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Identifying commodity-specific priority investments in selected districts of Uganda

FAO AGRICULTURAL DEVELOPMENT ECONOMICS TECHNICAL STUDY



Identifying commodity-specific priority investments in selected districts of Uganda

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Preface

The Government of Uganda aims to invest public funds and attract private sector investment in food and agriculture under its Third National Development Plan 2022/21–2024/25 and Agriculture Sector Strategic Plan 2022/21–2024/25.

In response, the Economic Policy Research Centre (EPRC) of Uganda and the Monitoring and Analysing Food and Agricultural Policies (MAFAP) programme in the Agrifood Economics Division (ESA) of the Food and Agriculture Organization of the United Nations (FAO) worked together to identify key commodities in high-potential locations in Uganda that could improve commodity production and food security as well as reducing poverty reduction and creating a wide range of socioeconomic benefits.

Building on two previous FAO studies on priority investments in food and agriculture for Uganda, this report focuses on the most-pressing investment areas (electricity, extension services, fertilizers, irrigation, mechanization, research and development, roads and seeds) for a key commodity in five selected districts.

This technical study is aligned with FAO's *Strategic Framework 2022–2031* and supports two programme priority areas: resilient agrifood systems (BL5) and transparent markets and trade (BN5).

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Abbreviations and acronyms

ACDP	Agricultural Cluster Development Project
COREC	Coffee Research Centre
DDA	Dairy Development Authority
ERA	Electricity Regulatory Authority
FAO	Food and Agriculture Organization of the United Nations
FGD	focus group discussion
IDI	in-depth interview
KII	key informant interview
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MTIC	Ministry of Trade Industry and Cooperatives
MoWT	Ministry of Works and Transport
MWE	Ministry of Water and Environment
NAADS	National Agricultural Advisory Services
NaCCRI	National Crops Resources Research Institute
NADEC	National Agricultural Development Company
NAEZ	Northern Agro-Ecological Zone
NAGRC	National Animal Genetic Resources Centre
NAGRC & DB	National Animal Genetic Resources Centre and Data Bank
NARO	National Agricultural Research Organisation
NaSARRI	National Semi Arid Resources Research Institute
NDA	National Drug Authority
OWC	Operation Wealth Control
PPA	priority policy areas
R&D	research and development
REA	Rural Electrification Agency (REA)
UNBS	Uganda National Bureau of Standards
UCDA	Uganda Coffee Development Authority
UFZA	Uganda Free Zones Authority
Ug-IFT	Uganda Intergovernmental Fiscal Transfers

Executive summary

Despite impressive growth over the past two decades, Uganda has not attained its anticipated middle-income status and lags behind in key development indicators. The Government of Uganda aims to invest public funds through its National Development Plan III, 2020/21–2024/25 and the Agriculture Sector Strategic Plan 2020/21–2024/25 and attract private funds to accelerate the development of strategic sectors, including agriculture, to achieve broad-based development and increase household income. Previous work by the Food and Agriculture Organization of the United Nations (FAO) identified sectors and potential locations with a high potential to impact economic indicators and reduce poverty, given adequate investment. However, these studies did not provide information on the types of investment required in the identified sectors and locations areas to make the most of their potential.

This study seeks to identify the most promising areas for investment in a particular commodity in five selected districts (millet in Soroti, maize in Serere, cassava in Lira, goats in Kibaale and coffee in Masaka). The objective is to rank the relative importance of eight priority policy areas (seeds, fertilizers, mechanization, irrigation, extension, research and development (R&D), roads and electrification) for each selected district–commodity combination. The ranking was obtained by consensus during focus group discussions (FGDs) and these findings were triangulated with key experts (district extension/production/veterinary officers and representatives of key research institutions) using a range of qualitative methods, including key informant interviews (KIIs) and in-depth interviews (IDIs). Based on the results of these interviews, the study provides a final ranking of the different investments and proposes clear and actionable recommendations on sector-specific investments in the prioritized districts.

