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EDITORIAL NOTE

Bishop Stuart University is delighted to release (JODET Vol. 3 Issue 1). This Academic Journal of Development, Education and Technology rounds up its second year since its launch with a flourish. It is therefore only a short time since JODET was accepted for indexing in Google Scholar and CrossRef, thus strengthening BSU's standing as a fast-growing research-based institution in Uganda. We are proud to reaffirm that we're not just any other learning institution among Uganda's institutions of Higher Learning but an establishment that creates new knowledge and contributes to the country's development by seeking solutions to the nation's challenges.

JODET is currently attracting and welcoming articles from near and far that cover a wide range of disciplines reflecting the serious intentions of the institution to provide an avenue for development that is commensurate with the needs of a vibrant economy like Uganda's.

Research is the bedrock of knowledge on which the future of a developing nation can depend. It is a reflection of the thinking of the future leaders whose duty is to create a better tomorrow for everyone, regardless of their pursuits in life.

BSU is a fast-growing Christian-based institution of over 6000 learners and researchers who are proud to be among builders of the future. It stands by its motto which proclaims to know the way, show the way and go the way! Our God Reigns!

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Christianity and the Environment: Underneath the Concurrence and Implications on Uganda's Sustainable Development

*George Muganga[1]

Uganda Management Institute

ABSTRACT

The paper highlights the linkages between religion and environment in the context of growing ecological and climate change impacts. It focuses on religion with particular reference to Christianity and Uganda. In terms of approach, the paper adopts a hybrid methodology influenced by pragmatism, reflexibility and positionality. It uses publicly available secondary data obtained using internet search engines. The paper positions Christianity as a strong factor in building pathways towards sustainable development. It thus acknowledges a concurrence between Christianity and the environment. It however postulates that amidst this concurrence are salient but largely silent aspects through which the Christian system, particularly in recent years, has continued to expose the environment to degradation and related threats. These include physical occupation, unwise use of wetlands, and pollution, among others. The paper proposes a package of integrated

Muganga George (✉)
E-mail: gmuganga1@gmail.com

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Mechanisms for mitigating the effects and paving the way for a sustainable development pathway.

Keywords: *Lived Experiences, Devotion to Prayer, Born-Again, Anglican Christians and Longevity in Marriage.*

INTRODUCTION

Religion refers to a particular system of faith and worship that is bent on specific attitudes, beliefs, and practices. Religion is not a single thing, and from an individual lens, it is a body of behavior unified by failure to find a simple, suitable rational explanation (Dow 2007). It is not necessarily about God or gods, but rather a divine superhuman power regarded as holy, sacred, and absolute (Britanica 2024). Religion is mandated with an important divine environmental protection responsibility. The holy books—the Bible and Quaran emphasise the need for protection of the environment. In Genesis 2:15, God places man in the Garden of Eden to work and take care of it, while in Quaran 6:165, man/human beings are made vicegerents of God on earth. These divine roles continue to shape religion`s impact on the environment and society. Religion is also a socioeconomic and political agent. Karl Max described it as the opium of the poor, helping to console and relieve them from oppression and restoring back their human sense. It has historically been an impetus for social change and helps to cultivate and nurture abilities that are passed outwards into the wider social bloodstream, eventually influencing members beyond the target communities (Jarosz 2023).

Politically, religion mobilises the sensibilities of people in order to get their support and to capture or influence power (Mubarak 2009). It is the bloodstream for many political and governance systems across the globe, including the Vatican, most Arab states, and indirectly most countries. Across time, various political doctrines have been catalysed by religions (Wikipedia 2024). This sociopolitical powerhouse equally affects the use and management of the environment and natural resources. The world is largely religious, given that most people belong to and identify with a given religious group. Estimates indicate that eight out of ten people belong to a religious group, accounting for

around 84% of the global population (Pew Research Center 2012). There are more than 10,000 of these religious groupings, mostly represented through the big four: Christianity, Islam, Hinduism, and Buddhism. Other smaller groupings include Judaism, Folk, Bahai, and Shintoism, all accounting for an estimated 7% (Wasserman 2024).

Christianity is the major religious system of the world, accounting for 30.7% of the population (Pew Research Center 2015). The religion is based on the teachings and life of Jesus Christ. To be a Christian thus means to be like Jesus and follow his footsteps (Compassion International 2024). Just like at the global level, Christianity is also the leading religious system in Uganda and accounts for the majority population. To note, the country's population has been growing at an exponential rate. In 1969, the total population was 9.5 million, compared to the current 45.9 million in 2024.

The population density has also almost tripled from 85 persons in 1991 to 227 persons per square kilometer in 2024 (UBOS 2024). The increase in population has been followed by an increase in religious groups and believers. The 2014 National Population Census estimates close to 99.8% of the population identifying with a religious group and a negligible 0.2% with no religion.

Table 1: Religious affiliation in Uganda

Religious Group	**2002**	**2014**
Catholics	41.6	39.3
Anglicans	36.7	32.0
Moslems	12.4	13.7
Pentecostals	4.7	11.1
Other	4.5	3.6
Non-religious	0.9	0.2
Total		**100**

Source: UBOS 2016

Table1 below shows more Catholics in 2002 and 2014, followed by Anglicans and a very smaller number of non-religious people. This pattern has been and remains the same, with Christians accounting for

the majority population—around 85%.Religion is a prime factor for Uganda`s vision and strategic development, including environment management. This is summed into the country's motto, ``for God and my country, `` which expresses a Christian-centric belief of the nation. There is no dispute over the active role of Christianity in shaping environmental quality trends in the country. What is discussable is the nature, extent, and manifestations of such. In most cases, unfortunately, Christian linkages with the environment become visible only when positive effects manifest but remain undercover in times of degradation.

Thus underneath Christianity's impactful potential on the environment lies a subtle degradatory lens that is rarely discussed, which is the subject of this paper. The paper highlights the linkages and interactions between Christianity and the environment in the context of growing ecological and climate change impacts. It focuses on Uganda. It explores the state of the country's environment and examines the different religious environmental initiatives, environment degradation hotspots, and possible solutions.

Approach

The paper focuses on Christianity and Uganda as reference points. Christianity is an ideal target as it posts a staggering number and substantial evidence of various restorative but also degradative advances onto the environment. Uganda similarly posts a bigger number of Christian followers and experiences an increasing rate of degradation of the environment. The global Environmental Performance Index (EPI) ranked the country 154th out of 180 countries in 2024 (Yale University 2024). This paper employs the religious environmentalism philosophy. Religious environmentalism is anchored on the principle that humans are expected to play both a divine and moral role in caring and protecting the environment. It is part of a global thinking that seeks to integrate the most creative, humane, and hopeful parts of both secular society and religious tradition (Asif 2024). It focuses on application of principles of religion to achieve environmental sustainability and development (Chukwunonyelum et.al 2013, UNEP 2021, Imran 2024). In terms of approach, the paper adopts

a hybrid methodology influenced by pragmatism, reflexibility and positionality. Methodological pragmatism emphasizes experiential learning, use of a diversity of methods and individuals' views and life experiences (Kaushik and Walsh 2019, Mohamed and Mahmoud 2024).

That approach suits the author as the subject under study is limited by scanty formal literature. Scientific data and literature on Christianity and environment particularly ecosystem degradation is very scanty in Uganda yet informal literature (blogs, media posts and anecdotal articles), field observation and individual experience consistently trace this linkage. Pragmatism further avails the author the flexibility to undertake robust research using any method (Foster 2022). Reflexibility on the other hand is a central concept of pragmatism that aims at co-generation of new meanings and knowledge. It highlights positionality, an awareness of the author's role in the study and how this influences research outcomes (Haynes 2012).

Ayton *et al* (2023) classify positionality in the reflective approach which is a rejection of the idea that social research is separate from wider society rather part of the individual researcher's experience. The author and as clarified by Gounder (2025) opted for this approach out of his chosen position and relationship with research in the field of environment. This chosen position is grounded in pre-understanding fieldwork, fieldwork confessions, data collection in natural settings, and practical work among others (Gummeson 1991, Haynes 2012). Holmes (2020) further encourages authors to acknowledge and disclose their selves in their work aiming to highlight their influence on and in the research process (Holmes 2020).

As earlier noted, the author's positionality is shaped by observational, personal and work experiences with environmental agencies and in the field of environment and sustainable development. The option for positionality was motivated by the topical issue that exists in absence of empirical literature. There is undoubtedly scanty data on a number of specific areas of study including location characteristics of specific churches and houses of prayer, nature of religious denominations that impact negatively on the environment and probable causes. Through observation, experience and anecdotal date

however is an emerging pattern that points to key information on such existential but largely undocumented aspects.

The paper used publicly available secondary data mainly obtained using the Google and DuckDuckGo search engines. This key information and secondary data reinforced by authors experience provides data for the paper. The use of secondary data provides a rich grounding and is meant to counter check the possible biases that may arise of positionality and sole reliance on authors experience potentially generating a balanced body of knowledge for grounded theory. Importantly, there is increasing interest in reuse of existing secondary rather than generation of new data due to cost, effectiveness and environmental benefits (Wickham 2019, Cheong etal 2023). The secondary data management followed a three step process that started with setting research questions, identification of data and evaluation of data (Doolan& Froelicher 2009, Wickham 2019, Cheong *et al* 2023).

The research questions were derived from the focus of the paper that interrogated the contribution of Christianity to Uganda's environment. Three research questions were; how has Christianity contributed to Uganda's environmental sustainability agenda, how has Christianity affected Uganda's environment and how can the country's-Christianity-demographic dividend enhance the integrity and functionality of the environment and related resources.

The process of secondary data analysis involved in depth review of formal and informal past and current literature. A total of 41 secondary data resources were reviewed. These included 15 academic resources that included books and journal articles, 5 published reports and 20 non-academic resources that included Newspaper articles and website articles, letters and other non-academic sources. Out of the 15 academic resources, 3 directly related to Christianity and environment in Uganda while most of the academic resources directly focused on the topic and country pointing to scanty academic literature on the subject.

The bigger methodological equation for this paper is to determine what Christianity has or has not done to the environment, given that it is an abstract. To note, people, either as individuals or as institutions may or may not be religious or Christians for that matter but can affect the environment in many ways and for different reasons.

The reverse is also true. How then do we draw the dividing line between people as individuals and institutions as entities different from when they are Christian? When is environmental degradation Christian? Would a priest who encroaches on a wetland as an individual family member, for instance, mean Christianity or religious encroachment? What about a church that owns a natural forest and replaces it with sugar cane growing or a seminary that runs an old textile industry that is a noise and air pollution source for the neighboring community?

These questions are intriguing, as it may not be clear when apportioning liability. To answer these, we revert to the meaning of religion, which is a pursuit that is followed with devotion and ultimately a pursuit and system of action shared by groups of people (UBOS 2016). Christianity has a theological mandate to care for creation (Kimanje 2025) and further emphasises teaching and emulating the life of Jesus Christ.

In all the above scenarios cited, the common denominator is a Christian actor who, either as an individual or as institution must uphold related beliefs and values. Thus, a priest who encroaches on a wetland does not do it as a private individual, family member or simply a citizen but as a Christian/priest. If it were not the case, priests would, after performing Christian religious rituals, change their robes and perform non-religious counterparts. Both the societal expectation and the person`s individual or institutional role point actions and responsibility to Christian liability.

The same applies to the church, the textile industry, and the followers though such followers are skimpier and have always put on a double face in apportioning blame. While Christians mostly attribute religious liability only to their leaders and institutions in times of public scrutiny, they are equally liable as long as they confess to being Christians. All Christians, leaders or not, are bound by the same related doctrines and teachings.

Christianity's contribution to Uganda's environmental sustainability agenda

Uganda is a religious country and protection of the environment and natural resources is not only a religious mandate but also a legal requirement. The country' religious stance is cemented in its motto "For God and my country". This stance equally extends to protection of the environment among others. Chapter XIII of the Constitution provides that the state shall protect important natural resources, including land, water, wetlands, minerals, oil, fauna, and flora, on behalf of the people of Uganda. Section 4.1 of the 2019 National Environment Act further stipulates that nature has a right to exist and function.

In addition, environment management in the country is a shared responsibility, and every person has a duty to create, maintain, and enhance the environment (Republic of Uganda 2019). Christians, just like other groups, are expected to promote Uganda's sustainable development agenda. To understand the contribution of Christianity to the country's environment and sustainable development agenda, two interlinked questions were set. How has Christianity contributed towards preservation and environmental restoration and towards policy and advocacy for sustainable development.

Preservation and environmental restoration

Review and analysis conducted indicates that Christianity has been at the center of Uganda´s historical and current political, socioeconomic, and environmental development. This is mainly linked to the religion`s ownership and control of key natural resources particularly land. Religious institutions in the country, especially the traditional Christian denominations own more land in comparison with more recent or other religious denominations. The actual extent of some of the landholdings of particularly old missionary-established churches in Uganda is unknown, even to the churches themselves (Alava & Shroff 2019). Importantly, one notable contribution by these churches has been their resolve in maintaining such resources intact, despite the pressure from within and outside.

While Uganda experiences serious degradation, most of the natural resources owned by Christian institutions are relatively in a better state compared to those under other arrangements. The traditional Christian churches known to occupy strategic hilltops have fairly kept these places intact. Key among these include Rubaga, Namirembe, the smallest church in Africa at Biku in Nebbi, and related hills to which the author postulates would have been worse if owned and occupied by other entities.

In addition to places of worship, several restoration interventions are visible across the country. A number of Christians and related institutions also manage other critical environment and natural resources other than land, including forests, some wetlands, and minerals, among others. With increasing degradation, these have launched several restoration efforts. A number of mainline churches have setup several initiatives in water and forestry, and some have developed policies and plans (Omona 2022). The Catholic Church has, for instance, committed 600 acres of land for the restoration of the Nandere Natural Forest Reserve in Kasana Luwero. The Church of Uganda similarly offered land to the National Oil Company to address climate change effects. Similar initiatives are ongoing in most churches through several partnerships with the public and private sectors.

In addition, Christian-related institutions, including schools, hospitals, banks, and affiliated civil society organisations are leading key restoration efforts. By December 2023, Centenary Bank had implemented 30 sustainability initiatives, including planting 14689 trees in the three cities of Kasese, Masaka, and Mbale (Centenary Bank 2024). Under the Restore Africa Project, Catholic Relief Services is restoring 560,000 hectares of degraded landscapes in 34 districts by 2027 (The Cooperator News 2024).

Adventist Development and Relief Agency has been leading environment and climate change initiatives in Uganda with the most recent U$4.8 million STRENGTH project. The project promotes climate smart agriculture and aims to develop climate resilience practices in Karamoja, Acholi, and South Sudan (Tous droits réservés, 2025). Other organisations include Caritas International, A Rocha Uganda, Ndejje, Bishop Stuart, and Uganda Pentecostal Universities,

among others. These have been involved in several initiatives, including waste management, water harvesting, and energy efficiency, among others.

Policy and advocacy

A number of Christian-based faith institutions, including churches and companies, have developed policies and strategies. A study in 2021 reported that the Anglican Church of Uganda had managed to develop an environmental policy; Pentecostals had a draft, while the Catholic Church already had such a policy in Central and Southern Uganda (Mucunguzi 2021). Bunyoro Kitara Diocese has a policy for every one of its parishes to plant a wood lot of pines with every candidate for confirmation and baptism planting a pine tree. Other institutions have, through such policies, been able to implement corporate social responsibility and outreach programs for sustainability.

Environmental education, particularly through preaching and sermons, is also a vibrant tool for environmental protection. Pope Francis' encyclical Laudato Si remains a key guidance framework for all Christians and not only Catholics. In the Anglican Church, pastoral letters and synod resolutions increasingly raise the need to combat degradation through deforestation, water pollution, and climate change among others (Church of Uganda 2015). A 2022 pastoral letter from Uganda Joint Christian Council for instance called on everyone to protect the environmental through better and friendly environmental practices (UJCC 2022). The letter further discouraged encroachment on wetlands, lake shores and river banks. Pentecostal churches have equally raised this call in and outside church sessions through biblical stewardship principles and community environmental action-oriented engagements.

In addition to preaching and sermons, Christians have also influenced advocacy for environment actively participating in related events. Tree planting remains a key message, followed by direct, active engagement. In 2020, the Uganda Joint Christian Council (UJCC) condemned the decision to convert Bugoma forest for sugar cane growing. Several other Christians have called for the banning of the use

of plastics, climate action, and halt of oil and gas development activities, among others. In 2022, the Roman Catholic Church joined the call to halt oil development activities if they were to displace communities and endanger wildlife (Publicist 2022). In 2023, more than 35 Ugandan religious leaders issued a joint statement opposing the East African crude oil pipeline, citing cases of unfair compensation (Ezaruku 2023). These, among others, confirm Christianity's positive mark on Uganda's sustainable environment management agenda.

Environmental degradation in Uganda through Christianity's lens

How has Christianity affected Uganda's environment? Amidst the strong religious quest and stable religious and Christian numbers is a steady and increasing rate of environmental degradation. The theoretical underpinning would be that the big religious and Christian numbers in the country would translate into better environmental indicators due to strong spiritual and moral values. Table 2 shows a consistent poor environmental record for the country particularly the period 1990 onwards.

Table 2: Selected environment parameters for Uganda between 1990 and 2024

Indicator	Base	Current	Source
Wetland Cover	1994 (37,575 sq. Km)	2021 (20,940 sq. Km)	Ministry of Water and Environment - Uganda
Forest Cover	1990 (24%)	2019 (13%)	National Forestry Authority-Uganda
Environmental Performance index	2002 (48.7)	2024 (35.80)	Yale/Columbia University

As shown in Table 2 above, almost all of the country´s environmental parameters have been on decline, and 41% of the country`s total land area is degraded (CIAT et al. 2017). The 1990s are the start of most of

the degradation, followed by sustained periods of degradation. The table shows wetland coverage declining from 37575 km^2 in 1994 to 20,940 km^2 in 2021. Forest cover follows a similar trend, from 4.9 million hectares in 1990 to 1.8 million hectares in 2018. All other statistics can be found in the country's Environmental Performance Index, which reduced from 48.7 in 2002 to 35.8 in 2024. The Environmental Performance Index ranked Uganda 125 out of 181 with respect to tree cover loss in 2022 and 154 in 2024 (Yale University 2024). Are these statistics linked to Christianity? Christianity's footprint on degradation can be examined from many angles. Demographically, the country's 99% religious population, and particularly the majority 85% Christians, have something to do with degradation.

The major economic mainstay for most Ugandans is agriculture, and 65% of the population is engaged in agriculture, forestry, and fishing (UBOS 2018, World Bank 2018). There is no doubt that agriculture employs and sustains many of the Christians in the country. These are largely smallholder subsistence farmers that rely on traditional methods, most times environmentally unfriendly. The increasing Christian population adds more demand and pressure on the environment and natural resources for agricultural inputs and production, including land, wood fuel, and water for irrigation, among others. As more land is opened up for agriculture, buffer zones between human settlement and protected areas are lost (NEMA 2016 in Cooper 2018). Importantly, the manner in which trees are indiscriminately cut in the era of Christianity is unprecedented and has never been experienced (Kimanje 2024).

In principle, the large Christian numbers in the country compared to other religious groups contribute to degradation following the population agricultural lens. Historically, the colonial legacy preceded by the European missionary settlement in Uganda biased ownership and use of natural resources towards Christianity. This was particularly through the allocation of huge chunks of land to the church, government, and selected individuals. The governance system at the time, both at the center and within kingdoms, was Christian, resulting in an emergency of more prominent and powerful Christian landowners versus other groups.

Before colonisation, Islam had a strong presence, particularly in Buganda; it would later be overtaken by Christianity and relegated to an underprivileged minority (Ward 1991). In 1900 Buganda Agreement for instance, the Kabaka was allocated 906 sq km of Buganda's land, with the remaining community land being allocated to the predominantly Christian kingdom's traditional chiefs (Vicky 2011). Similar land´s allocation systems followed suit across the country. Lands allocated contained environment and natural resources, and with increasing population coupled with urbanization and industrialisation these have come under human encroachment from all religious groups, with more Christians being given a larger share on account of their being the majority of the country's 45 million people.

The British Christian colonialists further promoted degradation of some key natural resources. For instance, wetlands were classified as wastelands; their resources were not considered valuable and remained nobody's property (Ntambirweki 1998). Naturally, increasing Christian populations would find these wastelands as alternatives for settlement and livelihood. Incoming governments further embraced this colonial legacy.

In the 1970´s, existing governments resorted to managing land pressure by encouraging wetland reclamation (ALTER 2014). Overpopulated regions in the country reclaimed existing wetlands for farming and settlement. Southwestern Uganda, which benefited most from this programme, was and is largely Christian. Until now, in a district like Kabale, around 99% of the population is Christian and only 0.8% is affiliated to Islam (UBOs 2017). It obvious that most of the ``degraders`` are Christians. Christianity´s observable mark on natural resources is further evidenced through the uptake and use of wetlands as places of worship. There is still scanty data about the number of such places of worship amidst natural resource hotspots. The author postulates that the Greater Kampala Metropolitan Area incorporating Kampala, Mukono and Wakiso hosts the biggest number of these churches. Anecdotal data already shows staggering numbers, and these have been increasing.

A 2006 crude estimate by a government official in New Vision newspaper report put the number of churches located in wetlands at over 100 within Kampala and the neigbhouring districts. This is currently an underestimate given the time factor. There is, however, something unique about churches in wetlands. Most of them appear relatively newer mainly from the year 2000 onwards. A number of these are also semi-permanent and individual rather than communal owned. Such churches have been reported widely and a number demolished, the most recent being Blood of Jesus Church in Mukono Municipality (Nile Post 2024).

A blog by John Semakula (January 2025) notes numerous Pentecostal churches situated in wetlands in the country. Christians are also said to predominate in the destruction of the environment (Afunaduula 2023 in Muwado 2025). While these may be more informal and personal view points, they appear consistent, wildly held and undisputed. Several reasons, including lower initial investment costs and impunity, followed by relaxed regulatory enforcement and lack of ecological intelligence (Mategyero 2024) offer most probable explanation. Christians, including their leaders, have orchestrated several other instances, including illegal sand mining, rice growing, and the building and construction of other structures in wetlands.

In addition to encroachment on wetlands, Christians have greatly contributed to worsening the soundscape of host areas and communities. Enhanced by advances in sound technology, most of the churches today have sound equipment that emit noise reaching far beyond their boundaries. There is increasing noise pollution from churches particularly those with longer services and the changing patterns of worship from weekly to daily and almost on a 24-hour basis, which used not to be the case.

