Livestock of Burundi 2023, give 3.380 households practicing irrigation activities along river Kajeke. The first group of respondents targeted during this research were the irrigating households in Bubanza. The second group are the community leaders. The other group includes personnel from the institution of the Ministry of Environment, Agriculture, and Livestock. The three groups were adequate for this study because they have the knowledge and experience that the study requires.

Sampling Techniques

From the pool of participants described above, the researcher sampled a small number of representatives from each group, who participated in the study. For the sample represented the target population, The Yamane (1967) formula was used to determine the sample size to participate in this study.

$$n = \frac{N}{1+N\,(e)^2}$$

Where: n= Sample Population Size, N= Target Population Size e= Level of Precision (0.1).
$n=3{,}380/1+3{,}380(0.1)^2$

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

n=3,380/1 +3,380(0.01)
n=3,380/34.8
n=97

Both simple random sampling and purposive sampling were applied during this research. For the irrigating households and community leaders, the researcher used the simple random sampling. On the other hand, when selecting the personnel from the government ministry of agriculture, purposive sampling was sufficient.

Table 1: Sample Size Distribution

	Target Population	**Sample Population**
Irrigating households in Bubanza Province	3,325	85
Community leaders	35	7
Personnel from Ministry of Environment, Agriculture, and Livestock	20	5
Total Target population & sample size	**3,380**	**97**

Source: Researcher (2026)

Data Collection Instruments

The study collected primary data using semi-structured questionnaires and interviews. Secondary data was obtained through a review and analysis of existing scholarly literature and reports, and other publications relevant to the research topic.

Data Processing and Analysis

The qualitative data that was obtained from the surveys and interviews was analyzed using the content analysis method which facilitated the organization of information into distinct themes. The results were then being presented in textual form within the study. Quantitative data was analyzed using descriptive statistics in order to describe what the data shows. The tool utilized was the Statistical Package for the Social Sciences (SPSS) for quantitave data and Nvivo for qualitative data. Frequency tables, bar charts, and pie charts were adopted to visualize the data, which helped to enhance clarity and comprehension.

Ethical Considerations

The researcher prioritized ethical considerations throughout the research process. First, responses from children were not allowed. The researcher made sure that the participants were informed of the study and the intentions of the study. This was done through relevant introductory letters. The participants were not coerced to participate in the study. Consent was sought from the respondents prior to their participation in the study. Willingness to partake in the study was obtained from respondents after clear explanation of the course of the study and data collection.

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

Respondents who were not willing to participate in the study were not included in the process of data collection. The researcher also ensured confidentiality and anonymity of the respondents' identities. This was achieved by asking participants not to state their names on record. All data was anonymized and stored in encrypted electronic files.

RESULTS

This section presents the findings emanating from data collected from the field for analysis and reporting. It opens with describing the demographic factors and eventual presentation of results based on the specific objectives.

Demographic Information

This section presents the demographic profiles of the respondents who participated in the study. Understanding characteristics such as gender, age, role in the mission, provides context for interpreting their responses.

When asked about the gender distribution, 42 were men and 55 were women. This means that 43.3 percent of the participants were males and 56.7% females. Although unequal, the representation by both the male and female genders was adequate to capture their realities on matters of irrigation and food insecurity in Bubanza province. This is proof that the views represent the perspectives of both genders. The gender representation in this study enhanced the quality of the researcher. This is because the involvement of both men and women helped to attain broader viewpoints on subject of study.

Regarding age bracket of the respondents, the younger generation of between 21-30 years made up 19.6% of the respondents, persons between the ages of 31-40 years made up 55.7% of the respondent. This age category was the most represented in the study. 41-50 years were 15.5% of the participants. 61 years and above made up 9.2%. The diversity of the participants strengthened the validity of the results. The age distribution brings forth views of all age brackets. The young people brought about fresh perspective on matters of irrigation in Bubanza Province, while the older persons offered valuable perspectives that captures the transformation brought forth by irrigation compared to rain-fed agriculture.

In terms of the literacy status distribution of the people who participated in the study. Statistics show that majority of the participants (39.2%) have not been to school. 29.9% had primary education, 15.4% had secondary education, 5.2% had gone up college, and 10.3 were degree holders. These participants, majority of whom have not attended school, require more intensive support from agricultural extension agents regarding irrigation systems. The education level distribution shows that the opinions of the people of differing education levels was presented in this research. The unlearned people majorly depend on their experiences when responding to

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

questions and they also possess valuable historical knowledge. This was helpful in this study to capture the reality of agricultural practice in Bubanza Province.