The study found that, although priority investments differed by commodity, improved seeds/breeds, extension services and fertilizers were generally identified as critical in most cases. Specifically, issues related to lack of access to improved seeds/breeds, inadequate extension services and suboptimal use of fertilizer (due to cost, lack of information or fertilizer quality) were highlighted as major bottlenecks. Other important but less frequently identified issues included a low level of mechanization throughout the value chain, poor institutional linkages preventing sufficient transmission of R&D from research institutions to farmers, and the high cost of irrigation, which hindered its large-scale adoption by farmers. Access to roads and electrification were not considered major bottlenecks. This is understandable given that most roads in the selected districts are all-weather and passable, and most interviewees were engaged in primary production of commodities, rather than processing, thus requiring limited electricity.

Nine key recommendations in five of the eight priority policy areas (PPAs) emerged from the fieldwork:

PPA1. Improved seeds/breeds

- ◆ Invest in the development, certification, regulation and distribution of improved seeds and breeds. Complementary services, such as effective regulation and seed inspection (to ensure quality) were seen as important factors for maximizing the impact of access to improved seeds.
- ◆ Provide support to goat-breeding centres at the district level to supply farmers with improved breeds at a subsidized cost.

PPA2. Extension services

- ◆ Recruit, train and motivate extension workers to deliver services to farmers.

- ◆ Broaden the sources of extension information to include affordable and clear formats with wide coverage, including radio, television, demonstration farms and pamphlets.
- ◆ Strengthen links between district extension workers and other government institutions such as the Zonal Agricultural Research Institute (ZARDI) and the National Animal Genetic Resources Centre (NAGRC).

PPA3. Fertilizers

- ◆ Subsidize the price of fertilizers to increase uptake.
- ◆ Enforce fertilizer regulations to mitigate the negative effects of fake and adulterated fertilizers on the market.

PPA4. Mechanization and irrigation

- ◆ Promote affordable and appropriate low-cost technologies that meet the needs of farmers to improve production and productivity. These include hand tractors, weeding equipment, harvesting machines, storage aids, small-scale irrigation systems and recyclable seeds.

PPA5. Research and development

- ◆ Invest in R&D technologies that prolong the shelf life of fresh produce to increase market opportunities for traders, growers and consumers.

1 Introduction

Although Uganda has experienced impressive economic growth over the past two decades, accompanied by a significant reduction in poverty, the country has not attained middle-income status as expected. Despite evidence of structural transformation, with a steady decline in agriculture's share of GDP, the agricultural sector still employs most of the labour force. In a bid to reach middle-income status and accelerate economic transformation, the Government of Uganda rolled out an ambitious development plan, the National Development Plan III (NDP III), for the period 2021–2025. Agriculture features prominently in the NDP III with the main aim to increase household income through agro-industry. The plan will require a set of key interventions by the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and its agencies during the 2020/21–2024/25 period. Given the magnitude of the planned investments, policymakers will need to make very concrete and strategic decisions to ensure the best outcomes and this will often require selecting a specific commodity, location and type of investment. However, tools that support decision-making at this level of granularity are often not available.

FAO implemented a three-step approach to support Uganda's development process. First, an economy-wide computable general equilibrium modelling approach was used to identify production sectors where investments to boost commodity production would be most cost-effective (Sánchez, Cicowiez and Pereira Fontes, 2022). This process ranked the commodities that policymakers should use to prioritize subsectoral investments. The second step used a spatial tool to consider where to invest for commodities that have a high predicted impact on economic indicators (Adjin, Pereira Fontes and Sánchez, 2022).

Combining these results with the priority districts defined by the government, this study addresses the third step: to determine the most pressing investment needs in selected districts for selected commodities. The study seeks to:

- ◆ establish priority district–commodity pairs for an in-depth analysis of investment gaps;
- ◆ report and rank the most pressing gaps across priority policy areas;
- ◆ propose clear and actionable recommendations on sector-specific investments in the priority districts.