The churches and Christians concerned continue to insist that they have a right to ``worship and emit noise for Jesus`` and a number of these have petitioned for exercising this right. In July 2022, a group of church leaders in Uganda petitioned the country's president and NEMA-the environmental agency, requesting to be allowed to exercise their right to worship. This is amidst noise pollution complaints from church neighbors. Table 3 below shows how between October 2020 and

March 2021,as many as 25 noise pollution complaints against churches were received from community members via phone calls compared to only 14 against bars. There are no publicly available statistics on the number of noise pollution complaints filed in Uganda about churches but city authorities acknowledge that most of the citizen complaints are on midnight churches and entertainment centers.

Table 3: Hotline and phone call noise pollution complaints to Kampala Capital City Authority

Type of complaints	**Type of premise**	**Months**						**Total**
		2020			2021			
		Oct	Nov	Dec	Jan	Feb	Mar	
Hotline /phone calls	Bars	5	5	3	0	1	0	14
	Churches	11	6	3	1	2	2	25
	Others	20	12	8	1	5	5	51
Grand Total		**36**	**23**	**14**	**2**	**8**	**7**	**90**

Source: KCCA 2021

That churches emit noise is a new pattern given that previously entertainment places used to emit most of the noise. There is a high possibility that churches could pollute more than bars, which has not been the case. This is further plausible given that most times, sound systems and speakers are projected outward instead of inside the places of worship. There are also instances where two-three people inside some churches use sound systems to amplify sounds that mimic multitudes of people. In order to realise sustainable development, this change in pattern and techniques calls for a detailed investigation on the possible motivations and effects on society.

Environmental Sustainability

The population of Christians in Uganda will continue increasing, and so will the institutions. By 2022, for instance, Full Gospel churches were over 16000 (Full Gospel Churches of Uganda 2022) while over 25000 Anglican local churches had been established across the country (Church of Uganda 2024). As the numbers of followers increase, so will the churches, but this will also impact the environment. It is thus important that deliberate effort is made to tap into this Christian demographic dividend to enhance the integrity and functionality of the environment and related resources. An integrated package of measures is proposed for environmental sustainability and includes five focus areas of Educating, Influencing, Integrating, Implementing and embracing Technology, summed up as EIIIT.

Education as noted by the Holy Father, Pope Francis, the misuse of creation begins when we no longer recognize any higher instance than ourselves, when we see nothing else but ourselves. To make Christians recognise the environment as integral to their survival, it is important that awareness, sensitisation, and education are stepped up. There is already ongoing momentum in this area, but more needs to be done. Environment education and training need to be augmented by sustainability and climate education. Key focus areas of values, mindset change, sustainable lifestyles, and climate action should be integrated into all areas of learning, starting with early childhood education. It is important that Christian leaders spearhead this shift of reorienting learning. Formal education is good, but only when it is reinforced by informal and lifelong learning. Informal educators, particularly the home, church, and community, need to be engaged in for this to be effective.

Christians have been vocal in influencing Uganda's key development outcomes, including good governance, women's rights, and peace, among others. Few have, however, led initiatives to engage top policymakers to influence action towards a better environment. There are, for instance, hardly any meetings of Christians and their leaders engaging Parliament or the President on issues of environment and climate change. More dialogue with environmental stewards is

needed, and focus needs to change from petitioning for more freedom to worship and prayer to sustainable prayer sessions and harmony with nature and community. The mass and numbers of Christians are a good engagement basis and impact. It is important that Christians require that existing environmental safeguard policies work and impunity is openly condemned and halted.

Environmental sustainability should be integrated into the Christian-individual and institutional life cycle. Many Christian institutions have not developed sustainability strategies and action plans. Very few have environment management systems. These should mirror national aspirations. There are already effective environmental sustainability initiatives in the country, including the ban on plastic carrier bags, littering and waste management, and energy efficient schemes, among others. These need to be adopted and integrated into key operational and guidance frameworks.

Environmental action goes beyond policy and integration to involvement and execution of tasks on the ground. The vast amount of natural resources within the control of Christians provides an opportune moment for regenerative and restorative efforts. The existing empty and underutilised land spaces can be used to offset the environmental deficit when effectively utilized. There is a need to tap into available innovative mechanisms, including green financing, carbon credit, and trading mechanisms, among others, to enhance the value and sustainability potential of currently owned resources.

Technology needs to be integral to every action, particularly for environmental gain. There are positive developments, including real time monitoring of the environment, virtual church services, and low-carbon emission advances, that Christians need to embrace. Church services should, for instance, be communicated over technology forums and bulletins, smart sound level measurement tools installed, church property mapped and demarcated, and social media used for massive awareness, sensitisation, and education, among others.

CONCLUSION

It is clear from the interrogation that Christianity and its followers have contributed enormously to sustainable environment management in Uganda. The big numbers and ownership of vast amounts of natural resources, particularly land, puts Christianity in an advantaged position to promote better environment management. These resources have, however, not been effectively deployed for better environment and climate change proofing. The reverse instead holds with Christians, including their leaders and institutions, perpetuating further degradation. This calls for a deliberate effort to restore the environment by streamlining existing mechanisms and arrangements. Key among these include the need for enhanced education, engagements, integration and adoption of technology among others summed into the EEIT integrated package for Christian-environmental sustainability.

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Implementing Competence-Based Education in Large Professional Courses for Teacher Trainers in Ugandan Universities

Judith Arinaitwe, PhD[1], *Israel Mwebembezi*[1], *Syson Amutuhaire*[1], *Arthur Ahumuza*[2]

[1]Bishop Stuart University, [2]United Nations Mission in South Sudan

ABSTRACT

This scholarly investigation examines the integration of competency-based education into substantial professional courses for teacher trainers at universities in Uganda. It is contended that, despite Uganda's efforts to integrate competency-based education into significant professional courses for teacher trainers at its academic institutions, a considerable gap remains between its design and implementation. The inquiry was conducted using a qualitative research methodology, which encompassed a comprehensive assessment of secondary sources. The principal conclusion drawn was that, although competency-based education is available within major professional courses for teacher

Judith Arinaitwe (✉)
ORCID: https://orcid.org/0000-0002-2582-6496
E-mail: jajudith42@gmail.com

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trainers at Ugandan universities, its implementation has not been executed effectively, thereby adversely impacting the quality assurance competencies of the educators. It is recommended that, by accentuating personal self-actualization alongside pedagogical responsibilities, the competency-oriented approach has the potential to substantially enhance the caliber of professional education, while concurrently aligning with global educational standards and effectively addressing local educational requirements.

Key Words: *Competence-Based Education, Curriculum Review, Teacher Trainers, Professional Development*

INTRODUCTION

The implementation of competency-based education (CBE) within significant professional programs for teacher educators in Ugandan universities presents unique challenges and opportunities. While Uganda has embraced CBE, the effective realisation of this pedagogical framework requires the resolution of issues about teacher preparation, allocation of resources, and engagement of stakeholders (Bwembya *et al*, 2025). This educational paradigm equips aspiring lecturers with the essential skills and knowledge necessary to meet the evolving demands of the educational environment. The CBE seeks to reconcile the gap between theoretical understanding and effective teaching practices by emphasising practical competencies and real-world relevance. On a global scale, competency-based education (CBE) within teacher training programs is increasingly recognized as a pivotal strategy for preparing educators to address the requirements of modern educational settings (Catacutan, 2023).

This instructional approach prioritises the development of specific competencies, encompassing knowledge, skills, and attitudes that are essential for competent teaching. When executing CBE in extensive professional programs for teacher educators at international institutions, factors such as curriculum development, pedagogical expertise, and digital literacy are of paramount importance (Njiru & Odundo, 2024; Ogada, 2025). Competency-based curriculum frameworks are vital for

teacher education as they align educational outcomes with the competencies demanded by the labour market. This approach promotes professional advancement and underpins sustainable educational policies (Piri, 2021). The curriculum must be constructed to facilitate both personal and professional development, incorporating cultural and ethical values alongside traditional educational subjects (Stukalenko *et al*. 2016).

In the realm of higher education, educators are expected to possess a broad spectrum of pedagogical competencies, which include personal, research, and instructional skills. Such proficiencies are crucial for delivering high-quality education and adapting to diverse classroom dynamics (Moriera et al., 2022). Students tend to prioritise personal skills and attributes, while educators focus on curriculum design and instructional effectiveness. In light of the rapid technological advancements, digital competence emerges as a fundamental component of teacher education. Establishing standards for digital literacy is essential to guide training programs and ensure that educators are adequately prepared to seamlessly incorporate technology into their teaching methodologies (Basantes-Andrade et al., 2022). Training programs should be customised to meet the specific needs of university faculty, equipping them with the resources and knowledge necessary to improve their digital skills (Rhoney et al., 2024). Although the incorporation of CBE into teacher training programs offers notable advantages, it simultaneously introduces challenges (Nombo, 2022).

These challenges include the necessity for comprehensive frameworks that encompass the diverse competencies needed across various educational contexts, as well as the integration of digital tools in ways that augment rather than complicate the teaching process. Furthermore, it is imperative to achieve a balance between the emphasis on performance-based models and the acknowledgement of situational and cultural diversity within educational environments (Moriera et al., 2022; Basantes-Andrade et al., 2022).

In Uganda, the Ministry of Education has initiated reforms targeted at the integration of Competence-Based Education (CBE) into teacher training programs and various educational sectors (Kyobe & Rugumayo, 2005). As delineated by Kyobe and Rugumayo (2005), the

Uganda Vocational Qualification Framework (UVQF) was instituted to guide the formulation of occupational profiles and standards, which are crucial for the effective implementation of CBE. By aligning educational curricula with the competencies essential for efficacy in the classroom, CBE significantly enhances the relevance of teacher preparation (Kikomeko *et al*, 2019). It facilitates the development of practical skills and encourages active learning, both of which are vital for the delivery of effective instruction (Ndeezi *et al*, 2024). Notwithstanding its merits, the transition to CBE is fraught with challenges, including inadequate training for educators and institutional barriers that impede effective implementation (Ezati *et al*, 2014). To effectively tailor training programs to the pedagogical competencies required by university faculty, thorough needs assessments are essential.

While CBE provides a comprehensive framework for enhancing teacher preparation in Uganda, systemic challenges that may hinder its effective implementation require systematic attention. Attaining the desired educational outcomes will necessitate a judicious balance between institutional support and the enhancement of competencies. It is crucial to recognise that the incorporation of Competence-Based Education (CBE) within extensive professional courses for teacher trainers at Ugandan universities is increasingly acknowledged as a method to improve educational outcomes and align training with industry demands. This literature review synthesizes findings from various studies that emphasize the significance, challenges, and frameworks relevant to the implementation of CBE in teacher training initiatives.

The CBE framework is instrumental in enhancing the competencies of professionals, particularly in the health and education sectors, to meet the demands of the 21st century (Katoue, 2020). It underscores the importance of practical skills and real-world applications, which are essential for promoting effective teaching and learning across diverse contexts (Piri et al., 2024). The Ministry of Education in Uganda has embarked on reforms aimed at integrating CBE into vocational training by establishing the Uganda Vocational Qualification Framework (UVQF), which guides curriculum

development and assessment methodologies (Kyobe & Rugumayo, 2005). Empirical research indicates that frameworks such as EQUIP have been effectively incorporated into university curricula, thereby demonstrating the feasibility of CBE in pre-service education (Topcu, 2023). Despite the potential benefits, challenges such as inadequate training for educators and the lack of standardised assessment frameworks persist (Zigama, 2025).

Recommendations advocate for the enhancement of faculty training in CBE methodologies in conjunction with the development of robust assessment tools to ensure effective implementation (Piri et al., 2024). While the transition towards CBE in teacher training presents considerable promise, it is imperative to address the existing barriers to ensure that these educational reforms result in substantial improvements in teaching quality and professional preparedness. This study posits that while Uganda has sought to adopt competence-based education in big professional courses for teacher trainers at Ugandan institutions, there remains a mismatch between its design and implementation**.** It is against this context that this study aimed to evaluate the implementation of competence-based education in large professional courses for teacher trainers at Ugandan universities.

METHODOLOGY

The study's research approach was qualitative, which involved reviewing and interpreting secondary data. Secondary sources for the information included textbooks, journal articles, and reports from both physical and online data sources, including Google Scholar. Data collaboration was done to ensure authenticity and dependability. Exclusion criteria were achieved through ensuring the study adopted a qualitative research methodology only. Exclusion was achieved by ensuring that only newly published secondary literature was considered. Beyond collaboration, data reliability (dependability) and validity (credibility) required more than basic triangulation, involving a rigorous, transparent, and reflexive process designed to build trustworthiness.

The researcher maintained a detailed, step-by-step record of all research decisions, from the initial research design to the final data analysis. Self-awareness and disclosure of the researchers' own biases, preconceptions, and influence on the research process were ensured. Colleagues and experts not directly involved in the study were engaged to review the analysis and challenge assumptions. Data analysis involved content analysis, which is a procedure for organising unstructured data into groups or subjects using trustworthy deduction and interpretation. To identify patterns, thematic analysis entailed six essential steps: familiarisation (reading data), creating initial codes, looking for themes, reviewing themes, defining and naming themes, and producing the report. This methodical approach ensured rigour and clarity by moving from deep data immersion to finding, honing, and presenting significant patterns (themes) that addressed the research issue. This allowed the researcher to identify areas of resemblance and distinction, establishing a foundation for the examination.

FINDINGS AND DISCUSSION

Benefits of competence-based education

The implementation of competence-based education (CBE) in comprehensive professional courses for teacher trainers at Ugandan universities is an intricate endeavor aimed at enhancing the caliber and applicability of teacher education. This strategy focuses on giving aspiring teachers the knowledge and abilities they need to fulfill the demands of contemporary classrooms. Studies that emphasize CBE's overall advantages, feasibility, and prospective benefits and problems lend support to its incorporation into teacher training programs in Uganda. Makerere University's implementation of the EQUIP competency-based approach shows that standardizing competency levels and filling up curriculum gaps are feasible. This method places a strong emphasis on developing practical abilities, which is essential for teacher candidates (Ndeezi et al., 2024).

The Ndeezi *et al*. (2024) study emphasized the necessity of a longer training period for teachers to gain confidence in implementing the EQUIP approach, the critical role-play plays in enhancing learning experiences, and the significance of feedback in encouraging participants' self-assurance and skill development. These results imply that, despite their concentration on clinical psychology, comparable approaches can be useful for introducing competence-based education in extensive professional courses for teacher trainers in Ugandan universities. Human Nutrition and Dietetics training is an example of how Competence-Based Education (CBE) improves professional competence and is in line with teacher education needs (Kikomeko *et al*, 2019) (Kikomeko *et al, n.d.*). The emphasis is on creating and verifying skills that meet the unique requirements of Uganda's educational systems (Kikomeko *et al*., 2019; Kikomeko *et al., n.d.*).

The study emphasized the necessity of identifying and validating the competences necessary for efficient performance within the nation's health systems and argued for the use of competency-based education (CBE) in the training of Human Nutrition and Dietetics (HN/HND) professionals in Uganda. It emphasized that the lack of these skills could hinder the advancement of HN/HND education, leading to inefficient spending and subpar training results. In order to improve the efficacy of training programs in Uganda's health sector that calls for a change towards Competency Based Education which may have an impact on other professional courses.

The adoption of CBE in Uganda's vocational education highlights challenges, such as the need to create standards, evaluation instruments, and occupational profiles. These issues are pertinent to teacher preparation programs, which need comparable frameworks to guarantee successful execution (Kyobe & Rugumayo, 2005). The study also covers the Ministry of Education and Sports in Uganda's initiative to implement Competency-Based Education and Training (CBET) in order to reform business, technical, and vocational education and training. This includes the creation of the Uganda Vocational Qualification Framework (UVQF) with input from a number of stakeholders.

Conversely, the application of competence-based education in extensive professional courses for teacher trainers in Ugandan institutions was not expressly covered by the study. Nonetheless, it describes how Competency-Based Education and Training (CBET) is being implemented in Ugandan vocational education, with a focus on developing occupational profiles, standards, and curricula. Along with highlighting issues, it also lists advantages for sectors including water and sanitation, indicating the need for more research on the use of CBET in higher education settings.

A personality-driven educational process is a part of the shift to a competence-based approach in education, which can be challenging for institutions and teachers alike. It can be challenging to integrate the extensive collection of knowledge, abilities, and cultural values required by this approach into the current curriculum (Stukalenko *et al*, 2016). By including the knowledge, abilities, and moral principles necessary for professional development, competence-based education enhances the personality culture of aspiring teachers, according to Stukalenko et al. (2016).

This method can maximize the potential of teacher trainers at Ugandan universities by fostering a personality-oriented educational process. The competency approach, which emphasizes pedagogical responsibilities and human self-actualization, can significantly improve professional education quality while also aligning with international educational paradigms and successfully meeting regional educational needs. The study continues by examining the development of a new educational paradigm in the twenty-first century, with a focus on the necessity of cultivating the personality cultures of aspiring teachers. This includes all of the knowledge, skills, abilities, and moral and cultural values needed to create a person who is capable and professionally mature.

Therefore, the embodiment of knowledge, skills, and education that promotes social integration and personal self-actualization can be characterized as competence (Halatsyn, 2022; Dang, 2024). For that reason, a personality-oriented educational process that maximizes the teacher's personality potential in addressing pedagogical challenges is the definition of professional training for aspiring teachers. Although

there is promise in the application of CBE in Ugandan teacher preparation programs, it is crucial to consider the broader educational environment.

The creation of strong frameworks and educational institutions' dedication to embracing new pedagogical paradigms are essential to the success of CBE. Furthermore, to make sure that CBE successfully satisfies Uganda's changing teacher education demands, continuous study and assessment are required. The adoption of learner-centered pedagogy was greatly aided by the support of college-based mentors, as evidenced by related studies like Kisalama's (2019) finding that more than 90% of teacher-trainers were satisfied with the quantity and caliber of pedagogical mentorship they received during the intervention. Furthermore, 83% of respondents concurred that the mentoring and supervision they received had benefited their classroom instruction (Kisalama & Kibedi, 2019).

One important element in improving teacher-trainers' reflective skills was the incorporation of video into the mentorship process. The overall quality of their instruction was enhanced by the participants' reported gains in self-assurance in the classroom and ease accepting peer criticism. Additionally, mentors reported that video recordings made it easier to have evidence-based conversations and assess how well mentees were applying learner-centered strategies.

The significance of instructors possessing the ability to analyze, design, develop, and assess competency-based instructional offerings was highlighted in a related study by Elazier (2019), which identified a set of instructor competencies necessary for faculty professional development to transition to competency-based instructional programming. The study emphasized the necessity for educators to build dynamic, active learning experiences that foster students' acquisition of knowledge and skills in place of traditional, static information-based training. In order to move away from traditional, passive knowledge-based instruction and toward more dynamic and active learning experiences, it emphasized the significance of creating and refining a competency-based instructor training model that enables instructors to analyze, design, develop, and assess competency-based instructional offerings.

Challenges of competency based education

The implementation of competency-based programs faces a number of obstacles, according to a study by Eklund (2018). These include a lack of development resources, high expectations for students, confusion brought on by the amount of paperwork related to competencies, and the requirement for ongoing competency activity revisions. These challenges highlighted how difficult it is to carry out such undertakings successfully. According to the study, comments indicated that students preferred the autonomy provided by the competency-based curriculum over more conventional methods, and their sentiments toward it was generally positive.

However, students expressed concerns about the excessive workload and requested more engaging activities, highlighting the need for further program development and longer-term operation to increase efficacy (Eklund, 2018). According to Atuhura (2024), a lack of instructional materials, time constraints, and large class sizes are the main reasons why secondary school English teachers in Uganda face significant challenges when implementing the 2020 English language competency-based curriculum. Effective teaching and learning in low-income educational environments are hampered by these barriers.

Additionally, the results indicate that the challenges faced by ESL teachers are exacerbated by inadequate planning and support from stakeholders, as well as a mismatch between local culture and learning styles. This demonstrates that the challenges of implementing a competence-based curriculum are widespread in many educational settings across Sub-Saharan Africa and the global south, not only in Uganda. This illustrates how these challenges are common to the majority of ESL classrooms in the global south, bringing to light the same problems that educators face while creating and executing competence-based curricula in Sub-Saharan Africa and the rest of the global south.

Cross-sector insights

In a comparable parallel study, Mukasa (2020) found that technical teachers and instructors in Uganda are better educated by instructional techniques that encourage experiential and constructive learning. These tactics enhance the overall competency of educators in the field by fusing knowledge with a scientific foundation with real-world abilities and values.

According to the study, these teaching techniques help instructors better assess the learning requirements of their students, plan and oversee learning activities, and create an atmosphere where students can freely experiment, explore, and seek solutions—all of which contribute to the improvement of Technical and Vocational Education in Uganda. This is in line with results from a study conducted at Makerere University by Ezati (2014), which discovered that participating academics' teaching experience varied. Most had between 11 and 15 years of experience, especially from the Faculty of Veterinary Medicine, while a smaller percentage had more than 20 years of experience, mostly from the Faculty of Law. This suggests that the training was especially helpful for the teaching staff, who were mostly in their early to mid-career stages. Of the 101 academics who took part in the study, 29.7% were female and 70.3% were male.

This suggests that there is a large gender gap among the academic staff, with roughly twice as many male academics as females. Day (2016) argues in the chapter on Competence-based Education and Teacher Professional Development that although competence is a basic quality of teachers, professional development should not only concentrate on it because teaching involves a complex fusion of cognitive and emotional skills, knowledge, attributes, and values that go beyond clearly defined competencies. In contrast to being restricted to externally determined criteria of competence, this highlights the significance of professional development systems that enable teachers to participate in deeper learning, such as comprehending and utilizing robust data systems and awareness of external requirements.

Conclusion and Recommendations

The research endeavored to explore the impediments associated with the incorporation of competency-based education (CBE) into substantial professional curricula for teacher educators within universities in Uganda. It underscored that, despite the theoretical accessibility of CBE, its practical implementation remains insufficient, thereby compromising the essential skills required for quality assurance. To further investigate this matter, the researcher utilized qualitative methodology, which included an exhaustive review of secondary literature.

The primary challenges encompass the requisite for extensive knowledge, skills, and cultural values, in addition to inadequate financial resources and a deficiency of support from relevant stakeholders. The findings suggest that a more profound alignment with international educational standards and local necessities is crucial for the advancement of professional education quality.

The research asserts that competency-based education (CBE) possesses the potential to enhance the quality of professional education within Uganda's teacher training programs. It is proposed that there is a need to establish capacity-building programs to support the implementation of CBE. Digital literacy training is also vital for the successful implementation of the program. Mentoring models are vital in supporting competence-based education by providing personalised guidance, fostering self-directed learning, and bridging the gap between theoretical knowledge and practical application.