Predisposing Factors Towards Adoption of Irrigation in Alleviating Food Insecurity

The major focus, was to identify the challenges that farmers faced before they began using irrigation on their farms, that reflected negatively on households' food security status. Firstly, the researcher sought to establish the nature of food availability within the households before they adopted irrigation. Therefore, they were asked, "Have you experienced food shortage or famine when you relied on rainfall for farming?" Their responses were as follows:

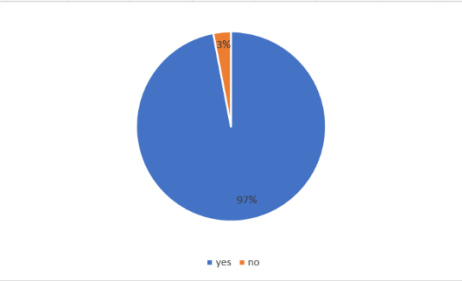


Figure 1: Respondents experience and food shortage before adopting irrigation
Source: Researcher (2026)

Figure 1 shows that the 97% of the study participants reported to have experienced food shortage or famine during the period they were practicing rain-fed agriculture. This shows that the decision to start irrigated farming was largely influenced by growing food insecurity. The researcher went further to inquire on the reliability of rainfall in Bubanza province for agriculture.

Reliability of Rainfall in Bubanza Province

The respondents were asked, 'How reliable is rainfall in Bubanza for crop production.' They were asked to select from the following four choices: very reliable; reliable; unreliable; Very unreliable. Their responses are illustrated by the chart below.

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

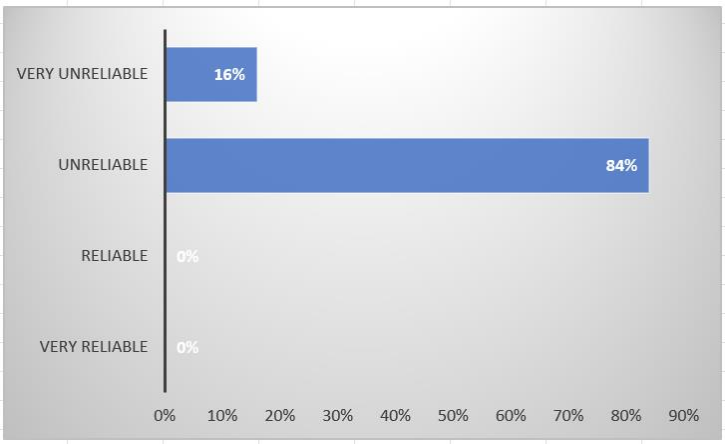


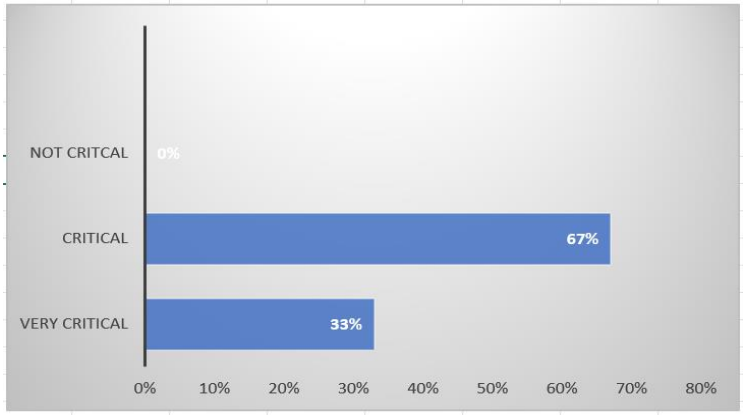
Figure 2: The reliability of rain for agriculture in Bubanza Province
Source: Researcher (2026)

The respondents were asked to provide their views on the reliability of rainfall in Bubanza Province for agricultural activities. As presented in Figure 2, 84% of the respondents described the rainfall as unreliable, while 16% described it as very unreliable. The findings indicate that all respondents perceived rainfall in the study area as unreliable to some degree.

The respondents were further asked whether they had experienced crop failure when relying on rainfall for farming. All respondents (100%) reported having experienced crop failure when they relied on rainfall for agricultural production.

Level of Importance of Irrigation in Bubanza Province

To further determine the importance of irrigation to farmers in Bubanza Province, the respondents were asked to select the level of importance of irrigation to achieving high crop production. They were presented with three options: Very critical; critical and not critical. Their responses are illustrated by Figure 3.



ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

Figure 3: Respondents perception on importance of irrigation to high farm production
Source: Researcher (2026)

Figure 3 shows that (33%) of the respondents answered that irrigation is very critical to achieving high crop production (67%) responded that irrigation is critical to gaining high yields from the farms. The use of irrigation makes it possible for farmers to achieve high yields during droughts and floods. It works because during droughts farmers can supply just enough of what the crop needs to remain alive and productive. It also works during heavy rains or floods because the farms are designed to remove excess water, thereby preventing uncontrolled inundation. In the same line, interviews observed the following: KII 001said that the major challenge which forced households to practice irrigation was food shortage; KII 002 said the unpredictable rainfall motivated households to engage in irrigated agriculture. Qualitative data support quantitative data.

DISCUSSION

The study findings reveal a strong and unanimous perception among respondents that household small-scale agricultural production has improved following the adoption of irrigation. All respondents reported harvesting more food compared to when they relied solely on rain-fed agriculture. This finding is consistent with the broader evidence that irrigation improves agricultural productivity by providing a more reliable supply of water and reducing farmers' dependence on rainfall. For instance, Mango et al. (2018) found that variability in rainfall patterns negatively affects rain-fed agricultural production and undermines farmers' ability to maintain stable yields. Similarly, Nonvide (2018) established that unreliable rainfall increases the vulnerability of agricultural systems and negatively affects farm productivity. The present finding therefore demonstrates how irrigation can address one of the major constraints identified in these studies by providing farmers with greater control over water availability and enabling more consistent crop production.

The reported increase in harvest volumes further supports the findings of Hussain and Hanjra (2004), who demonstrated that irrigation can generate substantial improvements in agricultural productivity and contribute to poverty reduction among rural households. Their study emphasized that access to irrigation enables farmers to overcome water constraints, increase cropping intensity and improve agricultural returns. Likewise, Namara et al. (2010) observed that smallholder irrigation in sub-Saharan Africa can contribute significantly to improved agricultural productivity and food security, although the magnitude of these benefits varies according to the technology and institutional conditions under which irrigation is implemented. The current study is therefore consistent with this body of evidence, showing that farmers in Bubanza have experienced increased production after gaining access to irrigation.

Respondents also reported improvements in both the quality and quantity of agricultural produce under irrigation. This finding is supported by Namara et al. (2010), who noted that irrigation can

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

enhance agricultural productivity by enabling farmers to provide crops with water at critical stages of plant development and by supporting more reliable production cycles. The finding is also consistent with Burney, Naylor and Postel (2013), who found that small-scale irrigation can improve food production and contribute to enhanced food security in developing-country contexts. The convergence of these findings suggests that the benefits of irrigation extend beyond simply increasing the amount of land under cultivation; reliable water availability can also improve the conditions under which crops are produced, contributing to more stable and potentially better-quality agricultural output.

The reported increase in household production and the perceived decline in the prices of maize, beans and rice also have implications for local food security. Burney et al. (2013) established that small-scale irrigation can increase food production and improve food availability among rural populations, particularly where farmers previously depended heavily on rainfall. Similarly, Molden et al. (2007) emphasized that improved agricultural water management can contribute to increased food availability and improved livelihoods in areas experiencing water constraints. The present study reflects these findings, as increased production under irrigation appears to have strengthened household access to food. However, the reported decline in market prices should be interpreted cautiously because prices are determined by multiple factors, including aggregate supply, consumer demand, seasonality, transport costs and market access. Therefore, while increased production may contribute to greater market availability and potentially lower prices, the present study does not provide sufficient evidence to establish irrigation as the sole cause of observed price changes.

An important finding is that irrigation has improved food sufficiency for household consumption but has not generated substantial surpluses for commercial sale. This finding is consistent with Namara et al. (2010), who observed that although smallholder irrigation has considerable potential to improve productivity and livelihoods in sub-Saharan Africa, many irrigation schemes remain constrained by limited scale, technology and institutional support. Similarly, You et al. (2011) noted that the potential for agricultural intensification in Africa is affected by constraints related to infrastructure, access to inputs, markets and investment. The current study therefore suggests that irrigation in Bubanza has primarily strengthened household-level food security rather than facilitating a complete transition towards commercially oriented agricultural production.

The continued reliance on traditional irrigation techniques provides further explanation for the limited commercial surplus reported by respondents. Higginbottom et al. (2021) observed that the scale of irrigation development in Africa remains substantially below the continent's potential irrigable area. This limitation is particularly relevant to the present study because farmers using manual or traditional irrigation methods are required to commit considerable amounts of labour to water application. Consequently, households may be able to irrigate only a relatively small proportion of their available agricultural land. The finding therefore supports the argument that the productivity benefits of irrigation depend not only on access to water but also on the efficiency, affordability and scalability of irrigation technologies.