FAO's three-step approach, which this study completes, provides concrete evidence on commodity-specific investment needs across eight district-level priority areas (seeds, fertilizers, mechanization, irrigation, extension, R&D, roads and electrification) with due attention given to the knowledge of potential beneficiaries and experts on the ground. This involved focus group discussions (FGDs) in five districts to better understand context and perceptions of the most pressing investment and policy needs. The district ranking was based on consensus in the FGDs; the ranking was then discussed with sector experts and key technical people in the districts. The approach ensured that the process of gathering evidence was participatory and that expert opinion was available to highlight important constraints and policies/investments that may fall outside the most common priority investment areas.



2 Methodology

KEY MESSAGES

- ◆ A number of districts in Uganda were initially chosen for this investment study based on their untapped production potential and poverty rates.
- ◆ Commodity–district pairings were identified using an iterative elimination algorithm, which matched maize, millet and sugar cane with districts in northern and eastern Uganda. For bananas, cassava and coffee, the algorithm mainly selected regions in central and western Uganda.
- ◆ Based on discussions with the Government of Uganda and stakeholders, five commodities and districts were selected for further study: cassava in the Lira district; coffee in the Masaka district; goats in Kibaale district; maize in the Severe district; and millet in the Soroti district.

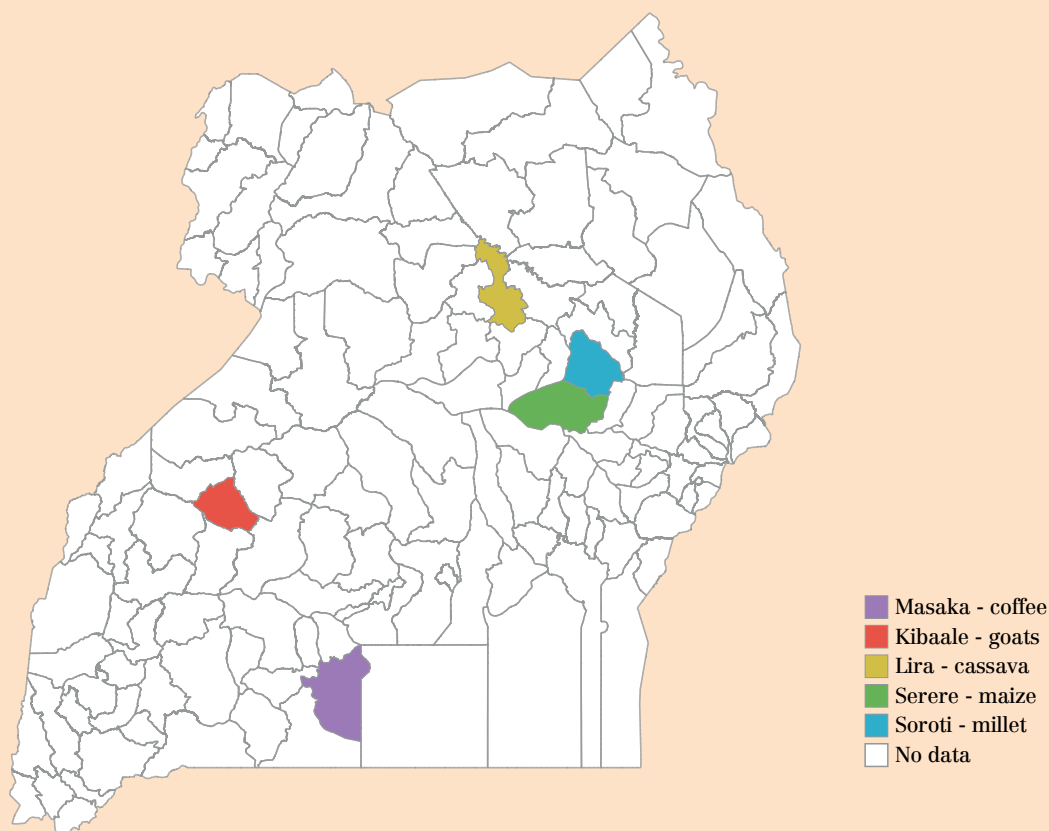
2.1 Selection of districts

The methodology used to arrive at the commodity–district pairings used a study by Adjin, Pereira Fontes and Sánchez (2022) as the starting point. This study selected a limited number of districts in Uganda, based on unrealized potential and poverty, and applied an iterative elimination algorithm to assign priority. The districts with the highest theoretical investment potential for millet, sugar cane and maize are mostly located in the northern and eastern regions of the country. For banana, cassava and coffee, the identified districts are mostly located in the central and western regions. The results were more heterogeneous for goats, with districts located across three different regions.

The priority districts identified in the Adjin, Pereira Fontes and Sánchez study were discussed with experts and complemented by a selection of government priority commodities and districts. This led to the selection of five commodity–district combinations (see Figure 1): millet (Soroti district)¹ in Katine and Olabai subcounties; maize (Serere district) in Pingire subcounty; cassava (Lira district) in Ogur and Adyel subcounties; goats (Kibaale district) in Bugarama subcounty; and coffee (Masaka district) in Kyanamukaka subcounty.

¹ Initially, the team was supposed to assess millet production in the Moroto district. The change was due to the limited cultivation of millet in Moroto, making it impossible to collect sufficient information on priority investments. Efforts to survey another district in the Karamoja subregion were frustrated by the insecurity in the region.