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Availability of data and material for data transparency:
The Google Scholar repository, [https://scholar.google.com/], contains the datasets created and/or analysed during the current study. This

published article [and its additional information files] contain all data produced or analysed during this investigation.

Declaration: I certify that the data in this paper has not been offered for publication anywhere.

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A Review of Farmer Attitudes and the Persistent Challenge of Newcastle Disease in Smallholder Poultry Systems

*Able Ninsiima[1], Gershom Nuwemuhwezi[1], Charles Musinguzi[1]

Bishop Stuart University,
Faculty of Agriculture, Environmental Sciences and Technology

ABSTRACT

Newcastle Disease (ND) remains a primary constraint to smallholder poultry production in sub-Saharan Africa, resulting in cycles of poverty and food insecurity. While effective vaccines exist, their adoption remains inconsistent. Understanding the socio-behavioural factors, particularly farmer attitudes, is critical for bridging the gap between technical knowledge and effective control. This review synthesizes findings from a community-based study in Kashari Sub-County, Uganda, to analyze local poultry farmers' attitudes towards Newcastle disease and its control, situating these findings within the broader literature on disease management in smallholder systems.

Ninsiima Able (✉)
ORCID: https://orcid.org/0009-0003-2375-9183
E-mail: aninsiima@faest.bsu.ac.ug

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A descriptive, mixed-methods survey was conducted with 24 respondents (21 farmers and 3 local council leaders) using questionnaires and interview guides. Data was analysed using descriptive statistics and thematic analysis. The study reveals a high level of awareness (91.7% combined "very much aware" and "aware") and significant concern (87.5%) about Newcastle disease among farmers. Experienced farmers could identify key clinical signs, with watery stools (25%), lack of appetite (17%), and dragging legs (17%) being most recognized. Despite this awareness, farmers reported recurrent outbreaks, high mortality, and reduced income, indicating a critical disconnect between knowledge and practice. Barriers such as limited access to veterinary services, vaccine cost and distribution challenges, and insufficient extension support were identified as key impediments. Technical knowledge of Newcastle disease among smallholder farmers is necessary but insufficient for sustainable disease control. The findings underscore the imperative for integrated, community-sensitive interventions that move beyond awareness campaigns to address the structural and socio-economic barriers to vaccination uptake. Strengthening extension systems, promoting affordable and thermostable vaccines, and embedding control practices within local livelihood strategies are essential for reducing the burden of Newcastle disease.

Keywords: *Newcastle Disease, Smallholder Poultry, Farmer Attitudes, Vaccination, Disease Control, Uganda, Knowledge-Action Gap.*

INTRODUCTION

Poultry production is a vital component of global food security, providing a scalable source of affordable animal protein and a critical income stream for millions of rural households [1]. In sub-Saharan Africa, over 80% of poultry populations are managed by smallholder farmers who rely on indigenous, free-range chickens for income, food, and socio-cultural functions [2, 3]. Despite its importance, this sector is chronically hampered by infectious diseases, with Newcastle Disease

(ND) standing out as the most devastating viral pathogen [4].Newcastle disease, caused by virulent strains of Avian Avulavirus, can cause mortality rates approaching 100% in unvaccinated flocks, leading to severe economic losses and undermining household resilience [5, 6]. The technical solution to ND control—vaccination—is well-established. Thermo-tolerant vaccines, such as the I-2 strain, have been developed specifically to overcome the cold-chain limitations prevalent in rural areas [7]. However, decades of vaccination efforts have yielded suboptimal results, with ND remaining endemic in many regions, including Uganda [8].

A growing body of evidence suggests that the failure of disease control programs is often not due to a lack of technology, but to a poor understanding of the socio-economic and behavioural contexts in which farmers operate [9, 10]. While epidemiological and economic studies on ND in Uganda are available [11, 12], research focusing on the human dimension—specifically, the attitudes, perceptions, and decision-making processes of local farmers—is scarce. As Rushton [9] argues, the economics of animal health cannot be divorced from the perceptions of those who manage the animals.

This paper reviews the findings of a study conducted in Kashari Sub-County, Mbarara District, Uganda, which sought to investigate this gap. By analysing local farmers' awareness, perceptions, and attitudes towards ND, this review aims to contribute to a more nuanced understanding of why effective control remains elusive. The central thesis is that a profound "knowledge-action gap" exists, where high awareness does not translate into consistent preventive practices, and that closing this gap requires interventions that are as much social and economic as they are technical.

METHODOLOGY

Study design and setting

A descriptive cross-sectional survey, employing a mixed-methods approach, was conducted in Kashari Sub-County, Mbarara District, Uganda. This design was selected to capture both quantitative trends in

farmer awareness and qualitative insights into their perceptions and challenges at a single point in time [13].

Sampling and data collection

A total of 24 respondents were selected, comprising 21 local poultry farmers and 3 local council (LC) leaders. A combination of purposive (for LC leaders) and simple random sampling (for farmers) was used to ensure representation of key perspectives. Data were collected using pre-tested, structured questionnaires for farmers and semi-structured interview guides for key informants. The tools gathered data on demographic characteristics, farming practices, awareness of ND, identification of clinical signs, and perceptions of the disease's impact.

Data analysis

Quantitative data were analysed using descriptive statistics (frequencies and percentages) with results presented in tables. Qualitative data from interviews were analysed thematically to identify recurring patterns and contextual explanations for the quantitative findings.

Ethical considerations

Ethical approval was granted by the Bishop Stuart University Research Ethics Committee. Informed consent was obtained from all participants, and confidentiality was maintained throughout the research process.

Table 1. Respondent profile and sampling technique.

Respondents	Sample Size	Sampling Technique
Farmers	21	Simple Random Sampling
Local Council Leaders	3	Purposive Sampling

Total	**24**

RESULTS AND DISCUSSION

High awareness but variable knowledge

The study found an overwhelmingly high level of awareness of Newcastle disease among respondents. As shown in Table 2, 91.7% of farmers reported being aware or very much aware of the disease. This high level of consciousness is a positive foundation for any disease control program and aligns with findings from other regions where ND is endemic [14].

Table 2. Level of awareness of Newcastle disease among farmers n=24

Awareness Level	Frequency	Percentage
Very Much Aware	12	50.0
Aware	10	41.7
Not Aware	2	8.3
Total	**24**	**100**

However, awareness alone is only a crude metric. A deeper look at the identification of clinical signs (Table 3) reveals a more nuanced picture. While farmers demonstrated practical knowledge, with watery stools (25%), lack of appetite (17%), and dragging legs (17%) being the most frequently identified signs, knowledge of other specific neurological (e.g. twisting neck, 4%) and respiratory (e.g. coughing, 4%) signs was less common. This suggests that while farmers can recognize a sick bird, their ability to specifically diagnose ND, especially in its early or atypical forms, may be limited. This partial knowledge can delay targeted responses and contribute to the rapid spread of the virus.

Table 3. Clinical signs of Newcastle disease identified by farmers (n=24)

Identification Signs	Frequency	Percentage
Watery Stools	6	25
Lack of Appetite	4	17
Dragging Legs	4	17
Reduced Eggs laid	3	13
Gasping	2	8
Dullness	2	8
Coughing	1	4
Raising of Feathers	1	4
Twisting the Neck	1	4
Total	**24**	**100**

Significant Concern and Perceived Severity

Farmer attitudes reflected a deep-seated concern about the impact of ND. A significant majority (87.5%) expressed concern about the disease's effect on their flocks (Table 4), and 45.8% perceived it as "very serious" (Table 5). These attitudes are rational responses to the tangible economic losses experienced. Farmers reported effects including bird death, reduced income, and decreased egg production (Table 6), which are consistent with the documented pathogenesis of virulent ND strains [5, 15].

Table 4. Farmer concern about the impact of Newcastle disease.

Response	Frequency	Percentage
Yes	21	87.5
No	3	12.5
Total	**24**	**100**

Table 5. Perceived seriousness of Newcastle disease.

Perceived Seriousness	Frequency	Percentage
Very Serious	11	45.8
Moderately Serious	8	33.3
Slightly Serious	4	16.7
Not Serious	1	4.2
Total	**24**	**100**

Table 6. Reported effects of Newcastle disease on productivity.

Effects	Frequency	Percentage
Reduced Income	6	25
Death	5	21
Development of Culls	5	21
Reduced Egg Production	4	17
Increased Health Costs	3	13
Abnormal Egg Colour/Albumin	1	4
Total	**24**	**100**

The Knowledge-Action Gap: A Central Challenge

The most critical finding of this review is the stark disconnect between high awareness/concern and effective disease control. Farmers in Kashari Sub-County, despite their experience and knowledge, reported recurring ND outbreaks. This "knowledge-action gap" is a well-documented phenomenon in public and animal health [9, 16]. The barriers are not primarily informational but structural and economic:

- **Access and Cost:** Consistent access to affordable, quality vaccines (like I-2) and reliable vaccination services remains a key challenge [7, 8].
- **Extension Support:** Inconsistent veterinary and extension support leaves farmers without the ongoing guidance needed to implement and maintain control practices.
- **Socio-economic Priorities:** For farmers with small flocks, the perceived cost of vaccination (both financial and in terms of labour) may outweigh the perceived risk, especially if outbreaks are seen as sporadic or inevitable.

The dominance of semi-intensive and free-range systems (71% combined) in the study area further complicates biosecurity and coordinated vaccination, as birds are more difficult to gather and manage routinely.

CONCLUSION AND RECOMMENDATIONS

This review confirms that local poultry farmers in Kashari Sub-County are acutely aware of and concerned about Newcastle disease. They possess a foundational knowledge that is necessary for engagement in control programs. However, this awareness has not been sufficient to catalyse widespread and consistent preventive action, particularly vaccination. The persistence of ND is therefore not a failure of farmer knowledge, but a failure of the system to convert that knowledge into practical, accessible, and economically viable solutions. Technical interventions must be embedded within a broader support framework that addresses the real-world constraints of smallholder farmers.

Based on this synthesis, the following recommendations are proposed:

1. **Go Beyond Awareness Campaigns:** Extension services should shift focus from creating awareness to facilitating action. This includes hands-on training in vaccine handling and administration, and the establishment of community-based vaccinator programs.

2. **Strengthen Vaccine Supply Chains:** Government and development partners should invest in decentralized distribution systems for thermo-tolerant I-2 vaccines to ensure they are consistently available and affordable at the village level.
3. **Integrate ND Control with Livelihood Programs:** Link poultry health to income generation. Support farmer access to high-value markets for eggs and meat, so that investing in flock health has a clear and tangible economic return.
4. **Promote Low-Cost Innovations:** Train farmers in low-cost, improved housing designs that facilitate bird management and provide a first line of defence against disease transmission.

In conclusion, closing the knowledge-action gap for Newcastle disease control requires a paradigm shift from a purely technical approach to a socio-technical one. By aligning control strategies with farmer attitudes, economic realities, and local practices, sustainable reductions in ND prevalence can be achieved, thereby securing the critical role of poultry in rural livelihoods.

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Remittances, Human Capital and Economic Growth in Uganda

*Geoffrey Natumanya[1], Arineitwe Killian[2], Phiona Natuha[3], Turyareeba Dickson, PhD[3]

[1]Inspectorate of Government, [2]Uganda Bureau of Statistics, [3]Makerere University Business School.

ABSTRACT

This study investigated the effect of remittances and human capital on Uganda's economic growth using quarterly data for the period from 1999 to 2023. Three objectives were particularly investigated: (i) To investigate the effect of personal remittances on Uganda's economic growth, (ii) To investigate the effect of human capital on Uganda's economic growth, and (iii) To examine the combined effect of personal remittances and human capital on Uganda's economic growth. A linear symmetric autoregressive distributed lag (ARDL) model of Pesaran et al. (2001) was adopted in the estimation of the empirical models. Findings from the study have shown that variations in both personal remittances and human capital individually have a positive effect on real GDP per capita in Uganda, both in the short run and in the long run.

Natumanya Geoffrey (✉)
Email: geoffnat3611@gmail.com

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However, the estimates indicate that a unit change in human capital has a larger marginal effect than a unit change in personal remittances in their influence on Uganda's economic growth. Personal remittances and human capital have a positive and statistically significant combined effect on real GDP per capita in Uganda, both in the short run and in the long run. A comparative analysis of the individual and the combined effect reveals that the marginal individual effect of remittances and the marginal combined effect of remittances and human capital are not significantly distant from each other, suggesting that variations in personal remittances have independent effects from the variations in human capital on Uganda's economic growth. Findings suggest that Uganda's economic growth can be enhanced if deliberate policy is directed toward increasing investment in human capital development. Findings also suggest that Uganda's economy can reap some tangible benefits from labor externalization under a streamlined labour migration policy.

***Keywords**: Remittances, Human Capital, Real GDP per capita, ARDL, Uganda*

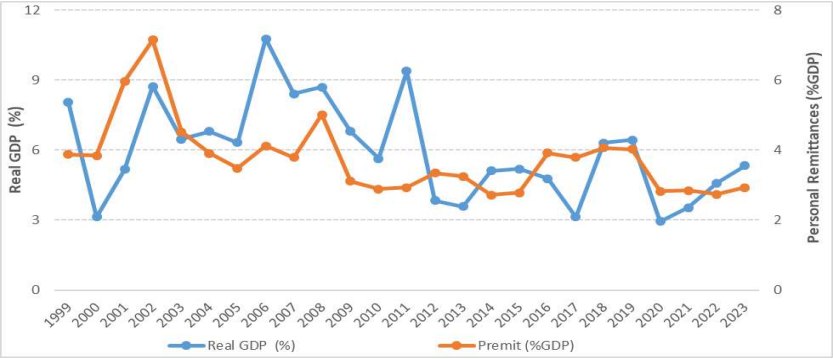
BACKGROUND OF THE STUDY

Economic growth remains a central driver of development worldwide, reducing poverty, creating jobs, and enabling structural transformation (Rizwanul, 2004). External financial inflows, particularly remittances, foreign direct investment (FDI), and official development assistance (ODA), play vital roles in this process (OECD, 2024). Globally, remittances reached $626 billion in 2022, with low- and middle-income countries receiving about 75% (IMF, 2023; WorldBank, 2023a). In many developing economies, remittances have historically surpassed FDI and ODA, providing a stable, countercyclical source of foreign exchange (Barajas, Chami, Gapen, & Montiel, 2009; Ratha, 2013). In Sub-Saharan Africa, remittances support household consumption, financial inclusion, and small-scale investments while acting as a buffer against shocks such as the 2008 financial crisis and the COVID-19 pandemic (World Bank, 2023b; Oteng-Abayie, Adom, & Arthur, 2020).

Remittances contribute to economic growth through several mechanisms: they smooth consumption and reduce poverty by boosting household income; enhance human capital via investments in education and health; stimulate entrepreneurship and small business creation; and stabilize macroeconomic conditions by improving balance of payments and reducing volatility (Chen, 2023). However, their long-term growth impact depends on complementary factors like skilled labor, financial sector development, and strong institutions; otherwise, funds may skew toward consumption rather than productive investment, limiting transformative effects (Azizi, Aftabi, Azizkhani, & Yektansani, 2024; Shirazi, Javed, & Ashraf, 2018).

In Uganda, sustained economic growth, averaging 5-6% annually, has been a national priority for poverty reduction, employment, and structural change despite structural challenges and external vulnerabilities (World Bank, 2023c; World Bank, 2022). Remittances have been a key external inflow, rising from $232.6 million in 1999 to approximately $1.3-1.4 billion in 2023 (WorldBank, 2023a). As a share of GDP, they peaked above 6% (and up to ~7% in some early 2000s estimates) but have declined steadily to about 2.63% by 2023 (Wamala, 2010).

Figure 1: Trends of personal remittances and real GDP growth over time



Source: World Development Indicators

This downward trend in the remittance-to-GDP ratio signals potential concerns: while absolute inflows have grown, their relative contribution to the economy has diminished amid faster GDP expansion and possibly shifting migration patterns or diaspora dynamics (Barro, 1996). This decline may weaken remittances' role as a reliable stabilizer and growth catalyst, especially if they increasingly fund consumption rather than investment, exacerbating vulnerability to external shocks and limiting support for industrialization or productivity gains (Aregbeshola, 2022).

A critical factor influencing remittance effectiveness is human capital. Higher education and skills enable households to channel remittances into productive uses, such as business startups, technology adoption, or industrialization rather than immediate consumption (Chen, 2023; MoES, 2022). Uganda has advanced through programs like Skilling Uganda, Universal Primary Education, and National Development Plans (NPA, 2020) Yet, over 60% of the labor force lacks formal secondary education, constraining access to high-productivity sectors (UBOS, 2021). Persistent brain drain further complicates this: emigration boosts remittances and foreign exchange but depletes skilled domestic labor, potentially hindering the country's ability to absorb and leverage inflows for sustained growth (Adarkwa, 2015; Aregbeshola, 2022; Barro, 1996). This creates a policy paradox: whether diaspora remittances can offset human capital losses or if talent outflows ultimately undermine long-term transformative potential.

Macroeconomic conditions, including gross capital formation, trade openness, FDI, exchange rate stability, inflation, and domestic savings, also mediate remittance impacts (Ralph, et al., 2008; Nyasha & Odhiambo, 2022). Weak financial systems and governance often divert funds from entrepreneurship to consumption (Barajas et al., 2009). This study examines interactions among remittance inflows, human capital, and economic growth in Uganda from 1999 to 2023, integrating key macroeconomic factors. Unlike prior studies treating these elements separately, it assesses how remittances and human capital jointly drive growth and offers evidence-based recommendations to optimize remittance use, bolster skills investment, and strengthen economic resilience and long-term development.

Problem statement

Uganda's economic strategy emphasizes sustained GDP growth to reduce poverty, create jobs, and support structural transformation (NPA, 2020; MoGLSD, 2016). Although the country has averaged about 5–6% annual growth in recent decades, progress remains fragile due to structural constraints such as low industrialization, limited value addition, export concentration, and sectoral productivity gaps (World Bank, 2023b). These weaknesses increase vulnerability to external shocks and commodity price volatility (IMF, 2023). Remittances have historically supported household welfare, foreign exchange earnings, and national income. Their share of GDP peaked at about 7.15% in 2002 and exceeded 6% in the early 2000s, but declined to roughly 2.63% by 2023 despite rising absolute inflows (WorldBank, 2023a). This decline may indicate that overall GDP growth has outpaced remittance growth, potentially reducing their macroeconomic stabilizing role and long-term development impact (Ify, 2024).

At the same time, Uganda faces a significant human capital deficit. Over 60% of the labor force lacks formal secondary education (UBOS, 2021), limiting productivity and access to high-value sectors (Owamah, Egbon, & Ishioro, 2025). Persistent brain drain further weakens the domestic skills base, with Uganda's human flight and brain drain index remaining high at 6.1 in 2023 and 6.0 in 2024 (IMF, 2023).

While migration generates remittances that support short-term consumption and foreign exchange, the loss of skilled labor may constrain the economy's ability to channel these inflows into productive investment (Usman, Ozdeser, Çavuşoğlu, & Aliyu, 2022; Kyeyune & Barungi, 2020). Although prior studies (Nsiah & Fayissa, 2013; Adarkwa, 2015; Shirazi et al., 2018; Oteng-Abayie et al., 2020; Nyasha & Odhiambo, 2022) have examined remittances and human capital separately in relation to growth, limited research explores their interaction in Uganda. This study addresses this gap by analyzing the relationship between remittances, human capital, and economic growth in Uganda from 1999 to 2023, controlling for gross capital formation, foreign direct investment, and trade openness, to inform policies that enhance resilience and inclusive growth.

Objectives

This study investigated the effects of remittances and human capital on Uganda's economic growth from 1999 to 2023. Specifically, it aimed to examine the effect of personal remittances on economic growth, investigate the impact of human capital on economic growth, and analyze the combined effect of personal remittances and human capital on Uganda's economic growth.

METHODOLOGY

This study employed a descriptive and explanatory research design within a non-experimental framework to examine the effects of remittances and educational attainment on Uganda's economic growth (Wooldridge, 2010). A quantitative econometric approach was adopted to investigate both short-run and long-run dynamics using quarterly secondary data from 1999Q1 to 2023Q4, obtained from the World Bank Development Indicators, Uganda Bureau of Statistics, and the Bank of Uganda (World Bank, 2023c; UBOS, 2021).