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

The constraints identified by respondents, including inadequate infrastructure, limited access to financing and insufficient agricultural extension support, are also consistent with findings from previous research. You et al. (2011) identified inadequate infrastructure, limited investment and restricted access to agricultural inputs as important constraints to agricultural development in Africa. Similarly, Namara et al. (2010) emphasized that the performance of smallholder irrigation is influenced by institutional, technological and financial factors. The current findings indicate that these constraints remain relevant in Bubanza Province, where farmers may recognize the benefits of irrigation but lack the resources and technical support required to expand and modernize their irrigation practices. Thus, the limited commercial benefits observed in the study may be attributed not to the ineffectiveness of irrigation itself but to the broader constraints surrounding its implementation.

The finding that farmers are cultivating a greater variety of crops under irrigation is particularly important in relation to climate adaptation and household food security. Mango et al. (2018) found that changes in rainfall patterns have adversely affected rain-fed agricultural systems and encouraged farmers to adopt alternative strategies for maintaining production. Irrigation provides one such strategy because it allows farmers to produce crops during periods when rainfall would otherwise be inadequate. Similarly, Di Falco and Chavas (2009) demonstrated that agricultural diversification can form part of farmers' responses to climatic risk by reducing dependence on individual crops and spreading production risks. The increased crop diversity observed in Bubanza therefore suggests that irrigation is contributing not only to higher production but also to farmers' capacity to manage climatic and production risks.

The relationship between irrigation and food security is further supported by Burney et al. (2013), who found that small-scale irrigation can contribute to improved food availability and household welfare in developing-country settings. In the present study, the cultivation of a wider range of crops under irrigation potentially increases the variety of foods available for household consumption while reducing dependence on a narrow range of rain-fed crops. This may have positive implications for dietary diversity and household resilience, particularly where climatic shocks would otherwise affect several rain-dependent crops simultaneously. The finding therefore suggests that the contribution of irrigation to food security extends beyond increased yields to include greater flexibility in household production decisions.

CONCLUSION

The study concluded that rainfall unpredictability and climate variability were the primary factors influencing farmers' adoption of irrigation in Bubanza Province. Irrigation had therefore emerged largely as a coping and climate-adaptation strategy through which farmers reduced their dependence on unreliable rainfall and stabilized agricultural production. The findings further demonstrated that irrigation had contributed to increased yields, improved quality of agricultural produce, greater crop diversification and improved household food availability. However, limited government support, continued reliance on traditional irrigation methods, inadequate

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

infrastructure and limited access to financial and technical services constrained farmers' ability to realize the full potential of irrigation. Although irrigation along River Kajeke had become an established agricultural practice, its benefits remained largely at the household food-security level, with limited production of marketable surpluses. The study therefore concluded that irrigation represented an important pathway for strengthening agricultural resilience and food security in Bubanza Province, but its long-term effectiveness depended on stronger institutional, technological and financial support.

Based on the study findings, the study recommended that the Government of Burundi, through the relevant agricultural institutions, strengthen support for smallholder irrigation by investing in reliable irrigation infrastructure, improving agricultural extension services and establishing accessible financing mechanisms for farmers. Irrigation infrastructure should have ensured reliable and equitable access to water, while extension services should have provided practical training on water management, improved irrigation technologies, crop management, pest control and equipment maintenance. In addition, affordable credit, subsidies for irrigation equipment and cost-sharing mechanisms should be introduced to enable farmers to transition from traditional to more efficient irrigation systems and expand beyond subsistence-level production. These interventions are expected to enhance productivity, increase marketable surpluses, strengthen household food security and enable irrigation to contribute more substantially to agricultural commercialization and national food security in Burundi.

REFERENCES

Aboyitungiye, J. B., & Suryanto. (2025). Vulnerability of the agriculture of Burundi to climate change: A review and linkages between climate change, food security, and food production. Economía Agraria y Recursos Naturales, 25(2), 33-53. doi:10.7201/earn.2025.02.02

African Development Bank (AfDB). (2022). Africa agriculture transformation scorecard.

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. https://doi.org/10.1073/pnas.1203597110.

Di Falco, S., & Chavas, J.-P. (2009). On crop biodiversity, risk exposure, and food security in the highlands of Ethiopia. American Journal of Agricultural Economics, 91(3), 599–611.