◆ **FIGURE 1** Map of selected districts and agrifood commodities



Source: OCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2020. Uganda – subnational administrative boundaries. In: *OCHA/The Humanitarian Data Exchange*. Cited 12 December 2021. <https://data.humdata.org/dataset/cod-ab-uga>, modified by the author.

2.2 Objectives of data collection and development of the questionnaire

Following a systematic desk review of agricultural transformation in Uganda, the research team was able to identify data gaps and develop objectives and a process for data collection. The team established objectives to collect qualitative and quantitative information on critical investment gaps in eight priority areas for a particular commodity and district. Based on information collected through questionnaires, we set out to provide recommendations on the most pressing investment needs for each of the commodity–district pairings. Copies of the two questionnaires are attached in Annexes 1 and 2.

2.3 Sampling strategy

The research team was assisted by district officials, led by a district production officer, to select the subcounties and participants in the FGDs. Given budget constraints and the unavailability of readily available sample frames suited to the desired population, we adopted a purposive sampling to identify and select the participants. We selected individuals or groups of individuals with experience in growing the commodity of interest, taking into consideration their scale of operations, the amount of time devoted to producing the commodity and their gender. Details about the participants are included in Annex 3.

2.4 Data collection

The study collected information (qualitative and quantitative) on critical investment gaps in eight priority areas (seeds, fertilizers, mechanization, irrigation, extension, R&D, roads and electrification). For each identified priority district–commodity pair, we ranked the most pressing investment gaps, recommended specific investments, and justified the reasons for the suggested investments.

The fieldwork took ten working days. Formal letters authorizing the work were shared with district officials, community leaders and directors of relevant research institutes. The team worked closely with district production and extension officers, leaders of farmers' associations and other community groups.

We employed a range of qualitative data collection methods, including key informant interviews (KIIs), in-depth interviews (IDIs) and FGDs with different stakeholders. The interviews were conducted according to KII and FGD guides/tools, which were developed in close consultation with FAO's Agrifood Economics Division (Annex 1 & 2). The interviews were conducted according to the FGD guide in Annex 2 and we were careful to ensure that FGDs were limited to 10–12 participants per FGD and that appropriate consideration was given to gender disaggregation. To the extent possible, we also tried to ensure that participants who participated represented different stakeholders (e.g. mostly farmers, extension officers, unions, etc). In each of the five study districts, the survey team interviewed the district production officer (in crop-growing districts), the district veterinary officer (in goat-rearing districts), district extension officers (crops and livestock) and district engineers.