The main variables included personal remittances, human capital (proxied by the share of the population aged 25+ with at least primary education), an interactive remittance–human capital term, and controls such as gross capital formation, foreign direct investment, and trade openness. Remittances are expected to support growth by boosting consumption, investment, and financial stability, while human capital enhances labor productivity, and the interactive term captures their joint effect (Barro, 1996). Gross capital formation, FDI, and trade openness further influence growth by expanding productive capacity, technology transfer, and integration with global markets (Frankel & Romer, D, 1999). This approach allows rigorous statistical testing of causal relationships and provides robust insights into the role of remittances and human capital in Uganda's economic performance. The theoretical framework for the study was based on the Solow-Swan growth model (Solow, 1956; Swan, 1956) and its augmented version by Mankiw et al. (1992), which includes human capital as an additional factor of production. The Solow-Swan model can be expressed as:

$Y = Af(K, L)$…… (1)

Where Y is output, K is capital stock, L is labor, and A represents exogenous technology. With constant returns to scale, it takes the Cobb-Douglas form:

$Y = AK^{\propto}L^{1-\alpha}$ …… (2)

Where $0<\alpha<1$ represents the capital share in output, or total factor productivity (TFP). The augmented model adds human capital:

$Y = AK^{\propto}$…… (3)

Where $\alpha, \beta \epsilon [0,1]$ and $\alpha + \beta \ \epsilon [0,1]$. The empirical model, based on the augmented Solow framework, was specified as follows:

Model 1 (ARDL for Individual effects assessment)

$$LOG\_RGDPPC_t = \theta + \sum_{i=1}^{p} \beta_i \, LOG\_RGDPPC_{t-i} + \delta_1 \, LOG\_REM_t + \sum_{j=1}^{q1} \delta_j LOG\_REM_{t-j} + \pi_1 HC\_EDUATT_t + \sum_{k=1}^{q2} \pi_k \, HC\_EDUATT_{t-k} + \emptyset_1 \, GKF_t + \sum_{m=1}^{q3} \emptyset_m \, GKF_{t-m} + \varphi_1 \, FDI_t + \sum_{n=1}^{q4} \varphi_n \, FDI_{t-n} + \alpha_1 \, TRADEOPEN_t + \sum_{r=1}^{q5} \alpha_r \, TRADEOPEN_{t-r} + \varepsilon_t \quad \text{(a)}$$

Model 2 (ARDL for combined effects assessment)

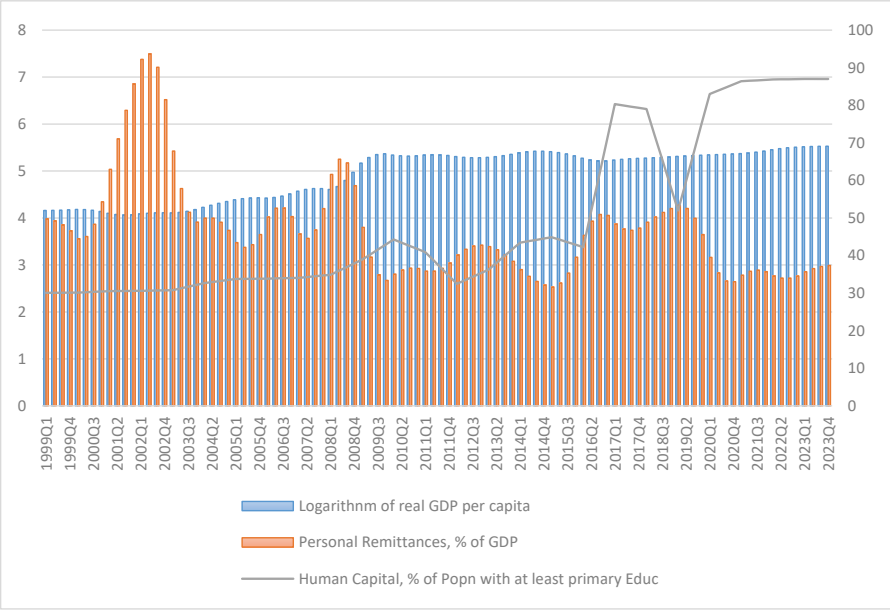
$$LOG\_RGDPPC_t = \phi + \sum_{h=1}^{p} \beta_h \, LOG\_RGDPPC_{t-h} + \sigma_1 LOG\_REM_t * HC\_EDUATT_t + \sum_{m=1}^{q1} \sigma_m LOG\_REM_t * HC\_EDUCATT_{t-m} + + \emptyset_1 \, GKF_t + \sum_{r=1}^{q2} \emptyset_r \, GKF_{t-r} + \varphi_1 \, FDI_t + \sum_{s=1}^{q3} \varphi_s \, FDI_{t-s} + \alpha_1 \, TRADEOPEN_t + \sum_{v=1}^{q4} \alpha_v \, TRADEOPEN_{t-v} + \mathrm{v}_t \quad \text{(b)}$$

Prior to estimation, stationarity of variables was confirmed using the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979), and cointegration was checked using Johansen (1995) and Pesaran et al.

(2001) tests. Multicollinearity was assessed through variance inflation factors (VIF) with a threshold of 10 (Hair et al., 2010; Kim, 2019). Post-estimation robustness checks included tests for autocorrelation (Breusch-Godfrey), heteroscedasticity (Breusch-Pagan), parameter stability (CUSUM), and omitted variable bias (Ramsey RESET), ensuring reliable and consistent estimation results.

Trend analysis in the main study variables over the study period: The trend analysis of the main study variables is depicted in figure 2.4 as indicated below;

Figure 1: Trends in the real GDP per capita, personal remittances and human capital over 1999Q1 – 2024Q4



Source: **Generated by author from analysis of raw data**

The trend depicted in Figure **2** above indicates that, over the study period, the variations in the variables of personal remittances and in the human capital proxy were remarkable than the variations in the variables real GDP per capita. The trend depicted in Figure 2 further indicates that, generally, real GDP per capita the human capital proxy (of the percentage population with at least primary education) followed an upward trend over the study period while personal remittances as a percentage of GDP generally followed a downward trend over the study period.

Descriptive statistics in the main study variables: These are the mean, minimum and the standard deviation of the study variables. The descriptive statistics are generated with the initial measurement units. Table 1 displays the summary of the said statistics.

Table 1: Descriptive statistics of interest on the Study variables

Variable Name	N	Mean	Min.	Max.	Std. Dev.	CV(%)
Real GDP Per Capita (current US $)	**100**	**157.45**	**58.25**	**251.89**	**68.38**	**43.43**
Personal Remittances (US $, billions)	**100**	**0.81**	**0.23**	**1.49**	**0.39**	**48.15**
Human Capital (% of pop with primary $educ^{+}$)	**100**	**48.80**	**30.08**	**86.99**	**20.88**	**42.78**
Gross Capital Formation (% of GDP)	**100**	**23.71**	**19.21**	**32.75**	**3.04**	**12.82**
Foreign Direct Investment (% of GDP)	**100**	**3.74**	**1.91**	**6.99**	**1.41**	**37.70**
Trade Openess (ratio of total trade, % of GDP)	**100**	**38.97**	**30.30**	**57.40**	**5.52**	**14.17**

Source: Author's compilation from analysis of data

Table1 above presents the descriptive statistics of key variables over the study period. Real GDP per capita had a mean of USD 157.45 and

a coefficient of variation (CV) of 43.43%, indicating moderate variability, while personal remittances averaged USD 0.81 billion with a higher CV of 48.15%, reflecting larger fluctuations. Human capital showed a mean of 48.8% and a CV of 42.78%, suggesting moderate variation, whereas gross capital formation (mean = 23.71%, CV = 12.82%) and trade openness (mean = 38.97%, CV = 14.17%) were relatively stable. Foreign direct investment averaged 3.74% of GDP with a CV of 37.70%, indicating moderate variability.

Minimum and maximum quarterly values further illustrate these variations: GDP per capita ranged from USD 58.25 to 261.89; personal remittances from 0.23 to 1.49 billion USD; human capital from 30.08% to 86.99%; gross capital formation from 19.21% to 32.75% of GDP; foreign direct investment from 1.91% to 6.99% of GDP; and trade openness from 30.3% to 57.4% of GDP. Standard deviations indicate that all variables are relatively tightly clustered around their means. GDP per capita had an SD of 68.38, remittances 0.39 billion USD, human capital 20.88%, gross capital formation 3.05%, foreign direct investment 1.41%, and trade openness 5.52%. Since the SD values are smaller than the respective means, this suggests low variability and limited presence of extreme values in the data.

Results from the multicollinearity test: In this study, two ARDL models were specified, one examining individual effects and the other combined effects, and multicollinearity was assessed using Variance Inflation Factors (VIFs) and their reciprocals (1/VIF). Following Hair et al. (2010), a VIF of 10 or above indicates serious multicollinearity, 5–10 signals moderate concern, and below 5 suggests low or no multicollinearity. Tables 2 and 3 present the VIF and 1/VIF values for each explanatory variable in Models 1 and 2, respectively, showing that all regressors fall within acceptable limits, indicating that multicollinearity is not a concern in either model.

Table 2: VIF values per regressor in Model 1 (Model 1 assess individual effects)

Regressor	Notation	VIF	1/VIF
Logarithm of Personal Remittances	*LOG_REM*	8.50	0.117601
Human capital	*HC_EDUCATT*	4.37	0.229003
Gross Capital Formation	*GKF*	2.69	0.371217
Foreign Direct Investments	*FDI*	1.45	0.687291
Trade Openness	*TRADEOPEN*	1.69	0.591028
Mean VIF		**3.74**	

Source: Author's compilation

Table 3: VIF values per regressor in model 2 (Model 2 assesses combined effects)

Regressor	Notation	VIF	1/VIF
Logarithm of Product of Personal Remittances and Human Capital	*LOG_REM*HC_EDUATT*	7.29	0.137251
Gross Capital Formation	*GKF*	1.94	0.515777
Foreign Direct Investments	*FDI*	1.46	0.686403
Trade Openness	*TRADEOPEN*	1.48	0.677870
Mean VIF		**3.04**	

Source: Author's compilation

The multicollinearity tests for both ARDL models indicate no serious concerns. In Model 1, all individual VIFs and the mean VIF (3.74) are below the threshold of 10, while in Model 2, the individual VIFs and mean VIF (3.04) are also below 10. These results suggest that severe multicollinearity is not present in either model, even with all explanatory variables included as specified in equations a and b.

Stationarity test results: The inquiry implemented the Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) unit root method for stationarity assessment of factors in each of the specified models for empirical estimation. The null hypothesis tested is of non-stationarity. Lag order has been determined by the Akaike's Information Criteria (AIC). The stationarity test summary values are indicated in Table 4 and Table 5 as indicated below;

Table 4: Stationarity results and order of integration of the variables in model 1(Model 1 assess individual effects)

	Levels			First Differences			
Variable	**Lags**	**ADF Z(t) Stat.**	**Prob. for Z(t)**	**Lags**	**ADF Z(t) Stat.**	**Prob. for Z(t)**	**OOI**
Logarithm of real GDP per capita	3	-1.059	0.7311	2	-4.86 ***	0.0000	I(1)
Logarithm of Personal Remittances	4	-1.726	0.4180	4	-3.423**	0.0102	I(1)
Human Capital	4	0.150	0.9693	4	-4.29***	0.0005	I(1)
Foreign direct investment	3	-5.37***	0.0000	–	–	–	I(0)
Gross capital formation	4	-1.66	0.4506	3	-5.70	0.0000	I(1)
Trade Openness	3	-4.77***	0.0000	–	–	–	I(0)

Source: Author's compilation. ***P<0.01; ** P<0.05; OOI =Order of Integration

Table 5: Stationarity test results and order of integration of the variables in model 2(Model 2 assesses combined effects)

Variable	Levels			First Differences			
	Lags	**ADF Z(t) Stat.**	**Prob. for Z(t)**	**Lags**	**ADF Z(t) Stat.**	**Prob. for Z(t)**	**OOI**
Logarithm of real GDP per capita	3	-1.059	0.3764	2	-3.57***	0.0064	I(1)
Logarithm of product of Personal Remittances and Human Capital	2	0.181	0.9712	1	-4.05***	0.0012	I(1)
Foreign direct investment	3	-5.37***	0.0000	–	–	–	I(0)
Gross capital formation	4	-1.66	0.4506	3	-5.70	0.0000	I(1)
Trade Openness	3	-4.77***	0.0000	–	–	–	I(0)

Source: Author's compilation. ***P<0.01; OOI =Order of Integration

The stationarity tests for both models show mixed orders of integration. In Model 1, LOG_RGDPPC, LOG_REM, HC_EDUCATT, and GKF are non-stationary in levels but become stationary after first differencing (I(1)), while FDI and TRADEOPEN are stationary in levels (I(0)). Similarly, in Model 2, LOG_RGDPPC, LOG_REM*HC_EDUATT, and GKF are I(1), typically exhibiting trending behavior over time, reflecting structural changes, capital accumulation processes, and sustained macroeconomic growth dynamics. Their non-stationarity at levels suggests that shocks to these

variables may have persistent, long-term effects. whereas FDI and TRADEOPEN are I(0) implying that they fluctuate around a stable long-run mean, possibly due to policy adjustments, regulatory frameworks, or external constraints that limit prolonged divergence from equilibrium levels.

Results from the Johansen's (1995) cointegration tests: This study implemented the Johansen (1995) cointegration as an a priori test. According to Nkoro & Uko (2016), the Johansen (1995) cointegration may be used on multivariable regressions with potential of having at least two cointegration vectors irrespective variable order of integration, but cointegration in such regressions exists among the I(1) variables (Kripfganz, 2014). Table 7.4 gives a summary of the Johansen's cointegration test outcomes for Model 1 and Model 2.

Table 6: Johansen's cointegration test results in model 1 and model 2

	Model 1 [Model 1 assesses individual effects]			**Model 2** [Model 1 assesses combined individual effects]		
Max. rank	Eigen Value	Trace statistic	Critical value at 5percent	Eigen Value	Trace statistic	Critical value at 5percent
0	–	120.8827	94.15	–	167.0838	68.52
1	0.35139	78.8887	68.52	0.61529	73.4680	47.21
2	0.28686	**46.0951***	47.21	0.32840	34.4543	29.68
3	0.27092	15.4462	29.68	0.26055	**4.8731***	15.41
4	0.10941	4.2069	29.68	0.04031	0.8408	3.76
5	0.04032	0.2150	3.76	0.00854	–	–
6	0.00221	–	–	n/a	n/a	n/a

The Johansen cointegration results confirm the existence of stable long-run relationships among the variables in both specifications (Johansen, 1991). In Model 1, the test identified two cointegrating vectors (r = 2), implying that although the variables are individually non-stationary, there are two distinct linear combinations that are stationary. This suggests the presence of two independent long-run equilibrium relationships linking economic growth, remittances, human capital, and the control variables (Johansen, 1991).

In Model 2, three cointegrating vectors (r = 3) were detected, indicating a more complex long-run structure when the interaction term between remittances and human capital is introduced (Johansen, 1991). The presence of three stationary linear combinations implies that multiple equilibrium relationships jointly govern the dynamics of the system. Overall, these findings suggest that the variables in each model move together over time and adjust toward long-run equilibrium paths despite short-run fluctuations (Johansen, 1991).

Results from regressions: This study specified two ARDL models (Model 1 & Model 2) for empirical estimation.

Table 7: ARDL (2 0 0 2 0 3) regression estimates of model 1: (Objective 3 of the Study)

Dep. var.: (Logarithm of real GDP per capita)$_t$			
Variable	**Coef.**	**Std. Err.**	**P-value**
ECT (-1)	-0.0708***	0.013325	0.000
Short run Estimates			
Δ(Logarithm of real GDP per capita)$_{t-1}$	0.7765 ***	0.060279	0.000
Δ(Logarithm of Personal Remittances)$_t$	0.0255**	0.010689	0.019
Δ(Human Capital)$_t$	0.0046**	0.001605	0.005
Δ(Gross Capital Formation)$_t$	0.0213***	0.005262	0.000
Δ(Gross Capital Formation)$_{t-1}$	-0.0229 **	0.005185	0.000
Δ(Foreign Direct Investment)$_t$	0.0011	0.001297	0.403
Δ(Trade Openness)$_t$	-0.6153**	0.247551	0.015
Δ(Trade Openness)$_{t-1}$	0.7266 *	0.368732	0.052
Δ(Trade Openness)$_{t-2}$	-0.2116**	0.250309	0.400
Constant	-0.3711**	0.168312	0.030
Long run Estimates			
(Logarithm of Personal Remittances)$_{t-1}$	0.3597***	0.113366	0.002
(Human capital) $_{t-1}$	0.0656***	0.023971	0.008
(Gross Capital Formation) $_{t-1}$	0.0837***	0.014726	0.000
(Foreign Direct Investment) $_{t-1}$	0.0154	0.018230	0.402
(Trade Openness) $_{t-1}$	1.3111	0.813813	0.111
Post-estimation cointegration test Pesaran et al. (2001) bounds test: **Robustness test results**	P>F=0.000 & P>t=0.000 for I (0) variables P>F =0.002 & P>t =0.003 for I (1) variables 0.8447 p > chi.sq. = 0.118		

Adjusted R-square : B–G LM test for serial correlation: B–P test for heteroskedasticity: RESET test for omitted variables: CUSUM parameter stability test:	p > chi.sq. = 0.376 p > F = 0.119 Recursive stat.=0.298 ;critical value=0.948

Source: Author's compilation after ARDL regression. *P<0.1; **P<0.05; *** P< 0.01

Table 8: ARDL (2 0 2 0 1) regression estimates of model 2: (Objective 3 of the Study)

Dep. var.: (Logarithm of real GDP per capita)$_t$			
Variable	**Coef.**	**Std. Err.**	**P-value**
ECT (-1)	-0.0741***	0.012183	0.000
Short run Estimates			
Δ(Logarithm of real GDP per capita)$_{t-1}$	0.7313***	0.054357	0.000
Δ(Logarithm of Personal Remittances*Human Capital)$_t$	0.0277***	0.004761	0.000
Δ(Gross Capital Formation)$_t$	0.0202***	0.005148	0.000
Δ(Gross Capital Formation)$_{t-1}$	-0.0220***	0.005143	0.000
Δ(Foreign Direct Investment)$_t$	0.00756	0.001269	0.553
Δ(Trade Openness)$_t$	-0.14897	0.112425	0.189
Constant	-0.4880***	.0826596	0.000
Long run Estimates			
(Logarithm of Personal Remittances*Human Capital)$_{t-1}$	0.3738***	0.031039	0.000
(Gross Capital Formation) $_{t-1}$	0.0725***	0.010921	0.000

(Foreign Direct Investment) $_{t-1}$	0.010198	0.017045	0.551
(Trade Openness) $_{t-1}$	1.9512	0.659362	0.004
Post-estimation cointegration test Pesaran et al. (2001) bounds test: **Robustness test results** Adjusted R-square : B–G LM test for serial correlation: B–P test for heteroskedasticity: RESET test for omitted variables: CUSUM parameter stability test:	p>F=0.000 & P>t=0.000 for I (0) variables p>F=0.000 & P>t=0.000 for I (1) variables 0.8403 p > chi.sq. = 0.135 p > chi.sq. = 0.452 p > F = 0.096 Recursive stat.=0.577 ;critical value=0.948		

Source: Author's compilation after ARDL regression. *P<0.1; **P<0.05; *** P< 0.01

Assessment of the robustness test results: Before interpreting the ARDL regression results, the robustness of the model coefficients was assessed. The adjusted R-squared values were 0.844 for Model 1 and 0.8403 for Model 2, indicating that both models explain about 84% of the variation in the dependent variable. The minimal difference between the two values suggests similar overall fit, though Model 1 performs slightly better. Overall, both models demonstrate a high degree of explanatory power, supporting their reliability for analyzing the relationships among the variables and drawing policy-relevant conclusions.

The robustness checks for both ARDL models indicate that the estimated coefficients are reliable. The Breusch-Godfrey (B–G) LM test shows no evidence of serial correlation in the residuals, with P-values of 0.118 for model 1 and 0.135 for model 2. The Breusch-Pagan (B–P) test confirms homoscedasticity, with P-values of 0.376 for model 1 and 0.452 for model 2, indicating constant variance in the errors. The Ramsey RESET test suggests no omitted variable bias (P = 0.119 for model 1; P = 0.096 for model 2), and the CUSUM test confirms

parameter stability, with recursive statistics of 0.298 (model 1) and 0.577 (model 2) both below the critical value of 0.948. Overall, these results indicate that the ARDL models are well-specified, stable, and suitable for drawing reliable policy conclusions.

DISCUSSION OF THE FINDINGS: INDIVIDUAL EFFECTS OF PERSONAL REMITTANCES AND HUMAN CAPITAL

The ARDL estimates show that personal remittances have a positive and significant effect on Uganda's economic growth in both the short run and long run. Specifically, a 1% increase in remittances raises real GDP per capita by approximately 0.03% in the short run and 0.36% in the long run, indicating that economic growth responds inelastically to changes in remittances, though the long-run effect is stronger. Similarly, human capital, measured by the proportion of the population with at least primary education, also positively and significantly affects GDP per capita. A 1% increase in human capital raises GDP per capita by about 0.46% in the short run and 6.56% in the long run. Comparatively, human capital has a larger marginal contribution to growth than remittances, highlighting it as a more sustainable driver of long-term economic growth.

Combined effect of personal remittances and human capital

The interaction of personal remittances and human capital also has a positive and significant effect on Uganda's GDP per capita in both the short run and long run. In the short run, the combined effect (0.0277) is similar to the individual effect of remittances alone (0.0255), while in the long run, the combined effect (0.3738) is close to the long-run effect of remittances (0.3597). This suggests that the impact of remittances on economic growth largely operates independently of human capital, and while the interaction slightly enhances the overall effect, human capital does not significantly change the marginal contribution of remittances.

Individual effects of personal remittances and human capital on Uganda's economic growth

The study found that personal remittances have a positive and statistically significant effect on Uganda's economic growth in both the short run and long run, leading to the rejection of the null hypothesis (HO1). This aligns with theoretical expectations that remittances increase household income, consumption, and investment, thereby boosting aggregate demand and economic growth (World Bank, 2016; Barajas, Chami, Gapen, & Montiel, 2009). The findings also suggest that remittances are utilized more for productive investments than merely consumption, contrary to claims that remittances can cause inflation or dependency (Azizi, Aftabi, Azizkhani, & Yektansani, 2024).

Human capital, proxied by primary education attainment, also displayed a positive and significant impact on economic growth, leading to the rejection of HO2. The results indicate that a more educated workforce enhances productivity, innovation, and adaptability, consistent with endogenous growth theory (Lucas, 1988; Romer, 1990). The study further noted that the marginal contribution of human capital to growth is greater than that of remittances, highlighting domestic human capital development as a more sustainable driver of long-term growth. These findings align with previous studies in Uganda (Kyeyune & Barungi, 2020) and support national development priorities such as Vision 2040 and Uganda's NDPs (NPA, 2020).

Combined effect of personal remittances and human capital

The combined effect of remittances and human capital, assessed through an interactive term, was also positive and statistically significant, leading to the rejection of HO3. However, the marginal effect of the combined term was similar to that of personal remittances alone, suggesting that the impact of remittances on growth operates independently of human capital, and the interaction slightly diminishes the marginal effect of human capital. These findings broadly support the theoretical view that interactions between variables can amplify the

overall effect, though in this context, the combined effect primarily reflects the influence of remittances (Ratha, 2013).

CONCLUSION

The analysis considered both the individual and joint associations of remittances and human capital with economic growth. The findings indicate that changes in personal remittances and human capital are significantly associated with variations in Uganda's economic growth in both the short and long run. Furthermore, the interaction term suggests a complementary relationship, where the combined presence of remittances and stronger human capital is positively linked to growth outcomes. Nonetheless, given the observational time-series design, these results reflect long-run equilibrium relationships and predictive associations rather than definitive causal effects.

Arising from these findings, policy efforts should focus on strengthening domestic absorptive capacity to better harness remittance inflows for productive transformation. This includes increasing investment in high-quality, market-relevant education; expanding technical and vocational training aligned with industrial and technological needs; and improving institutional and financial systems that channel remittances toward entrepreneurship and investment rather than predominantly consumption. By reinforcing human capital formation and improving the domestic environment for productive investment, policymakers can better address the underlying paradox whereby migration generates foreign exchange inflows while simultaneously constraining the skilled labor base needed for sustained structural transformation.