Food and Agriculture Organization. (2023). The state of food security and nutrition in the world 2023. FAO. https://www.fao.org

Gebeltova, Z., Phiri, J., Bartoňová, K., Steininger, M., Malec, K., Blažek, V., … Flegel, E. (2024). Ensuring food sovereignty and nutritional sustainability in Egypt. Heliyon, 10(24), e40007. doi: 10.1016/j.heliyon. 2024.e40007

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

Higginbottom, T. P., Adhikari, R., Dimova, R., Redicker, S., & Foster, T. (2021). Performance of large-scale irrigation projects in sub-Saharan Africa. Nature Sustainability. https://doi.org/10.1038/s41893-020-00670-7.

Hussain, I., & Hanjra, M. A. (2004). Irrigation and poverty alleviation: Review of the empirical evidence. Irrigation and Drainage, 53(1), 1–15. https://doi.org/10.1002/ird.114.

Hussain, M. A., Li, L., Kalu, A., Wu, X., & Naumovski, N. (2025). Sustainable food security and nutritional challenges. Sustainability, 17(3), 874. doi:10.3390/su17030874

IPC. (2025). Just a moment... Retrieved from https://www.ipcinfo.org/ipc-country-analysis/en/?country=BDI

Kollmair, M., & Juli, S. (2002). THE SUSTAINABLE LIVELIHOODS APPROACH. University of Zurich. Retrieved from https://www.humanitarianlibrary.org/sites/default/files/2014/02/SLA_Gamper_Kollmair.pdf

Mango, N., Makate, C., Tamene, L., Mponela, P., & Ndengu, G. (2018). Adoption of small-scale irrigation farming as a climate-smart agriculture practice and its influence on household income in the Chinyanja Triangle, Southern Africa. Land, 7(2), 49. https://doi.org/10.3390/land7020049.

Molden, D. (Ed.). (2007). Water for food, water for life: A comprehensive assessment of water management in agriculture. Earthscan & International Water Management Institute.

Namara, R. E., Core, L. N., & Talbi, A. (2023, November 21). Growing against the odds: Three reasons why irrigated agriculture is critical in a changing climate. Retrieved from https://blogs.worldbank.org/en/water/growing-against-odds-three-reasons-why-irrigated-agriculture-critical-changing-climate

Namara, R. E., Horowitz, L., Nyamadi, B., & Barry, B. (2011). Irrigation development in Ghana: Past experiences, emerging opportunities, and future directions. IWMI Working Paper 127. International Water Management Institute.

Nonvide, G. M. A. (2017). Effect of adoption of irrigation on rice yield in the municipality of Malanville, Benin. African Development Review, 29(S2), 109–120. https://doi.org/10.1111/1467-8268.12266.

Nonvide, G. M. A., Sarpong, D. B., Kwadzo, G. T.-M., Anim-Somuah, H., & Amoussouga Gero, F. (2018). Farmers' perceptions of irrigation and constraints on rice production in Benin: A stakeholder-consultation approach. International Journal of Water Resources Development, 34(6), 1001–1018. https://doi.org/10.1080/07900627.2017.1317631.

ISSN: 2312-0134
African Research Journal of Education and Social Sciences, 13 (2), 2026 | Website: www.arjess.org

Pawlak, K., & Kołodziejczak, M. (2020). The role of agriculture in ensuring food security in developing countries: Considerations in the context of the problem of sustainable food production. Sustainability, 12(13), 5488. doi:10.3390/su12135488

Sayed, A., & Wadie, M. (2022, October 2). Modern irrigation strategy: Egypt aims for the "Inevitable" to utilize water resources. Retrieved from https://infonile.org/en/2022/10/modern-irrigation-strategy-egypt-aims-for-the-inevitable-to-utilize-water-resources/

United Nations University. (2025, June 24). Another development paradox: Irrigation improves child nutrition most where water is least sustainable, warns UN University. Retrieved from https://unu.edu/inweh/news/another-development-paradox-irrigation-improves-child-nutrition-most-where-water-least

USDA. (2024, November). 2023 Irrigation and Water Management Data Now Available. Retrieved from https://cropwatch.unl.edu/2024/2023-irrigation-and-water-management-data-now-available/

World Bank. (2008). World development report 2008: Agriculture for development. World Bank.

World Bank. (2024). Climate risk country profile: Burundi. https://climateknowledgeportal.worldbank.org/country/burundi.

World Bank. (2025, 21). The World Bank and Nutrition. Retrieved from https://www.worldbank.org/en/topic/nutrition/overview.

You, L., Ringler, C., Nelson, G. C., Wood-Sichra, U., Robertson, R., Wood, S., Zhu, T., Ermoliev, Y., & Msangi, S. (2011). What is the irrigation potential for Africa? A combined biophysical and socioeconomic approach. Food Policy, 36(6), 770–782.