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The Macroeconomic Determinants Of Agricultural Productivity In Uganda (1981–2023)

*Ruth KyomuhendoTuhamize[1], Killian Arineitwe[1], Francis Muhire[2], Warren Tibesigwa, PhD[2]

[1]Uganda Bureau of Statistics, [2]Makerere University Business School

ABSTRACT

This study examines the macroeconomic determinants of agricultural productivity in Uganda from 1981 to 2023. Specifically, it analyzes the effects of inflation, government expenditure, interest rates, and exchange rates using an ARDL (2, 0, 1, 2, 0) model to capture both long-run and short-run dynamics. The long-run results reveal that government expenditure significantly enhances agricultural productivity, while high interest rates negatively affect output. Inflation and exchange rates show no statistically significant long-term effects. In the short run, government expenditure remains positively significant, and inflation exhibits a temporary positive effect, possibly reflecting short-term price incentives. Although interest rates are insignificant in

Kyomuhendo Ruth Tuhamize (✉)
Email: rtuhamize@gmail.com

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the short run, their long-term negative effect suggests cumulative credit constraints over time. Exchange rate fluctuations are not significant in either period. Based on these findings, the study recommends increasing and efficiently allocating agricultural expenditure toward rural infrastructure and extension services, implementing financial sector reforms to reduce borrowing costs for farmers, maintaining inflation stability through prudent macroeconomic management, and adopting exchange rate risk mitigation strategies to protect agricultural incomes.

***Keywords**: Agricultural Productivity, Inflation, Government Expenditure, Interest Rates, and Exchange*

BACKGROUND

Globally, agricultural productivity is a key driver of economic growth, food security, and livelihood sustainability, particularly in developing countries where agriculture employs a large share of the labor force and contributes significantly to GDP (UN, 2019; Fuglie, 2018). Agricultural productivity is measured as the ratio of agricultural outputs to inputs, encompassing crop yields, efficiency in resource use, technological adoption, and resilience to environmental shocks (FAO, 2022; Fuglie, Gautam, Goyal, & Maloney, 2020). While global productivity gains have supported economic development and reduced food insecurity, many developing countries, including those in Sub-Saharan Africa, continue to face low agricultural performance, limiting economic growth and threatening food security (World Bank, 2023; Nin-Pratt, 2016).

Within Africa, agriculture remains the backbone of most economies, employing over 50% of the workforce and contributing substantially to national GDP (AUC, 2022). The East African Community (EAC) has made strides in promoting regional agricultural development through policy harmonization, common standards, cross-border trade facilitation, and cooperative research and development initiatives (Abro, Alemu, & Hanjra, 2020). Despite these efforts, productivity

remains uneven across the region: for example, average cereal yields in EAC member states range from 1.5 to 2.8 tons per hectare, below global averages of about 4.2 tons per hectare (FAO, 2022; FAO, 2024).

In Uganda, agriculture contributes approximately 25% to GDP, employs over 68% of the labor force, and accounts for nearly 40% of total export earnings (UBOS, 2022; BoU, 2023b). Yet average maize yields remain only 2.5 tons per hectare, only 35% of arable land is under cultivation, and subsistence farming dominates, with over 80% of farmers using rudimentary tools and minimal fertilizer or irrigation (IFAD, 2021; UBOS, 2022; Barungi, Odokonyero, & Ssewanyana, 2020). These figures position Uganda below the EAC average and underscore persistent structural challenges that limit the sector's contribution to economic growth and regional food security (IFAD, 2021; MAAIF, 2023; FAO, 2022).

Macroeconomic factors are key structural levers that influence agricultural productivity. Inflation affects input prices such as seeds, fertilizers, and mechanization costs; high inflation erodes farmers' purchasing power and reduces investment in productivity-enhancing inputs (MoFPED, 2021; MAAIF, 2023). Interest rates determine the cost and accessibility of agricultural credit, directly influencing farmers' ability to finance mechanization, irrigation, or technology adoption (BoU, 2023c; UDB, 2024). Exchange rate fluctuations impact the local cost of imported inputs and the competitiveness of export crops, affecting both profitability and investment incentives (BoU, 2023b; IPC, 2023). Government expenditure on rural infrastructure, irrigation, and extension services complements private investment, enhancing the translation of financial and technological inputs into measurable productivity gains (AUC, 2022; MoFPED, 2023). Collectively, these variables shape the enabling environment for agricultural productivity, where stable macroeconomic conditions encourage investment and growth, while volatility constrains output and efficiency.

Macroeconomic factors are key structural levers that influence agricultural productivity (Adebayo & Oladejo, 2022). Inflation affects input prices such as seeds, fertilizers, and mechanization costs; high inflation erodes farmers' purchasing power and reduces investment in

productivity-enhancing inputs. In Uganda, annual inflation averaged 4.2% between 2000 and 2023 but spiked to 6.9% in 2022, significantly raising input costs and reducing farmers' ability to adopt improved seeds or fertilizers (BoU, 2023a). Interest rates determine the cost and accessibility of agricultural credit, directly influencing farmers' ability to finance mechanization, irrigation, or technology adoption (Diao, Hazell, & Thurlow, 2017). Lending rates for agricultural loans averaged 19.5% in 2023, while only 12% of smallholder farmers accessed formal credit, limiting their investment capacity (BoU, 2023b). Exchange rate fluctuations impact the local cost of imported inputs and the competitiveness of export crops (Gollin, Lagakos, & Waugh, 2016). Between 2015 and 2023, the Uganda Shilling depreciated by approximately 28% against the US Dollar, raising the cost of imported fertilizers and machinery while affecting the pricing of exportable crops such as coffee and tea (BoU, 2023b). Government expenditure on rural infrastructure, irrigation, and extension services complements private investment; however, Uganda's agricultural budget has consistently fallen below the 10% CAADP target, averaging only 5.6% of the national budget between 2018 and 2023, limiting the provision of irrigation schemes and extension support critical for productivity gains (MoFPED, 2023).

Collectively, these variables shape the enabling environment for agricultural productivity, where stable macroeconomic conditions encourage investment and growth, while volatility manifested in high inflation, elevated interest rates, exchange rate swings, and insufficient government expenditure constrains output and efficiency (Bedasa, Gemechu, & Bedemo, 2025).Although previous literature extensively addresses technological, climatic, and sector-specific factors affecting agricultural productivity (Nhamo & Senthilkumar, 2025; Yamini, Singh, & Antar, 2025), there is limited analysis of the combined effect of macroeconomic determinants in Uganda, particularly in the regional EAC context. Most studies examine each variable in isolation, neglecting the potential interactions between inflation, interest rates, exchange rates, and government expenditure and their cumulative effect on productivity (Muwanga-Zake, 2018). This study addresses this gap

by explicitly linking these macroeconomic variables to agricultural output.

PROBLEM STATEMENT

Agricultural productivity remains a cornerstone of Uganda's economy, employing over 65% of the labor force and contributing approximately 24% to the national GDP (UBOS, 2023). The sector plays a pivotal role in food security, poverty reduction, and rural livelihoods, making its performance central to Uganda's achievement of Vision 2040 and the Sustainable Development Goals (SDGs) (IFAD, 2021).

However, despite its strategic importance, agricultural productivity in Uganda continues to underperform relative to its potential and to regional comparators. Between 2000 and 2023, agricultural value-added grew by an annual average of only 2.8%, falling short of the 6% growth target set under the Comprehensive Africa Agriculture Development Programme (CAADP) (AUC, 2022; FAO, 2022). This sluggish performance persists even as Uganda remains endowed with fertile soils, favorable climatic conditions, and abundant labor, conditions that should ordinarily position the country for agricultural excellence (World Bank, 2023).

Over the years, the Government of Uganda has implemented numerous macroeconomic and sectoral interventions to enhance agricultural productivity. Fiscal measures such as the Agriculture Cluster Development Project (ACDP), Operation Wealth Creation (OWC), and the Parish Development Model (PDM) have sought to expand agricultural financing, improve access to inputs, and strengthen market linkages (MAAIF, 2024). On the macroeconomic front, the Bank of Uganda has maintained inflation within the target range of 5% to ensure price stability and protect farmers' purchasing power (BoU, 2023c). Public expenditure toward agriculture has also increased modestly, averaging 3.4% of total government spending during 2010–2023, though still below the 10% Maputo Declaration target (AUC, 2022). Exchange rate management policies have aimed to stabilize the shilling against major currencies, while interest rate liberalization has

been pursued to improve credit access and stimulate investment in the sector (IMF, 2023).

Despite these commendable efforts, Uganda's agricultural productivity continues to face deep-rooted challenges linked to macroeconomic instability and limited financial access (MAAIF, 2023). Inflation volatility has eroded farmers' real incomes, increasing the cost of agricultural inputs such as fertilizers and seeds (Nangale, 2021). High lending rates averaging between 17% and 21% have restricted private sector borrowing for agricultural investment, especially among smallholder farmers and agribusinesses (BoU, 2023b). Similarly, exchange rate fluctuations have raised import costs for essential inputs and machinery while creating uncertainty for exporters (ADB, 2024). Furthermore, public expenditure in agriculture has been skewed toward recurrent costs and subsidies rather than infrastructure and research, thereby limiting the sector's long-term productivity gains (World Bank, 2023).

Uganda remains a net food importer for some commodities (wheat, sugar & cooking oil), and rural poverty persists at 29%, highlighting the disconnect between macroeconomic policy interventions and on-the-ground agricultural performance (UBOS, 2022; Bedasa, Gemechu, & Bedemo, 2025). Furthermore, the country faces high youth unemployment, estimated at 21.5%, which disproportionately affects rural youth who heavily rely on agriculture for income (MoGLSD, 2023; Barungi, Odokonyero, & Ssewanyana, 2020).

Most existing studies have focused on micro-level factors, such as climate change, technology adoption, and farm management practices, as drivers of agricultural productivity (Babyenda et al., 2023; Kamugisha et al., 2023; Nsubunga, 2022; Lule & Amone, 2022). While important, less attention has been given to the role of macroeconomic variables like inflation, government expenditure, interest rates, and exchange rate movements in shaping productivity in Uganda. Evidence from countries such as Ghana, Nigeria, and Tanzania shows that macroeconomic instability can affect agricultural output by influencing investment, input costs, and production incentives (Aidoo et al., 2021; Nchimbi & Msuya, 2020; Olayemi, 2022). This study therefore

addresses this gap by examining the effects of key macroeconomic factors on agricultural productivity in Uganda.

OBJECTIVES

The purpose of the study is to investigate the macroeconomic determinants of agricultural productivity in Uganda by examining how key macroeconomic variables shape the performance of the agricultural sector. Specifically, the study was designed to assess the effect of inflation on agricultural productivity, evaluate the influence of government expenditure on agricultural output, analyse the impact of interest rates on agricultural performance, and determine how fluctuations in the exchange rate affect agricultural productivity in Uganda.

THEORETICAL FRAMEWORK

This study is anchored in the modernization theory and structural transformation theory, which posit that agricultural productivity is driven by capital accumulation, technological progress, and efficient resource allocation (Rostow, 1960; Lewis, 1954). Modernization theory emphasizes the role of systematic investments and technological adoption in enhancing productivity, while structural transformation theory highlights the shift from subsistence agriculture to more productive and commercialized agriculture as a pathway to economic development (Rostow, 1960; Lewis, 1954). These theories provide a conceptual basis for analyzing how macroeconomic variables such as inflation, interest rates, exchange rates, and government expenditure affect agricultural output by influencing input costs, investment capacity, and sectoral efficiency.

Agricultural productivity (AVA) is conceptualized as a function of these macroeconomic factors:

$$AVA = f\begin{pmatrix} Inflation, Interest\ Rate, Exchange\ Rate, \\ Government\ Expenditure \end{pmatrix} \ldots\ldots\ldots 1.1$$

Inflation influences input prices such as seeds, fertilizers, and mechanization; high inflation reduces farmers' purchasing power, limiting investments in productivity-enhancing inputs (Adjognon, Liverpool-Tasie, & Reardon, 2017; MAAIF, 2021). Interest rates affect the cost of credit, shaping farmers' ability to finance mechanization, irrigation, or technology adoption (Akpan & Atan, 2021; UDB, 2024). Exchange rate fluctuations alter the local cost of imported inputs and competitiveness of export crops, impacting profitability and investment incentives (BoU, 2023b; IPC, 2023). Government expenditure on rural infrastructure, irrigation, and extension services complements private investment, translating financial and technological inputs into measurable productivity gains (AUC, 2022; MoFPED, 2023). Stable macroeconomic conditions encourage investment and technological adoption, enhancing productivity, while volatility constrains output and efficiency (Anang, Bäckman, & Rezitis, 2016).

METHODOLOGY

This study employed a longitudinal time series research design to analyse the macroeconomic determinants of agricultural productivity in Uganda, consistent with Kerlinger's (1986) definition of research design as a structured plan for addressing research questions. A time series approach is appropriate for capturing long-term trends and dynamic interactions between agricultural productivity and macroeconomic variables such as inflation, interest rates, government expenditure, and exchange rates (Stock & Watson, 2020). The study used secondary quantitative data obtained from credible national sources, including UBOS, MoFPED, and the Bank of Uganda, ensuring reliability and consistency for empirical analysis.

Variables were measured using internationally recognised indicators: Agricultural Value Added (AVA) for productivity (World Bank, 2022), CPI-based inflation, commercial lending rates for credit costs (BoU, 2023a), nominal UGX/USD exchange rates, and recurrent government expenditure in agriculture (MoFPED, 2023). A priori expectations were drawn from established literature (Fan et al., 2005;

Timmer, 2002; Barungi et al., 2020). The empirical model (i) was derived from the general time-series structure.

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i Y_{t-i} + \sum_{j=0}^{q1} \theta_{1j} X_{1,t-j} + \sum_{j=0}^{q2} Q_{2j} X_{2,t-j} + \cdots + \sum_{j=0}^{qk} Q_{kj} X_{k,t-j} + \varepsilon_t \ldots\ldots\ldots\ldots \text{i}$$

leading to the study's empirical specification (ii);

$$AVA_t = B_0 + \beta_1 IFR + \beta_2 logGEA + \beta_3 IR + \beta_4 LogER + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots ii$$

Pre-estimation involved unit root testing using the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979) to determine the order of integration of the variables. The ARDL bounds testing approach (Pesaran et al., 2001) was adopted due to its suitability for models containing a mixture of I(0) and I(1) variables. Model diagnostics, including the VIF test for multicollinearity, the LM test for serial correlation (Kennedy, 2008; Greene, 2012), and the White/Breusch-Pagan test for heteroscedasticity, were conducted to ensure robustness (Gujarati & Porter, 2009).

To stabilize the variance, reduce heteroscedasticity, and interpret the coefficients as elasticities, all continuous variables in the model were transformed into natural logarithms. This logarithmic transformation ensures that the relationships between variables are expressed in relative (percentage) terms, facilitating easier comparison and interpretation of the estimated effects (Stock & Watson, 2020). It also helps mitigate the influence of extreme values and improves the normality of the residuals, which is a key assumption in regression analysis (Wooldridge, 2013; Stock & Watson, 2020).

All analyses were performed using STATA 17, and ethical considerations were upheld through transparent, responsible use of secondary data for academic purposes (Stock & Watson, 2020). The independent variables, government expenditure, interest rates, inflation, and exchange rate volatility, were selected for their theoretical and empirical relevance to agricultural productivity (Obi, 2020; Deininger, Jin, & Ma, 2022). Population growth was controlled for to account for other factors that may affect the model's explanatory power

(Kamugisha *et al*., 2023). Agricultural value added (AVA) was used as a proxy for productivity because it quantifies sectoral output relative to inputs and provides a comparable measure of agricultural performance, even though it is not identical to true productivity (World Bank, 2023).

Descriptive analysis of the study variables

The table below presents the descriptive statistics of the Study variables. Table 1 below summarizes the main descriptive statistics for the study variables. Agricultural productivity had an average value of 32.02 units, with a standard deviation of 12.55, indicating moderate dispersion over the study period. The minimum and maximum values (17.18 and 54.72) show that productivity varied across years, while the coefficient of variation (39.2%) suggests moderate stability compared to other macroeconomic indicators. The exchange rate had a mean of 1,806.99 UGX, but showed substantial fluctuation, as reflected by its high standard deviation (1,173.63) and wide range from 44.67 to 3,730.35.

Its coefficient of variation (64.9%) indicates considerable instability, which may affect both input costs and export competitiveness. Government expenditure on agriculture also displayed large swings, with a mean of 4,100,175 units and a high CV of 125.6%, pointing to inconsistent annual budget allocations. Interest rates were relatively stable compared to other variables, averaging 23.0% with a CV of 22.6%, though they remained consistently high, potentially limiting farmers' access to affordable credit. Inflation, however, showed extreme volatility, with a mean of 36.3%, a very high standard deviation (64.3), and a CV of 177.1%, reflecting significant macroeconomic instability during the period.

Table 1: Descriptive analysis of the study variables (variables are in their original units of measurement)

Variable	n	Mean	Std. Dev.	Min	Max	Coefficient of Variation(CV)
Agricultural productivity	42	32.01	12.55	17.18	54.72	39.2
Exchange rate	42	1806.98	1173.63	44.67	3730.35	64.9
Government expenditure	42	4100175	5149278	482.05	1.74e+07	125.6
Interest rate	42	23.0	5.2	16.7	38.2	22.6
Inflation	42	36.3	64.3	-0.3	238.1	177.1

Source: Author's compilation

Augmented Dickey-Fuller (ADF) unit root test results for the series in levels: The study began by testing all variables for stationarity to determine their order of integration, which is essential for selecting the appropriate econometric model. The Augmented Dickey-Fuller (ADF) test was applied to each series in both levels and first differences. The results show that government expenditure and inflation are stationary at levels (I(0)), while agricultural productivity, exchange rate, and interest rate are non-stationary in levels but become stationary after first differencing (I(1)) as illustrated in Table 2 below.

Table 2: Augmented Dickey-Fuller unit root test results for the series

Variable	ADF Statistic	Probability	ADF in 1st Difference	Probability	Final Order of Integration
Agricultural productivity	-2.886	0.8512	-2.886	0.0012	I(1)
Log(Exchange rate)	-2.885	0.0665	-2.885	0.0000	I(1)
Log(Government expenditure)	-2.885	0.0028	—	—	I(0)
Inflation	-2.886	0.0034	—	—	I(0)
Interest rate	-2.886	0.1311	-2.886	0.0000	I(1)

Source: Author's compilation

This mixture of I(0) and I(1) variables supports the use of the **Autoregressive Distributed Lag (ARDL)** modeling framework.

Multicollinearity Test: Table 3 presents the Variance Inflation Factor (VIF) results used to assess multicollinearity among the independent variables in the regression model. The VIF values for all variables fall below the conventional threshold of 10, indicating no severe multicollinearity issues. Government expenditure (log-transformed) has the highest VIF (4.58), suggesting moderate correlation with other predictors, but it remains within acceptable limits. Inflation (VIF = 3.06) and the log-transformed exchange rate (VIF = 3.26) also show moderate multicollinearity, while the interest rate (VIF = 2.06) exhibits the lowest correlation with other regressors. The mean VIF of 3.24 further confirms that multicollinearity is not a significant concern in the model, ensuring the reliability of the regression estimates.

Table 3: Multicollinearity test using variance inflation factor

Variable	VIF
$loggovexp$	4.58
inf	3.06
$logexcrate$	3.26
lrate	2.06
Mean VIF	**3.24**

Source: Author's compilation

Bounds test for cointegration:

This was conducted to ascertain the existence of a longrun relationship as shown in Table 4. The bounds test for cointegration produced an F-statistic of 4.49, which exceeds the 5% upper critical bound value of 4.09, indicating evidence of a long-run relationship among the variables at the conventional significance level. At the stricter 1% level, the F-statistic falls between the lower and upper bounds, making the result less conclusive. Overall, the test confirms that a stable long-run equilibrium exists among agricultural productivity and its macroeconomic determinants, with the slight variation in strength reflecting the sensitivity of the test to different significance levels.

Table 4: Bounds test for cointegration

F-statistic	**4.486**	**K = 4**
Critical value bounds		
Significance	**I(0) Bound**	**I(1) Bound**
10%	2.474	3.570
5%	2.914	4.096
1%	3.874	5.220

Source: Author's compilation

Optimal lags for the ARDL model: The optimal lags for ARDL used in the model were based on the matrix list e(lags) as shown in Table 5 below. According to the results, the matrix list e(lags) selected, 2 for Agriculture productivity, 0 for the natural log of exchange rate, 1 for the natural log of government expenditure, 2 for inflation and 0 for interest rate as optimal lags for the ARDL model.

Table 5: Optimal lags for ARDL using matrix list

Variable	**Agrpdcvty**	**logexcrate**	**loggovexp**	**inf**	**ir**
Lag (r1)	2	0	1	2	0

Source: Author's compilation

Regression estimates for study objectives: Based on the unit root test results and cointegrating relationships in the empirical model, this study utilised the Auto-Regressive Distributed Lag (ARDL) model.

Table 6: The ARDL (2, 0, 1, 2, 0) regression estimates

agrpdcvty	Coef.	P-value	Sig
Long-run Estimates			
Log(excrate)	.372	0.197	
Log(govexp)	.766	0.015	**
ir	-.831	0.029	**
inf	.186	0.439	
Short-run Estimates			
Log(excrate)	.174	0.185	
Log(govexp)	1.989	0.000	***
ir	.0178	0.215	
inf	.0771	0.000	***
ECT	-0.021	0.038	***

Source: Author's compilation * *p<.01, ** p<.05, * p<.1***

In the long-run equilibrium relationship, two variables emerge as statistically significant determinants of agricultural productivity. Government expenditure shows a strong positive effect, which underscores the crucial role of sustained public investment in enhancing agricultural output. Conversely, interest rates demonstrate a significant negative relationship. This aligns with economic theory, as higher interest rates typically constrain farmers' access to credit and investment capacity. The exchange rate and inflation show no statistically significant long-run effects, suggesting their impacts may be neutralised over extended periods.

In the short run, Government expenditure maintains its strong positive influence, emphasising the effectiveness of timely fiscal interventions. Inflation shows a significant positive short-run effect, possibly reflecting initial price incentives for production before cost-push pressures emerge. Interestingly, while interest rates showed a statistically negative long-run effect, their short-run impact is statistically insignificant, suggesting their constraining effects

accumulate over time rather than appearing immediately. Exchange rate fluctuations continue to show no significant impact in the short run.

Error correction term: The statistically significant (P-value = 0.038) and negative Error Correction Term (ECT) of -0.021 confirms a valid long-run cointegrating relationship among the variables, indicating that any short-run deviations from equilibrium are systematically corrected over time. Specifically, this coefficient reveals a relatively slow adjustment speed, meaning approximately 2.1% of any disequilibrium from the previous quarter is corrected in the current period; for instance, a 1% shock to agricultural productivity away from its long-run path would be corrected by about 0.021% in the subsequent quarter.

Post diagnostic tests: The study conducted post-model estimation tests to validate the robustness of the model.

Test for heteroscedasticity using Breusch–Pagan test: As indicated in Table 7, the Chi-squared test statistic of 0.08 with 1 degree of freedom yielded a p-value of 0.7742, indicating that the null hypothesis of constant variance cannot be rejected. This suggests that there is no evidence of heteroscedasticity in the model. Therefore, the assumption of constant variance in the error terms holds, supporting the reliability of the regression results as indicated in Table 8.

Table 7: Breusch–Pagan test for heteroscedasticity

Chi2(1)	**P-value**
0.08	0.7742

Source: Author's compilation

Test for autocorrelation using the Breusch-Godfrey test: The Breusch-Godfrey test yielded a chi-square of 4.356 with a p-value of 0.6169, indicating no evidence of serial correlation in the ARDL model residuals. This suggests the model's error terms are independent over

time, supporting the adequacy of the lag structure and the reliability of the estimated coefficients.

Table 8: Breusch-Godfrey test for autocorrelation

chi2	Prob>chi2
4.356	0.6169

Source: Author's compilation

The Breusch-Godfrey test results presented in Table 8 provide crucial insights into the presence of serial correlation in our ARDL model residuals. The test yielded a chi-square statistic of 4.356 with a corresponding p-value of 0.6169, which is statistically insignificant at conventional levels (e.g., 5% or 10%). This high P-value (well above 0.05) leads us to fail to reject the null hypothesis of no autocorrelation, indicating that the residuals are serially uncorrelated.

DISCUSSION OF RESULTS: GOVERNMENT EXPENDITURE AND AGRICULTURAL PRODUCTIVITY

Government expenditure was found to be the most consistent and influential driver of agricultural productivity, exerting a strong positive effect in both the short and long run. Ideally, this suggests that sustained and well-targeted public spending should be scaled up to meet or surpass the CAADP benchmark of 10% of the national budget, thereby addressing Uganda's persistent underinvestment in agriculture, which averages only 3–5% (AUC, 2022; IFPRI, 2021).

This result is consistent with the modernization theory, which emphasizes the role of institutional support and state-led investment in accelerating agricultural development (Obi, 2020; Rostow, 1960), as well as in structural transformation theory, which stresses the importance of channeling resources into productive sectors to enhance long-term growth and structural change (Lewis, 1954; Adebayo & Oladejo, 2022). Empirical evidence reinforces this finding at both the national and global levels.

In Uganda, for example, MoFPED (2021) reports that increased government spending on extension services has improved farmers' access to information and skills, while investment in rural infrastructure such as roads and storage facilities has reduced post-harvest losses and enhanced market connectivity. Similarly, Kamugisha et al. (2023) highlight that government funding for agricultural research and technology adoption has contributed to yield improvements across several staple crops.

However, not all evidence is in complete agreement. Some scholars argue that the effectiveness of government expenditure is conditional on how resources are allocated. Spending that is skewed toward recurrent expenditures, subsidies, or poorly managed programs may not translate into productivity growth (Mogues & Benin, 2012; Benin, 2015). Furthermore, other authors caution that misallocation of public spending can even have negative growth effects, underscoring the importance of efficiency, composition, and governance in shaping outcomes (Devarajan, Swaroop, & Zou, 1996).

Interest rates and agricultural productivity

Interest rates were found to exert a significant adverse effect on agricultural productivity in the long run, while the short-run effect was statistically insignificant. Ideally, this suggests that maintaining affordable and stable credit markets would enable farmers to invest more sustainably in mechanisation, high-yield seed varieties, and modern farm inputs, thereby enhancing productivity and resilience. However, Uganda's persistently high lending rates, often exceeding double digits, continue to pose a barrier to long-term agricultural investment (BoU, 2023a).

The result is theoretically supported by structural transformation theory, which posits that high borrowing costs suppress capital accumulation and slow the transition from traditional to modern agricultural practices (Deininger, Jin, & Ma, 2022). By constraining access to affordable finance, elevated interest rates inhibit resource reallocation into productivity-enhancing technologies, undermining the structural shift needed for growth.

Empirical studies reinforce this conclusion. For instance, Nsubuga (2022) finds that elevated lending rates in Uganda significantly reduce the adoption of fertilisers and mechanisation among smallholder farmers. Similarly, Lule & Amone (2022) show that higher borrowing costs deter farmers from accessing formal loans, thereby limiting investment in irrigation and other long-term productivity measures. The delayed effect observed in this study may also be explained by farmers' initial reliance on informal credit networks or the lagged adjustment to monetary policy changes, which temporarily cushions the immediate impact of interest rate fluctuations (Nsubuga, 2022). Nevertheless, evidence from other contexts suggests that the relationship between interest rates and agricultural productivity may be conditional. Some studies argue that where credit guarantee schemes or subsidized lending programs exist, farmers are less sensitive to market interest rates (Sanka & Makhura, 2025). Others highlight that interest rate effects may vary across farm sizes and crop types, with commercial farmers being more responsive than subsistence farmers (Wang, Gui, Meng, Wang, & Hu, 2025).

Inflation and agricultural productivity

Inflation displayed a short-run positive effect on agricultural productivity, contrasting with its long-run insignificance. This aligns with Modernisation Theory's micro-level focus, where initial price rises may incentivise production (Smith & Okello, 2020). However, prolonged inflation can erode purchasing power. The long-run neutrality suggests that inflationary shocks are absorbed over time, possibly through adaptive strategies such as input substitution (Babyenda et al., 2023). Notably, the study results corroborate with Fugile (2018), who concluded that high inflation creates economic uncertainty, discouraging investments in productivity-enhancing technologies and practices critical for improving agricultural output.
Furthermore, the study results agree with Binswanger-Mkhize and Savastano (2017), who note that inflationary pressures often disproportionately affect smallholder farmers, who lack the resources to hedge against price volatility. Similarly, the study findings,

consistent with Headey and Fan (2010), demonstrate that inflationary spikes in food and input prices during the 2007–2008 global food crisis reduced agricultural productivity in developing countries by limiting access to inputs.

Inflation was found to exert a positive short-run effect on agricultural productivity, but its impact became statistically insignificant in the long run. Ideally, moderate price increases can incentivize farmers to expand production in the short term by promising higher returns (BoU, 2023b). However, to sustain these gains, policymakers would need to maintain inflation within a stable and predictable range, ensuring that rising prices do not outpace input affordability or erode farmers' purchasing power. Uganda's experience of volatile inflation rates illustrates how short-term incentives can be offset by long-term instability (BoU, 2023a).

The result is theoretically consistent with modernization theory, which at the micro-level highlights how rising prices can initially stimulate production responses by encouraging adoption of improved practices (Smith & Okello, 2020). Yet, when inflation persists, it undermines household welfare and discourages long-term investment, aligning with evidence from Sub-Saharan Africa showing that prolonged inflation weakens agricultural growth prospects (IFPRI, 2021).

Empirical findings reinforce this conclusion. For instance, Babyenda et al. (2023) show that farmers often adapt to inflationary pressures through input substitution and reduced reliance on imported inputs, which helps neutralize the long-run impact. Similarly, Fuglie (2018) concludes that high and sustained inflation generates economic uncertainty, discouraging farmers from investing in productivity-enhancing technologies and long-term practices (Fuglie, 2018). The findings also agree with Binswanger-Mkhize and Savastano (2017), who demonstrate that inflation disproportionately harms smallholder farmers, as they lack adequate financial buffers to hedge against price volatility.

Consistent with these observations, Headey and Fan (2010) document how the 2007–2008 global food price crisis sharply curtailed access to fertilizers and other critical inputs in developing countries,

thereby reducing agricultural productivity. Nonetheless, contrasting perspectives suggest that mild, stable inflation, if accompanied by well-functioning credit and input markets, can enhance agricultural incentives without destabilizing farmers' investment behavior (Ghosh, 2013; Ihugba, Ihugba, Eches, & Okafor, 2025). This highlights the importance of macroeconomic stability and complementary policies in determining whether inflation acts as a stimulus or a constraint on agricultural productivity.

Exchange rate and agricultural productivity

Exchange rate volatility was found to be statistically insignificant in both the short and long run, suggesting a limited overall effect on agricultural productivity in Uganda during the study period. According to trade theory, exchange rate movements can influence productivity through two channels: by affecting the cost of imported inputs, where depreciation raises costs, and by altering export competitiveness, where depreciation can boost revenue (Edwards & Golub, 2004). The observed insignificance may reflect offsetting effects between these channels, as also noted in empirical studies showing that exchange rate volatility can discourage agricultural investment due to uncertainty (Choga & Mashao, 2025), while Kato & Nuwagaba (2020) find that sharp depreciations in Uganda increased costs for smallholders using imported inputs, reducing productivity.

The divergence in this study may be explained by methodological differences, aggregated national data, or Uganda's relatively low reliance on imported inputs for staple crops. These results suggest that crop-specific studies, particularly for export-oriented commodities like coffee, could provide more nuanced insights into how exchange rate dynamics affect agricultural productivity (UCDA, 2020).

CONCLUSION

The study shows that macroeconomic factors affect agricultural productivity in Uganda in different ways. Government expenditure remains the strongest positive contributor, underscoring the value of

continued support to agricultural services and infrastructure. Interest rates negatively influence productivity in the long run by limiting farmers' access to affordable credit. Inflation has a mild short-run positive effect but no meaningful influence over time. The exchange rate was found to be insignificant, likely due to Uganda's limited dependence on imported inputs for most staple crops.

Policy Recommendations:

Prioritizing strategic public expenditure in agriculture

The Ugandan government should work toward meeting the CAADP target of allocating at least 10% of the national budget to agriculture. Increased funding should support key rural infrastructure such as roads and storage facilities to reduce losses and improve market access, while expanded extension services can help farmers adopt modern practices and build resilience. To maximise the benefits of public spending, efficiency and accountability must be strengthened through transparent budget tracking and more participatory planning processes that reflect farmers' real needs.

Reforming agricultural credit systems to lower financial barriers

Given the negative effect of high interest rates on productivity, Uganda's financial sector needs targeted reforms to improve credit access for farmers. The Bank of Uganda could support lower lending rates for agricultural loans and expand the Agricultural Credit Facility to reach more smallholders. The government, commercial banks, and microfinance institutions should also promote alternative forms of collateral, such as warehouse receipts and movable asset registries, while strengthening rural SACCOs. Complementing these efforts with financial literacy programs would help farmers make better use of available credit and ease long-standing access challenges.

Stabilise inflation through monetary and supply-side measures:

High inflation reduces farmers' purchasing power and disrupts input markets. Uganda's central bank should strengthen monetary policy to limit inflation spikes and support overall stability. The government can also promote domestic input production, such as fertiliser plants, to reduce dependence on costly imports. Well-targeted input subsidies can help farmers access essential inputs without distorting markets. Improving value chains and market information systems would further stabilise food prices and reduce supply-side shocks.

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A Competency-Based Curriculum Approach for Household Sustainability and Growth in Manafwa District

*Emmanuel Koboi[1]

The Church of the Province of Uganda

ABSTRACT

This study assesses the potential contributions of Uganda's competency-based curriculum (CBC) to household sustainability and economic growth in Manafwa District, where 75% of households depend on subsistence agriculture and only 42% complete secondary education. Employing a mixed-methods design with purposive sampling of 50 participants, including teachers, administrators, students, and church leaders, the research addresses three questions: CBC elements aligned with local economic needs, church-led capitalization of CBC-derived skills, and policy recommendations for income generation. Findings indicate that CBC's three competency

Koboi Emmanuel (✉)
Email: Koboiemma8@gmail.com
ORCID: https://orcid.org/0009-0003-2375-9183

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domains, technical skills (financial literacy, agricultural techniques), character development (leadership, resilience), and meta-learning capacities (growth mindset), directly apply to Manafwa's agricultural economy. The Church of Uganda, operating 37% of district schools and reaching 65% of households, can leverage this network through agricultural innovation centers, entrepreneurship incubation programs, skills-based cooperatives, and integrated spiritual-economic development initiatives. Evidence from existing programs shows household income increases of 28% from church-led coffee processing initiatives and 80% startup profitability within six months through CBC-aligned mentorship. Prioritized policy recommendations include localized teacher capacity building emphasizing coffee value chain analysis, formal church-government partnership frameworks, competency assessment reform measuring practical economic applications, targeted resource allocation to female-headed households (38% of households), and church advocacy establishing a CBC Economic Impact Observatory. An 18-month pilot project in three parishes is proposed to document baseline indicators, implement CBC-aligned skills development, provide enterprise mentorship, and measure quantifiable economic improvements. The research concludes that CBC offers substantial potential for household economic transformation when intentionally implemented with economic outcomes in mind, with the Church of Uganda strategically positioned as the catalyst for translating educational competencies into tangible household improvements.

***Keywords**: Competency-Based Curriculum, Household Sustainability, Economic Growth, Church of Uganda, Manafwa District, Agricultural Innovation.*

INTRODUCTION

Education is the cornerstone of progress and personal growth. In Manafwa District, where approximately 75% of households depend on subsistence agriculture and only 42% of residents complete secondary education (Uganda Bureau of Statistics, 2021), there is a critical need

for educational approaches that directly enhance economic outcomes. The competency-based curriculum (CBC) introduced by Uganda's Ministry of Education & Sports and the National Curriculum Development Council (NCDC) represents a potential catalyst for transforming learning into tangible household economic benefits.

This "competency based curriculum" shifts education from knowledge accumulation toward practical skill development. Unlike traditional education models, CBC emphasizes actionable competencies including technical skills (creativity, communication, critical thinking), character development (ethics, leadership, resilience), and meta-learning capacities (meta-cognition, growth mindset). In Manafwa's context, these competencies provide a foundation for entrepreneurship, agricultural innovation, and sustainable household enterprises (Ministry of Education and Sports, 2022).

Purpose of the study

This study examines the economic potential presented by the CBC implementation and how the Church of Uganda and associated institutions can leverage these competencies to increase household incomes and institutional sustainability within Manafwa District

Research questions

1. What specific elements of the lower secondary school competency-based curriculum (CBC) align with Manafwa's economic needs?

2. How can the church and its institutions within Manafwa District capitalize on CBC-derived skills to foster income-generating activities such as agricultural value addition, small-scale manufacturing, and service enterprises?

3. What targeted policy recommendations and implementation strategies can facilitate household income growth and economic sustainability in Manafwa's unique socioeconomic context?

METHODOLOGY

This study employs a mixed-methods approach with emphasis on qualitative data collection from both primary and secondary sources. Data collection instruments include semi-structured questionnaires and in-depth interviews with stakeholders across Manafwa District.

A purposive sampling strategy selected 50 participants representing key stakeholder groups: CBC-implementing teachers (15), school administrators (10), district education officers (5), secondary students (10), and church leaders engaged in community development (10). From each parish within Manafwa district, 5 participants were selected using stratified random sampling to ensure representation across demographic and geographic variables, following methodological approaches recommended by Wambui and Njoroge (2021).

Data analysis employed thematic coding techniques using NVivo software to identify patterns related to economic applications of CBC competencies. Quantitative economic indicators were analyzed using descriptive statistics to establish baseline household economic conditions. Triangulation of multiple data sources enhanced validity and reliability of findings.

What is a competency based curriculum (CBC)?

A competency-based curriculum represents an educational approach emphasizing the development of specific, measurable skills rather than mere knowledge accumulation. In Manafwa's context, where practical livelihood skills directly impact household sustainability, this distinction is particularly significant. Muwanguzi (2024) defines CBC as an approach that "equips learners with necessary skills and abilities to perform tasks effectively in real-life situations, emphasizing application over theoretical knowledge."

The CBC implemented in Uganda's lower secondary schools encompasses three primary competency domains:

1. **Technical skills**: Including financial literacy, digital competence, agricultural techniques, and creative problem-solving applicable to Manafwa's predominantly agricultural economy (National Curriculum Development Council, 2020).
2. **Character development**: Fostering leadership, ethical decision-making, and resilience important qualities for entrepreneurial success in resource-constrained environments (Eriya, 2024).
3. **Meta-learning capacities**: Developing growth mindset and self-directed learning that enable continuous adaptation to changing economic conditions (Kemboi & Maina, 2021)

For example, a CBC agriculture module in Manafwa schools includes project-based learning where students develop small-scale vegetable gardens using sustainable farming techniques, calculate profit margins, and develop marketing strategies directly applicable skills for household economic improvement (National Curriculum Development Council, 2020).

The CBC design allows learners to progress at individualized paces, emphasizing mastery of competencies rather than time spent in classrooms (Bhatt & Sharma, 2021). This flexibility is particularly valuable in Manafwa District, where seasonal agricultural demands often compete with educational schedules. As Mutisya (2019) notes, the CBC encourages a variety of teaching and learning approaches that engage learners more actively in the educational process, preparing them for practical application in real-world settings.

How the Church and Institutions within Manafwa District Capitalize On CBC for Sustainability and Household Growth

The Church of Uganda maintains significant influence in Manafwa District, operating 37% of schools and reaching approximately 65% of households through various ministries (Diocese of Mbale Annual Report, 2022). This extensive network provides an important platform for translating CBC competencies into household economic improvements through several specific strategies:

1. **Church-based agricultural innovation centers**: Churches can establish demonstration farms that apply CBC-derived agricultural competencies to local crops. For instance, St. Peter's Church in Bubutu Parish has implemented a youth-led coffee processing initiative that applies value-addition techniques taught in CBC science modules, increasing household income by 28% for participating families (Okiror & Otim, 2023).
2. **Entrepreneurship incubation programs**: Church institutions can create supportive environments for youth and women to develop CBC-acquired skills into viable businesses. The "Faithful Entrepreneurs" program at Christ Cathedral has mentored 35 small business startups since 2022, with 80% achieving profitability within six months by applying financial literacy and marketing skills from the CBC (Nambi & Otaala, 2022).
3. **Skills-based cooperative formation**: Churches can facilitate the formation of producer cooperatives organized around specific CBC competencies. The Manafwa Women's Crafts Cooperative, supported by three Anglican parishes, leverages artistic and mathematical skills from CBC to produce and market traditional crafts internationally via e-commerce platforms (Diocese of Mbale Annual Report, 2022).
4. **Integrated spiritual and economic development**: Rather than viewing spirituality and economic activities as competing priorities, churches can develop integrated programs where ethical business practices and community responsibility are framed as expressions of faith values. This approach addresses the historical reluctance of some church leaders to engage with economic initiatives (Nambi & Otaala, 2022).

Policy Recommendations and Strategies to Facilitate Income Generation & Growth

Based on Manafwa's specific context and the research findings, the following prioritized recommendations address barriers to CBC implementation for economic benefit:

1. **Localized teacher capacity building**: The Ministry of Education and NCDC should develop Manafwa-specific teacher training modules that emphasize CBC applications relevant to local economic opportunities (Kasozi, 2018). For example, training secondary school teachers to incorporate coffee production value chain analysis into mathematics and business studies to reflect the district's primary cash crop.

2. **Church-government partnership framework**: Establish formal collaboration mechanisms between the Church of Uganda and district education officials to align CBC implementation with community development initiatives (World Bank, 2022). This should include quarterly coordination meetings and joint monitoring of economic outcomes from educational initiatives.

3. **Competency assessment reform**: Develop assessment tools that measure practical economic applications of CBC competencies rather than theoretical knowledge alone (Mwiria, 2017). For rural Manafwa schools, this could include portfolio-based assessment of student-led agricultural projects or community business initiatives.

4. **Targeted resource allocation**: Government and development partners should prioritize CBC implementation resources to marginalized communities within Manafwa, particularly focusing on female-headed households (currently 38% of households) and youth groups in parishes with highest poverty incidence (Uganda Bureau of Statistics, 2021).

5. **Church advocacy role**: Church leaders should actively advocate for CBC policies that enhance economic opportunities by documenting and communicating successful implementations (Nambi & Otaala, 2022). The Diocese of Mbale could establish a CBC Economic Impact Observatory to monitor household improvements resulting from curriculum implementation.

Implementation timeline:

1. Immediate term (0-6 months): Establish church-government coordination mechanisms and begin teacher training
2. Medium term (6-18 months): Implement assessment reforms and targeted resource allocation
3. Long term (18+ months): Develop sustainable advocacy structures and impact measurement systems

CONCLUSION AND CALL TO ACTION

This research demonstrates that the competency-based curriculum offers substantial potential for enhancing household economic sustainability in Manafwa District when intentionally implemented with economic outcomes in mind. The Church of Uganda, with its extensive institutional presence and community trust, occupies a strategic position to translate educational competencies into tangible household improvements (Nambi & Otaala, 2022).

We propose an immediate pilot project: "CBC Economic Transformation Initiative" in three Manafwa parishes (Bukhofu, Bumbo, and Bubutu) where church institutions, schools, and district officials would collaborate to implement integrated learning and economic activities based on the CBC framework (Okiror & Otim, 2023). This 18-month pilot would:

1. Document baseline household economic indicators for 150 participating families

2. Implement targeted CBC-aligned skills development in both school and community settings
3. Provide mentorship and startup resources for household enterprises
4. Measure quantifiable economic improvements and document implementation lessons

This pilot would generate evidence-based models for scaling CBC economic applications throughout Manafwa District and potentially other regions facing similar economic challenges. The time for theoretical discussion has passed Manafwa's households need practical applications of educational innovation that the CBC, properly implemented, can deliver (World Bank, 2022).

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Water Availability and Household Adaptive Mechanisms of Smallholder Farmers in Refugee Settlement Camps: Insights from Nakivale, Uganda

*Ahmed Said Abdi[1]

Bishop Stuart University,
Faculty of Agriculture, Environmental Sciences and Technology

ABSTRACT

Smallholder farmers in refugee settlements demonstrate resilience to climate change through localized adaptation, yet inadequate water infrastructure, economic limitations, and weak institutional support constrain their efforts. Despite this, limited empirical research has examined how displaced farmers cope with water scarcity, as most studies focus on host communities and overlook refugee contexts. This study, therefore, assesses water resource availability and adaptive mechanisms among smallholder farmers in Nakivale Refugee Settlement, Uganda one of the largest and most climate-stressed

Said Abdi Ahmed (✉)
Email: donyale101@gmail.com

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settlements in East Africa. A cross-sectional design was used, involving 384 randomly selected households and 12 purposively selected key informants. Data were collected through household questionnaires and interviews, and analyzed using descriptive statistics, chi-square tests, and thematic analysis. Results showed heavy reliance on precarious water sources, with most farmers depending on rainfall and purchased water, followed by river water, boreholes, wells, and taps. Major challenges included poor water quality, long distances to water sources, seasonal drying of water points, insufficient supply, conflicts over water access, and climate-induced variability. To cope with scarcity, households adopted mechanisms such as rainwater harvesting, storing water, seeking alternative sources, reducing cultivated land, and planting drought-resistant crops. However, adoption of water-saving technologies remains low due to financial barriers and limited training. Community collaboration in water management is also minimal, indicating weak collective action. The study underscores the need for targeted policies and interventions to strengthen resilience in refugee settlements, including expansion of reliable water infrastructure, promotion of affordable water-saving technologies, enhanced community-based water governance, and integration of these efforts into broader climate adaptation and humanitarian programming.

***Keywords**: Water Scarcity, Adaptive Mechanisms, Smallholder Farmers, Nakivale, Uganda.*

INTRODUCTION

Water scarcity is one of the most pressing global challenges of the 21st century, with its effects felt most severely in arid and semi-arid regions and among already vulnerable populations (United Nations, 2023). The problem is multidimensional, driven by climate change, rapid population growth, and unsustainable water management practices. Worldwide, water shortages persist due to mismatches between water demand and supply, influenced by physical, economic, and institutional factors (Msongaleli et al., 2023). Physical scarcity arises when natural

water sources including rainfall, rivers, and aquifers, cannot meet household, agricultural, and industrial demand. Arid regions with annual renewable water availability below 1,000 m^3 per capita are particularly affected (Bakiika et al., 2023). Economic water scarcity, in contrast, occurs when water is available but inaccessible because of financial, infrastructural, or governance limitations, such as inadequate investment or inequitable distribution systems (Pastori & Sindico, 2020).

Water scarcity manifests differently across regions. In the Aral Sea Basin, unsustainable irrigation triggered ecological collapse (Pastori & Sindico 2020). Prolonged droughts in the Southwestern United States led to strict water conservation measures (Denis & Che, 2021). Australia's Millennium Drought (late 1990s to 2009) exposed vulnerabilities in water supply and prompted extensive investments in water infrastructure and management (Rey et al., 2019). These experiences illustrate the sensitivity of agriculture and food systems to climatic variability (Rey et al., 2019).

In Africa, water challenges have intensified due to climate change and rising population pressure. Madagascar has faced prolonged droughts that triggered severe food insecurity and displacement (Hanadé Houmma et al., 2022), while shrinking water resources in the Lake Chad Basin have fueled resource-based conflicts (Hanadé Houmma *et al*, 2022). Across East Africa, fluctuating climatic patterns have undermined water access and agricultural production. Somalia continues to experience recurrent droughts and humanitarian crises (Malkawi & Kapiel, 2024). Tanzania's major cities, including Dar es Salaam, struggle with water stress linked to rapid urbanization and climate variability (Smit & Wandel, 2006). Kenya's pastoralist communities have endured repeated livestock losses due to persistent droughts (Yator, 2024). Uganda also faces a dual challenge of droughts and floods, disrupting farming systems and water security (Price, 2020). These impacts vary regionally. Karamoja faces chronic drought and dependence on relief (Price, 2020) Kampala experiences infrastructure overload and sanitation risks, while Western Uganda suffers climate-induced flooding (UBOS, 2024).

In response to rising water insecurity, different countries have adopted diverse adaptation mechanisms. Singapore has invested in desalination and water recycling to secure long-term water access (Manungufala, 2021). Australia's Murray Darling Basin Plan seeks to balance environmental sustainability and economic water use (Pastori & Sindico, 2020). Globally, digital tools such as remote sensing and data analytics increasingly support water monitoring and planning (UBOS, 2024). Localized nature-based solutions — such as community rain gardens help reduce stormwater runoff and improve groundwater recharge (Manungufala, 2021).

Across Africa, adaptation strategies have prioritized strengthening water infrastructure, sustainable resource management, and building community resilience. Rwanda has expanded rainwater harvesting and small-scale irrigation to enhance rural water access (Pastori & Sindico, 2020). Ethiopia's Grand Renaissance Dam aims to improve storage and hydropower generation, though it has sparked geopolitical debate (OPM, 2019). Community-centred models, such as participatory irrigation associations, have improved equitable resource distribution(Zhang et al., 2021).

In East Africa, resilience efforts include investing in infrastructure, promoting drought-resistant crops, and diversifying livelihoods. Kenya's Northern Rangelands Trust supports collaborative natural resource management among pastoralists (Malkawi & Kapiel, 2024). while in Ethiopia, mobile platforms disseminate real-time water information to strengthen early warning systems (Naidoo, 2022).

In Uganda, resilience strategies focus on water infrastructure development, sustainable agriculture, and community-based management, though inequalities in access remain (Siregar, 2022). Integrating indigenous knowledge with modern technologies has also enhanced adaptive capacity (Choden et al., 2020). Despite these advancements, refugee settlements — often located in ecologically fragile areas experience heightened water scarcity due to their high population density, limited infrastructure, and exclusion from formal governance systems (Calderón-Villarreal et al., 2022).

In Nakivale Refugee Settlement, Western Uganda, water scarcity has especially affected smallholder farmers, who depend on water for domestic use and agricultural production. According to (UBOS, 2023) 60% of households spend over four hours daily collecting water, and 30% rely on unsafe sources, increasing exposure to waterborne diseases (UNHCR, 2021). Agricultural output has been heavily disrupted, with yield reductions of more than 50% due to unpredictable and insufficient water supply, heightening food insecurity among households largely dependent on rain-fed farming (Malkawi & Kapiel, 2024). Low income further limits adaptation: nearly 60% of smallholders earn less than $0.50 per day (Daoust & Selby, 2023), constraining access to irrigation, filtration technologies, or improved seeds.

Competition for scarce water resources has led to social tension and displacement within the settlement, with projections suggesting that up to 20% of Nakivale's population could migrate by 2030 due to water stress (Pastori & Sindico, 2020). Already, 15% of households report monthly conflicts over water access (UNHCR, 2021). Institutional responses remain limited, with only about 15% of households participating in water management programs. The absence of refugee-specific water policies deepens inequities in resource allocation, and existing governance frameworks do not sufficiently address the interconnected effects of physical scarcity, poverty, and institutional neglect. As a result, smallholder farmers experience a compounded vulnerability, especially given their dependence on rain-fed agriculture and limited access to alternative water sources. Persistent scarcity undermines livelihoods, economic stability, and social cohesion (Pastori & Sindico, 2020)

Although households develop coping strategies, their effectiveness depends on access to knowledge, financial resources, and institutional support (Smit & Wandel, 2006). Yet empirical research examining the relationship between water availability and household-level adaptation in refugee contexts remains limited. Consequently, policies often fall short of addressing the unique challenges facing displaced farmers. To address this gap, study in Nakivale Refugee Settlement focuses on two core questions:

1. What are the perceived causes of water scarcity for agriculture among smallholder farmers in Nakivale Refugee Settlement?
2. What adaptive mechanisms do households adopt to cope with water scarcity?
3. Theoretical perspectives of water resource availability and household adaptive mechanisms

This study employs the Sustainable Livelihoods Framework (SLF) as its theoretical framework to analyze the relationship between water resource availability and households' adaptive mechanisms to water scarcity among smallholder farmers. Within this framework, water resource availability is conceptualized as a critical component of natural capital, influencing the capacity of households to engage in productive agricultural activities and sustain their livelihoods (Choden et al., 2020).

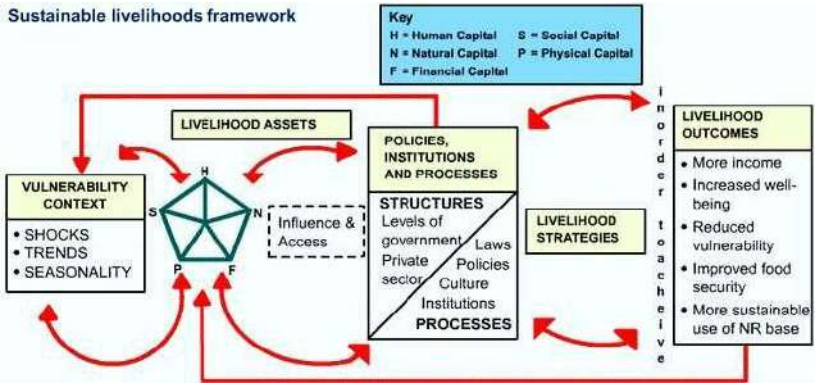

Figure 1: Sustainable Livelihoods Framework (SLF) (DFID (1999)

Household adaptive mechanisms are assessed by examining how smallholder farmers utilize their livelihood assets, including physical capital (water storage and irrigation infrastructure), human capital (knowledge and skills in water conservation), financial capital (resources to invest in water-saving technologies), and social capital

(community-based water management practices) to manage water scarcity (Fletcher et al., 2015). Policies, institutions, and processes are integrated into the framework to analyze how water governance structures, humanitarian support systems, and local regulations either facilitate or constrain farmers' capacity to access and use water resources efficiently (Denis & Che, 2021; Mukasa et al., 2020).

Adaptive mechanisms such as rainwater harvesting, the use of water-efficient technologies, and crop diversification are explored within the SLF as livelihood strategies adopted by households to cope with water scarcity while maintaining agricultural productivity and household food security (Chepkoech et al., 2020; Matewos, 2020).

The framework further assesses livelihood outcomes including income stability, food security, and reduced vulnerability; as critical indicators of resilience under water-stressed conditions (UNHCR, 2021). By adopting the SLF, this theoretical framework systematically examines how water resource availability interacts with household adaptive mechanisms to determine resilience to water scarcity. It provides a structured approach to identify leverage points for policy and community-based interventions aimed at enhancing sustainable water management and adaptive mechanisms among smallholder farmers in Uganda and similar contexts.

METHODOLOGY

Description of the study area

The study was conducted in Nakivale Refugee Settlement, located in Isingiro District, Southwestern Uganda. The settlement lies approximately 35 kilometers south of Mbarara City and is one of the oldest and largest refugee settlements in Africa. Geographically, Nakivale is situated at coordinates approximately 0.8500° S latitude and 30.8500° E longitude. The settlement covers a vast area subdivided into several zones, each hosting refugees from different countries including Somalia, the Democratic Republic of Congo, Burundi, Rwanda, and Ethiopia (OPM, 2019).

Nakivale experiences a tropical savannah climate, characterized by two rainy seasons (March–May and September–December) and two dry seasons. Average annual rainfall ranges between 600 mm and 1,000 mm, while temperatures vary from 18°C to 30°C. The climatic conditions influence agricultural activities, which remain the backbone of livelihoods within the settlement (UNHCR, 2021).

The living conditions of refugees in Nakivale vary depending on access to services, resources, and humanitarian support. The cost of living has progressively increased due to high demand for basic goods, limited employment opportunities, and fluctuating market prices. Households often face challenges related to access to food, water, health services, and shelter. Although basic social services are available, they are sometimes overstretched due to the high population size(UBOS, 2023).

The economic livelihood of refugees in Nakivale relies mainly on small-scale farming, petty trade, casual labor, fishing, and humanitarian aid. Many households cultivate small plots of land provided by the Office of the Prime Minister (OPM), growing crops such as maize, beans, cassava, sweet potatoes, and vegetables. Other residents run small businesses including shops, tailoring, motorbike transport (boda boda), and food vending. However, income levels remain low, making households vulnerable to shocks such as drought, food price increases, and reduced humanitarian assistance(OPM, 2019).

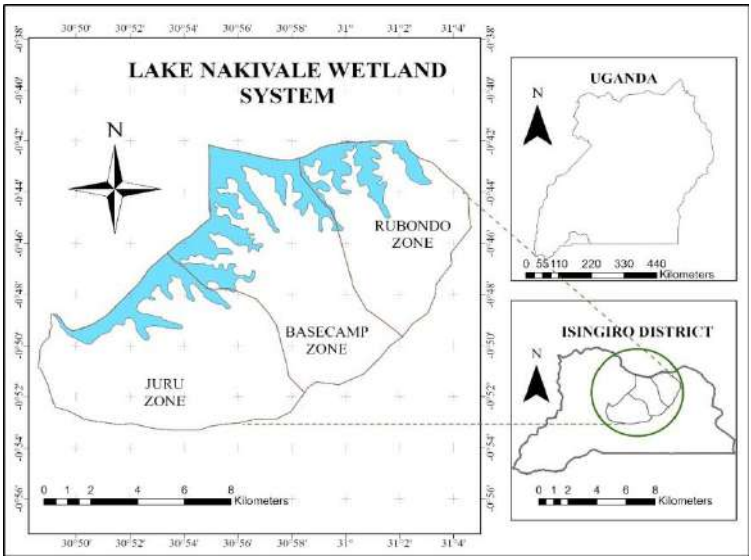

Figure 2: Map of the study area

Research design

The study employed a cross-sectional research design, allowing data collection at a single point in time to examine the relationship between water availability and adaptive mechanisms among smallholder farmers (Weyant, 2022). This design was appropriate due to the need to gather quantitative and qualitative information from a large population within limited time and resources. The design also enabled the comparison of household experiences, perceptions, and adaptive responses to water scarcity across different zones of the settlement.

Data collection (methods and tools)

Both quantitative and qualitative approaches were used to strengthen reliability and validity. A household survey served as the primary quantitative data source. A sample of 384 households was randomly selected based on population proportion across the settlement zones. A

structured questionnaire was administered to collect data on demographic characteristics, water sources, water challenges, agricultural activities, and coping strategies.

For qualitative data, Key Informant Interviews (KIIs) were conducted with 12 purposively selected participants, including camp leaders, water officials, agricultural extension workers, and humanitarian actors supporting water and agricultural programs. An interview guide was used to explore deeper insights on institutional responses, water governance, and community-based adaptation.

Pilot testing of the tools was carried out to ensure clarity, consistency, and cultural sensitivity. Ethical considerations such as voluntary participation, confidentiality, and informed consent were strictly observed throughout the data collection process.

Data analysis

Data were entered, cleaned and coded in Microsoft excel, and later analyzed using R software version 4.5.0 (R Core Team, 2025). Descriptive statistics (frequencies, percentages, and means) were used to summarize household characteristics, primary water sources, and the prevalence of various adaptive strategies. To test relationships between variables, chi-square tests were employed to determine the association between water resource availability and the adoption of adaptive mechanisms among households.

RESULTS AND DISCUSSION

This section presents a detailed analysis of the quantitative and qualitative findings on water source usage, access challenges, and adaptive mechanisms among smallholder farmers in Nakivale Refugee Settlement. The interpretation is framed within the Sustainable Livelihoods Framework (SLF) and situated within the broader context of existing literature on water scarcity and adaptation in refugee and fragile contexts.

Demographic characteristics of the respondents

The demographic characteristics of the 384 surveyed households provide a crucial context for understanding their vulnerability and adaptive capacity to water scarcity. The community is predominantly of working age, with 86.5% of respondents aged between 18 and 50 years. This suggests the presence of a significant labor force capable of implementing labor-intensive adaptations, such as building rainwater harvesting structures or traveling long distances for water. However, this potential is critically undermined by other socio-economic constraints.

Table 1: Demographic characteristics of the respondents

Characteristic	Category	Frequency (n=384)	Proportion (%)
Age	Under 18	23	6.0
	18 – 35	159	41.4
	36 – 50	173	45.1
	Over 50	29	7.6
Gender	Male	190	49.5
	Female	194	50.5
Education level	No education	184	47.9
	Primary	141	36.7
	Secondary	51	13.3
	Tertiary	8	2.1
Household size	1 - 3 members	123	32.0
	4 - 6 members	175	45.6
	Above 6 members	86	22.4
Land size	0.1 - 0.5 acre	182	47.4
	0.6 - 1.0 acre	152	39.6
	Above 1 acre	50	13.0
Time of settlement in area	Below 1 year	54	14.1
	1 - 5 years	205	53.4
	Above 5 years	125	32.6

Household income	Mean (SD) Median [Min, Max]	220,000 150,000	(166,000) [30000, 700000]

The age distribution shows that the majority of the population (86.5%) is within the working-age bracket of 18-50 years. This suggests a significant labor force potential for implementing labor-intensive adaptations, such as building rainwater harvesting structures or walking long distances for water. However, as noted by Eriksen et al. (2021), a young and active demographic in a resource-scarce setting can also intensify pressure on limited natural resources if not coupled with sustainable livelihood opportunities.

The near-equal gender split (49.5% male, 50.5% female) is representative of the settlement's population. This variable is crucial as gender roles profoundly influence water access and management. The data corroborates global findings that women and girls are primarily responsible for water collection, a task that becomes more burdensome and time-consuming in conditions of scarcity (Graham et al., 2016). The time spent fetching water directly impacts women's ability to engage in income-generating activities or education, thereby constraining the development of human capital.

The education level is a stark indicator of human capital constraints. With 47.9% of respondents having no formal education and only 15.4% having secondary education or above, the capacity to comprehend, evaluate, and adopt new, technically complex water-saving technologies is severely limited. This finding aligns with Wutich *et al*. (2020), who demonstrated that low educational attainment is a significant barrier to the adoption of climate-resilient agricultural practices. The lack of literacy and numeracy skills can hinder farmers' ability to access training materials, calculate irrigation schedules, or engage with formal financial institutions for loans, perpetuating a cycle of low adaptive capacity.

Household size shows that 68% of households have 4 or more members. While larger households may have more labor available for tasks like farming and water collection, they also have greater aggregate water demands for both domestic and agricultural use (Kemeze, 2021).

This creates a double-edged sword: more labor to cope with scarcity, but also higher consumption that exacerbates the scarcity itself.

Land size is a key component of physical capital. The data reveals that 87% of households farm on 1 acre of land or less, with nearly half (47.4%) on plots between 0.1 and 0.5 acres. Such micro-plots, common in refugee settlements due to land allocation policies, limit the potential for agricultural diversification and the economic viability of investing in irrigation infrastructure. As shown by Zaitchik *et al*. (2019), the small scale of landholding often makes the per-unit cost of technologies like drip irrigation prohibitively high, pushing farmers towards lower-cost but less effective coping strategies.

The time of settlement indicates that most respondents (86%) have been in the settlement for over a year, with 32.6% for over five years. This suggests a population with settled livelihoods and local ecological knowledge, which is a form of human capital. However, as posited by Hunter et al. (2020), long-term residence without secure land tenure can lead to environmental degradation as farmers are unable to make long-term investments in soil and water conservation, fearing displacement.

Finally, household income reveals a community in poverty. With a median monthly income of 150,000 UGX (approximately 40 USD), households operate with extremely limited financial capital. The substantial standard deviation (166,000 UGX) indicates high income inequality, but even the upper range of reported incomes (700,000 UGX) is modest. This level of poverty directly constrains the ability to purchase water, invest in water storage, or acquire efficient irrigation equipment, thus forcing households into difficult trade-offs between immediate consumption and long-term resilience (Sovacool *et al*, 2021).

This profile paints a picture of a community with the labor force to implement adaptations but constrained by low education, small land holdings, and poverty. These factors directly shape both their access to water and the repertoire of adaptive strategies they can employ, consistent with the assets pentagon of the Sustainable Livelihoods Framework (Choden et al., 2020).

The sources of water for agriculture in Nakivale refugee settlement

Results show that residents of Nakivale Refugee Settlement rely on several key water sources to sustain farming activities and livelihoods. This section explores the primary sources of water available for agricultural use in the settlement.

Figure 3: hand-drawn picture shows population growth and water scarcity

Table 2: The sources of water for agriculture in Nakivale refugee settlement

Water source	Response	Frequency (n=384)	Proportion (%)	χ^2	p-value
Borehole	No	252	65.6	37.500	<0.001***
	Yes	132	34.4		
Well	No	289	75.3	98.010	<0.001***
	Yes	95	24.7		
Rain	No	63	16.4	173.344	<0.001***
	Yes	321	83.6		
Taps	No	371	96.6	333.760	<0.001***
	Yes	13	3.4		
River	No	228	59.4	13.500	<0.001***
	Yes	156	40.6		
Purchase	No	168	43.8	6.000	0.014*
	Yes	216	56.3		

The overwhelming reliance on rainwater aligns with findings from Murgor et al. (2021) in Kenyan refugee contexts, where its low cost and accessibility make it the primary source. However, this dependence creates acute vulnerability to climatic shocks. As noted by a key informant, *"Many people have adopted water harvesting technologies... for use during the dry season,"* indicating that rainwater use is intrinsically linked to storage capacity. The bimodal rainfall pattern in Nakivale means that without sufficient storage, this source is unavailable for long periods, directly impacting agricultural cycles and food security (Mukasa et al., 2020). This reliance on an unpredictable natural capital asset underscores the community's exposure to climate variability.

The high prevalence of purchased water is a telling indicator of economic water scarcity. This finding resonates with studies by Akello et al. (2022) and Calderón-Villarreal et al. (2022), who documented that poor households in displacement settings often allocate a substantial portion of their meager income to buying water. This diverts financial capital from other critical livelihood investments, such as agricultural inputs, education, or healthcare, thereby

perpetuating a cycle of poverty. A key informant highlighted the strain: *"There is a constant cost... I have to send money and pay from my pocket."* This market-based solution, while filling a critical gap, effectively taxes the poorest for a fundamental human right.

The significant use of river water raises major public health concerns, directly impacting human capital through health outcomes. This aligns with research by Nkwanda *et al*. (2020) and Baguma *et al*. (2013), which associates the use of untreated surface water with elevated risks of waterborne diseases like cholera and dysentery. The Ministry of Health (2023) reported 320 cholera cases in Nakivale in 2022, underscoring the real-world consequences of this reliance. The use of contaminated sources reflects a failure in the provision of safe physical capital (water infrastructure).

The limited use of boreholes (34.4%) points to a critical gap in protected groundwater infrastructure. While boreholes are typically classified as an improved water source, their uneven distribution and frequent breakdowns limit their reliability. Studies in similar settings, such as by Stoler et al. (2021), note that boreholes in refugee-hosting areas often suffer from mechanical failures and long queues, especially during dry seasons. Their limited coverage signifies an insufficiency in the physical capital necessary for a resilient water system.

The minimal access to taps and limited use of boreholes (34.4%) underscores a severe physical capital deficit. This finding is consistent with UNHCR (2023) reports and analyses by Tumushabe (as cited in Hussein Ahmed & Isse Ali, 2024), which point to chronic underinvestment in durable water infrastructure in refugee settlements. The extremely high and significant chi-square value for taps (χ^2 = 333.76) indicates that this is the most inequitably distributed resource, reflecting a systemic failure in public service provision and a critical gap in the settlement's built environment.

Furthermore, the distance to water sources was a significant barrier (Table 3). While 35.7% of households traveled less than 1 km, another 35.7% traveled 1-3 km, and 28.6% journeyed over 4 km. These long distances, consistent with UBOS (2023) data, disproportionately burden women and children, who are primarily responsible for water

collection, limiting their time for other productive activities and education (Bakiika et al., 2023)

Table 3: Distance to water sources (N=384)

Response	Frequency (n=384)	Proportion (%)	χ^2	p-value
Less than 1 km	137	35.7	97.042	<0.001***
1 – 3 km	137	35.7		
4 - 6 km	91	23.7		
More than 6 km	19	4.9		

The data shows that while 35.7% of households travel a relatively short distance (less than 1 km), an equal proportion travel 1-3 km, and over a quarter (28.6%) journey more than 4 km. The statistical test ($p < 0.001$) confirms the differences in distances moved by respondents are meaningful. This suggests uneven access to water, with many households facing long distances that could affect water use and increase burdens, especially for women and children. The results highlight the need for targeted improvements in local water infrastructure. These long distances, consistent with UBOS (2023) data, disproportionately burden women and children, who are primarily responsible for water collection. This time-consuming task represents a significant opportunity cost, limiting time for other productive activities, education, and rest, thereby eroding both human and social capital (Bakiika *et al*., 2023). The gendered nature of this burden reinforces existing inequalities, as the time and physical effort invested in water collection directly reduce women's capacity to engage in income-generating activities or community leadership.

Perceived causes of water scarcity for agriculture

Water shortage: The respondents were also asked if the water they got from the different sources was sufficient or not for their farming and household needs. The data on water sufficiency and shortage in Nakivale refugee settlement camps presents a nuanced picture of water availability for agricultural and household needs. Their responses were recorded and are presented below.

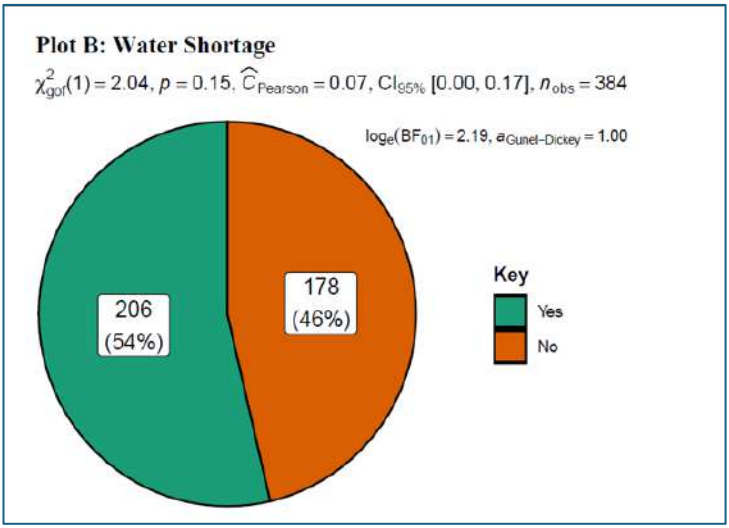

Figure 4: Water shortage

The data on water sufficiency and shortage in Nakivale refugee settlement camps presents a nuanced picture of water availability for agricultural and household needs. The statistical analysis reveals no significant difference in perceptions of water sufficiency (χ^2 (1) =2.04, p=0.15), with 54% of respondents reporting insufficient water and 46% indicating adequacy. Similarly, reports of water shortage mirrored this distribution (54% yes, 46% no) with identical statistical values, suggesting balanced but concerning divisions in water access experiences. The weak Pearson's C correlation

(C Pearson = 0.07) and Bayes Factor ($log_a(BF_{01})$ =2.19) leaning toward the null hypothesis indicate that these reports may not reflect extreme systemic scarcity but rather inconsistent access patterns. With 384 observations, these findings highlight that while half of the refugee farmers face water shortages that likely hinder agricultural productivity and domestic use, nearly half manage to meet their needs, pointing to uneven resource distribution within the settlement. Here, a key informant stated that

> *"It is a difficult situation as you see or feel. There are many days when there is no water and there is a constant cost that is not related to the arrival of water. For example, today if I do not have water, I have to send money and pay from my pocket".*

This disparity underscores the need for targeted interventions to improve equitable water allocation, particularly as climate variability and population pressures may exacerbate existing gaps in water security for vulnerable farming households.

Water shortage frequency

The results in the figure above reveal a severe and frequent water shortage problem in the refugee settlement, with 55.8% of respondents (115 out of 206) experiencing shortages "sometimes," 31.6% (65) facing them "often," and 12.6% (26) dealing with shortages "always" - a highly significant pattern (χ^2=134.85, $p<0.001$). The extremely significant pattern confirms that these patterns are not random occurrences but reflect structural deficiencies in water provision.

This situation has grave implications: the "always" group likely represents the most vulnerable households in the worst-served zones of the settlement, possibly facing permanent water insecurity that threatens basic survival needs. The high percentage facing frequent shortages ("often") suggests the water system operates at a consistent deficit even during normal conditions. These findings demand an urgent humanitarian response, Interventions should address both immediate water supply needs in the most affected areas and long-term

infrastructure improvements to prevent households that experience occasional shortages from transitioning into more severe and frequent water scarcity categories. The universal experience of shortages highlights how water access remains a fundamental failure in meeting basic rights for displaced populations.

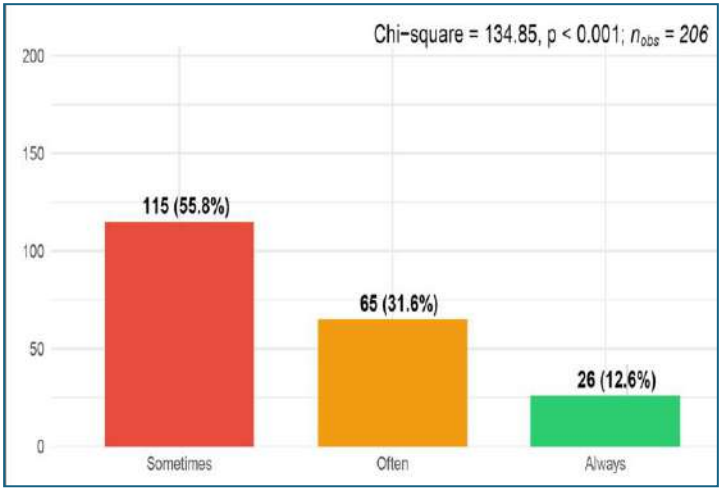

Figure 5: Water shortage frequency

Causes of Water Scarcity

Climate change as a cause of water scarcity

More than half of the respondents, i.e., 67% of respondents (257 out of 384) identified climate change as one of these water shortages, supported by extremely strong statistical evidence (χ^2=44.01, p<0.001) and a moderate Pearson's C correlation (0.32).

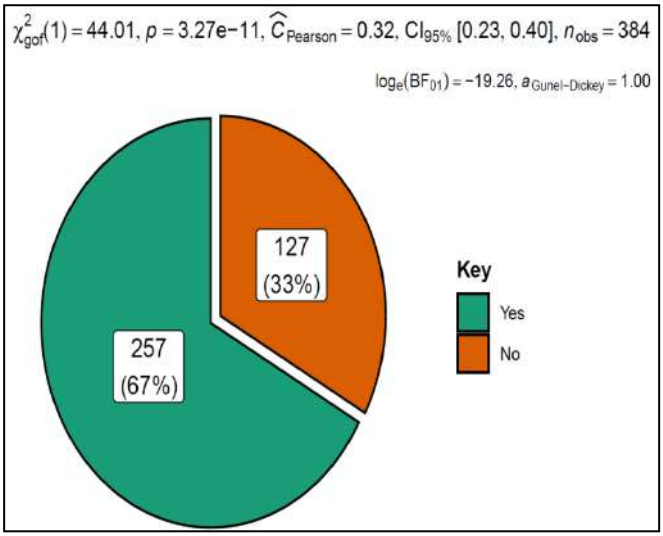

Figure 6: Climate change as a cause of water scarcity

The Bayes Factor ($\log_e$ (BF_{01})=-19.26) provides decisive evidence against the null hypothesis, confirming climate change's substantial role in exacerbating water scarcity. These findings paint a troubling picture of how climate impacts are disproportionately affecting vulnerable refugee populations, with frequent water shortages disrupting agricultural livelihoods and household stability. The results underscore the urgent need for climate-resilient water management strategies in refugee settlements, including improved water storage, drought-resistant farming techniques, and international support to address this growing humanitarian crisis

Non-Climate Causes of Water Scarcity

Apart from climate change being the leading cause of water shortage i.e., mentioned by 67% of the respondents, the following were also cited as other causes of water shortage.

Table 4: Non-climate causes of water scarcity

Causes of water scarcity	Frequency (n=384)	Proportion (%)	χ^2	p-value
More people using water				
No	152	39.6	16.667	<0.001***
Yes	232	60.4		
Deforestation				
No	246	64.1	30.375	<0.001***
Yes	138	35.9		
Poor water management				
No	235	61.2	19.260	<0.001***
Yes	149	38.8		

The data highlights several significant non-climate factors contributing to water scarcity in the refugee settlement, with population pressure emerging as the most prominent cause. A striking 60.4% of respondents (232 out of 384) identified "more people using water" as a key factor, showing strong statistical significance (χ^2=16.667, p<0.001). In line with this, a key informant stated that

> "*The few waterpoints available have been over powered by the high population, which sometimes lead to fights and conflicts over water. This is common in the dry seasons when the problem of water scarcity is faced by a very big proportion of the residents.*"

Other notable causes included poor water management (38.8%) and deforestation (35.9%), both demonstrating significant associations (χ^2=19.260 and 30.375 respectively, p<0.001 for both).

The Adaptive mechanisms used by households in response to water scarcity

The presented results in the table 5 below demonstrate statistically significant patterns in Adaptive strategies employed by Nakivale refugee households facing water scarcity (N=384), with chi-square tests revealing particularly strong adoption disparities (all p<0.01).

Table 5: The adaptive mechanisms used by households in response to water scarcity

Response	Frequency (n=384)	Proportion (%)	χ^2	p-value
Using water-saving methods				
No	292	76.0	104.167	<0.001***
Yes	92	24.0		
Using stored water				
No	148	38.5	20.167	<0.001***
Yes	236	61.5		
Reducing cultivated land area				
No	162	42.2	9.375	0.002**
Yes	222	57.8		

Switching to drought-resistant crops				
No	254	66.1	40.042	<0.001***
Yes	130	33.9		
Adopting rainwater harvesting technology				
No	147	38.3	21.094	<0.001***
Yes	237	61.7		
Seeking alternative water sources				
No	161	41.9	10.010	0.002**
Yes	223	58.1		

The high adoption of rainwater harvesting technology (61.7%) represents a proactive investment in physical capital to enhance control over a volatile natural capital asset (rainfall). This aligns with global recommendations from (Mukasa *et al*, 2020)and successful case studies in Rwanda and Northern Ghana (Mukasa *et al*., 2020). It indicates that households recognize the value of capturing seasonal rainfall. However, the term "technology" here often refers to simple gutters and small storage jars. The effectiveness of this strategy is contingent upon the capacity and quality of storage facilities. The study suggests that many households rely on small, inadequate containers, a limitation also found by Msongaleli et al. (2023). Scaling up this adaptation requires addressing the financial capital barriers to acquiring larger, more durable storage tanks.

The practice of using stored water (61.5%) is intrinsically linked to rainwater harvesting but represents the utilization aspect of this strategy. It highlights a household's ability to smooth water availability

over time. However, the capacity of storage dictates the duration for which this strategy is viable. When stores are depleted, households are forced to revert to more precarious sources or negative coping strategies. The high adoption of both harvesting and storage indicates a logical and widespread attempt to create a buffer against rainfall variability, yet the scale remains insufficient for long-term drought resilience (Mwiturubani et al., 2025).

Reducing Cultivated Land Area (57.8%) This is a classic *coping*, rather than *adaptive*, strategy. It is a distress response that immediately reduces agricultural water demand but at the cost of lower food production and income, directly undermining financial capital and food security. This finding is consistent with the work of Moser and Ekstrom (as cited in Crawford et al., 2016), who categorize such strategies as those that reduce vulnerability in the short term but can increase long-term susceptibility by depleting asset bases. It highlights the severe trade-offs households are forced to make between conserving water and maintaining their food sovereignty.

Switching to drought-resistant crop (33.9%): The relatively low adoption is surprising given their potential to build resilience. This can be attributed to several barriers identified in the literature: limited access to quality seeds (a physical and financial capital constraint), lack of knowledge on their cultivation (a human capital constraint), cultural preferences for traditional crops, and limited land for experimentation (Chepkoech et al., 2020). A key informant noted that despite distribution efforts, adoption rates remain low due to "insufficient technical guidance." This points to a significant gap in agricultural extension services within the settlement.

Water-Saving Methods (24.0%): The remarkably low use of techniques such as drip irrigation or mulching, despite their proven efficiency in conserving water and improving crop yields, is a critical finding that highlights gaps in knowledge, access to technology, and resource availability among smallholder farmers. This aligns with research by Inkani et al. (2021) that identifies cost as the primary barrier. Technologies like drip irrigation kits are often unaffordable for refugee households, representing a major financial capital hurdle. Furthermore, the human capital constraint, evidenced by the low

education levels, plays a role. As Nkonya et al. (2021) found, knowledge and skills are prerequisites for adopting such technologies. The complexity of managing and maintaining these systems often requires a level of technical understanding that may be lacking.

The support systems intended to bolster these adaptive capacities are themselves inadequate, as shown in Figure 8 and Table 5.

The Training or Support Received By the Farmers for Water Conservation

The analysis of training received for water conservation reveals a marginally significant divide (χ^2=4.17, p=0.04), with 55% (212) reporting having received some form of training or support, while 45% (172) had not.

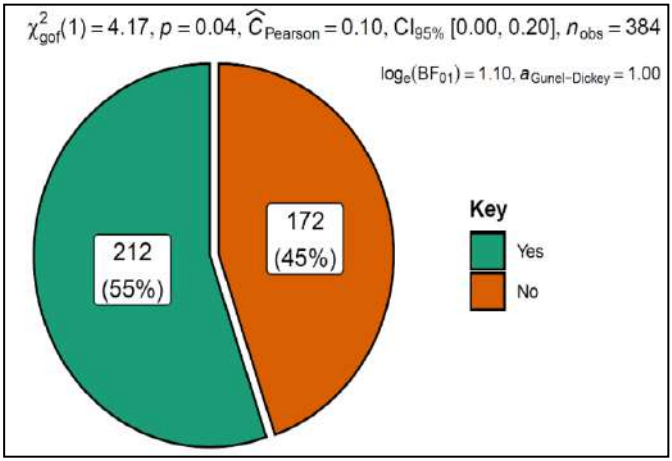

***Figure 7**: The training or support received by the farmers for water conservation*

The weak Pearson's C (0.10) and ambiguous Bayes Factor ($\log_e(BF_{01})$=1.10) suggest this training may not be sufficiently widespread or effective. These findings collectively demonstrate that

while climate change remains the primary driver of water shortages, anthropogenic factors - particularly population pressure and inadequate water management - significantly compound the problem (Brown et al., 2019; Talat, 2021). The modest levels of water conservation training indicate an area for potential intervention, suggesting that enhanced education and resource management programs could help mitigate some of these human-exacerbated water scarcity issues in the settlement (Denis & Che, 2021).

Table 6: The kind of Support or training received by the farm

	Response	Frequency (n=212)	Proportion (%)	χ^2	p-value
Water management training	No	33	15.6	100.55	<0.001
	Yes	179	84.4		
Irrigation equipment	No	134	63.2	14.79	<0.001
	Yes	78	36.8		
Financial assistance	No	145	68.4	28.70	<0.001
	Yes	67	31.6		

The data reveals significant disparities in the support received by refugee farmers, with water management training being the most commonly provided assistance (84.4% received it, χ^2=100.55, p<0.001), while access to irrigation equipment (36.8%) and financial assistance (31.6%) was markedly lower (χ^2=14.79 and 28.70 respectively, p<0.001 for both). This pattern suggests that while knowledge-based interventions have been prioritized, practical resources and economic support remain inadequate. The heavy emphasis on training without corresponding equipment and funding

creates an implementation gap - farmers may understand water conservation techniques but lack the tools and capital to apply them effectively. This imbalance has important implications for program design, indicating a need for more comprehensive support packages that combine education with material resources and financial enablement (Ali & Shahreen, 2024). The findings highlight a critical disconnect between humanitarian training initiatives and the tangible requirements for sustainable agricultural water management in refugee settings (Yasmin *et al*, 2023).

Willingness to adopt new water-saving techniques if trained

The respondents were also asked if they were willing to adopt new water saving technologies if they were trained. The results in Figure 8 shows a cautiously optimistic outlook regarding farmers' willingness to adopt water-saving techniques, with 55% expressing definite interest ("Yes") and 45% indicating tentative openness ("Maybe") (χ^2=3.76, p=0.05).

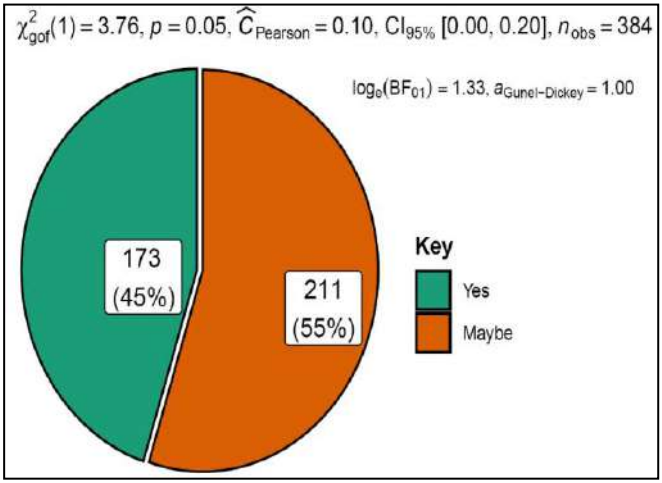

Figure 8: Willingness to adopt new water-saving techniques if trained.

The marginal statistical significance (p=0.05) and weak effect size (C=0.10) suggest this willingness is genuine but not overwhelmingly strong, likely depending on the specific techniques proposed and implementation support available. The nearly even split between definite and tentative responses implies that while there is substantial potential for introducing new water conservation methods, successful adoption will require addressing farmers' uncertainties through demonstration projects, peer learning, and guaranteed support systems. The Bayes Factor ($\log_e (BF_{01}) = 1.33$) showing only anecdotal evidence for willingness underscores the need for careful, phased implementation rather than assuming universal readiness. These findings highlight both an opportunity for water conservation programs and the importance of designing interventions that build confidence through practical, context-appropriate solutions with visible benefit

Integrated discussion: linking water sources and adaptive mechanisms

The results demonstrate a clear causal pathway: the precariousness of water sources dictates the nature of household adaptation**.** The high dependence on rainfall logically leads to the high adoption of rainwater harvesting and storage. However, when these stores are depleted, households are forced into negative coping strategies like reducing farm size or purchasing water. The low adoption of water-saving technologies and drought-resistant crops can be attributed to the "survival mode" imposed by economic scarcity. As the data shows, while 84.4% of those who received support got training, only 36.8% received irrigation equipment and 31.6% received financial assistance. This reflects a critical implementation gap. As one key informant succinctly put it, "While households purchase water for domestic use, agricultural activities remain entirely rain-dependent," highlighting how financial constraints force difficult trade-offs between domestic and productive water use.

Our findings align with broader literature. Mwiturubani et al. (2025) found that infrastructure-dependent solutions dominate in resource-constrained environments. The maladaptive strategy of

reducing cultivated land confirms findings by Abebe & Bisung (2025) on the spectrum of coping in humanitarian contexts, where immediate survival often trumps long-term sustainability. The barrier to adopting efficient technologies supports Hashimoto's (2025) argument that behavioral and economic hurdles are significant, even when the benefits are known.

The perceived causes of scarcity further contextualize these adaptations. With 67% of respondents identifying climate change as a primary cause and 60.4% citing population pressure, households understand the systemic nature of the problem. Yet, their capacity to respond effectively is systemically constrained by a lack of affordable technology, financing, and institutional support.

CONCLUSIONS AND RECOMMENDATIONS

Households in Nakivale mainly depend on a combination of water sources, including rainwater, purchased water, river water, boreholes, and wells. These sources form the backbone of daily agricultural and domestic needs, yet they remain highly constrained in both quality and quantity. Access to formal water infrastructure, such as piped taps, is extremely limited across the settlement. Only a small proportion of households benefit from such systems, leaving the majority reliant on unimproved and informal sources that are less reliable and more labour-intensive to access.

Most of the available water sources are seasonal, unreliable, and insufficient for consistent agricultural use. Streams and ponds often dry up during prolonged dry spells, while harvested rainwater is rarely adequate to sustain households through extended drought periods. This instability undermines both agricultural productivity and household food security. Climate change further exacerbates these challenges by intensifying rainfall variability and prolonging droughts. Erratic rainfall patterns disrupt traditional farming practices, while frequent dry spells reduce water availability, compounding the settlement’s vulnerability to food and livelihood insecurity.

Population pressure also plays a significant role in intensifying water scarcity. With the settlement hosting a large and growing refugee population alongside host communities, demand for already limited water resources continues to rise, leading to competition and occasional conflicts over access. Poverty and limited income further restrict households' ability to invest in improved water infrastructure. Many families cannot afford technologies such as storage tanks, filtration systems, or small-scale irrigation equipment, which would otherwise enhance their resilience to water scarcity.

Lastly, community-based collaboration on water use remains minimal. Collective action and governance structures are weak, limiting the potential for shared resource management and equitable access. Without stronger community-level organization, water scarcity challenges are likely to persist and deepen.

RECOMMENDATIONS

Expanding reliable water infrastructure, such as the installation of taps and piped systems, is essential to reducing dependence on seasonal and unimproved water sources. Access to safe and consistent water supply would not only improve agricultural productivity but also enhance household well-being by minimizing time and labor spent collecting water from distant or unsafe sources.

Promoting rainwater harvesting is another critical intervention for effectively utilizing seasonal rainfall. By investing in storage tanks, gutters, and simple collection systems, households can capture and preserve water during the rainy season, ensuring availability during prolonged dry periods. This strategy enhances resilience by reducing vulnerability to rainfall variability.

Fostering community-based water management is equally important to address the current minimal collaboration among households. Strengthening collective governance structures encourages equitable access to shared resources, reduces conflicts over water use, and builds trust between refugee and host communities. Such systems empower communities to take ownership of water infrastructure and ensure its long-term sustainability.

Integrating climate adaptation strategies into humanitarian programs is necessary to counter the effects of erratic rainfall and recurrent droughts. Incorporating practices such as drought-tolerant crops, small-scale irrigation, and ecosystem restoration helps align immediate relief efforts with long-term resilience building. This integrated approach ensures that water management contributes to both survival and sustainable livelihoods.

Finally, developing gender-sensitive approaches to water access and management is vital. Women and children often bear the greatest burden of water collection, which restricts their opportunities for education and economic participation. Ensuring their inclusion in decision-making processes and designing interventions that reduce their workload will promote equity, improve household resilience, and strengthen community-wide adaptation to water scarcity.

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