We conducted IDIs with agricultural research institutes including the National Animal Genetic Resources Centre and Data Bank (NAGRC & DB), the Mukono Zonal Agricultural Research and Development Institute (ZARDI), the Kabanyoro Agricultural Research Institute, the National Livestock Resources Research Institute, the Namulonge Agricultural and Animal Production Research Institute and the National Crop Resource Research Centre. We carried out 16 FGDs in the five districts. On average, we conducted about three FGDs per district, each of which involved about 10–15 participants.



3 Ranking the eight investment areas for the different commodities

KEY MESSAGES

- ◆ Quality, availability and access to inputs, such as seeds, are the key priorities for policy attention for four of the five commodities (maize, millet, cassava, and coffee). For goat rearing, improving breeds is critical.
- ◆ Agricultural extension services are limited and often only available at the start of the harvest season. Teaching good practices to smallholder farmers in local languages and providing adequate equipment and transport to extension workers are areas needing improvement.
- ◆ Access by smallholders to machinery is hampered by the shortage of suitable equipment, high prices, and lack of maintenance skills, making production very labour-intensive.
- ◆ Smallholders did not rank roads and electricity infrastructure as high priorities when compared to seeds, fertilizers, extension services, mechanization, irrigation and research and development.

This chapter details the results of the FGDs, IDIs and KIIs in the five districts. We present and discuss the eight priority investment areas (priority policy areas), pointing out constraints and ranking them from the most to the least pressing. Finally, we provide actionable recommendations for each commodity and justify the reasons for the suggested investments.

3.1 Millet production in Soroti district

Soroti is in the Teso subregion in the eastern part of Uganda. The district has a total population of 293 700 (UBOS 2020) and a land area of approximately 2 662.5 km². Soroti is bordered by Kaberamaido district (west), Serere district (south and southwest), Ngora district (southeast), Katakwi district (east), and Amuria district (northwest, north and northeast). Administratively, the district is divided into two counties (Dakabela and Soroti), one municipal council (Soroti municipality), and seven subcounties (Arapai, Asuret, Gweri, Kamuda, Katine, Soroti and Tubur). There are 50 parishes, 13 wards, 312 villages and 82 cells.

Millet is a major staple and a traditional crop in the Teso subregion. It has a high protein content and is an essential part of the local diet. Millet is also an important source of income for women, who process it into various fermented and non-fermented beverages. However, as noted by millet farmers, there are several important challenges in millet production. It is a labour-intensive crop that is not a priority for most government initiatives. As such, it has been neglected by the extension system. Farmers in Soroti noted additional constraints, including the prolonged drought that has hit the region in the last two to three years; declining soil fertility; insufficient seed; quality and cost of acquiring seed; lack of machinery;

inadequate knowledge and information; poor management skills; and limited access to fertilizer. Together, these constraints have affected the production and productivity of millet.

Respondents prioritized the intervention areas as follows: i) extension; ii) seeds; iii) mechanization; iv) fertilizers; v) irrigation; vi) roads; vii) R&D; and viii) electricity as shown in Table 1. Farmers focused on the urgent need for labour-saving technologies, particularly during weeding and harvesting. This could include transforming weeding operations from hand hoes to simple machines, especially where draught power is involved. The chief constraints, recommended actions and stakeholders for each proposed action on millet are summarized in Table 1 and explained more fully in the rest of this subsection.

◆ **TABLE 1** Recommendations for improving millet production in Soroti district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Extension	1	<ul style="list-style-type: none"> ▪ Inadequate extension services. ▪ Limited access to knowledge of millet agronomics and post-harvest handling, which affects management practices. 	<ul style="list-style-type: none"> ▪ Increase number of technical staff in extension services and improve their capacities. ▪ Increase the frequency and quality of extension services outreach. ▪ Explore using alternative extension channels (e.g. shows, demonstration gardens, field days, media). ▪ Develop, print and disseminate information materials in local languages. 	<ul style="list-style-type: none"> ▪ Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). ▪ Local government. ▪ Research institutions. ▪ Other extension providers.
Seeds	2	<ul style="list-style-type: none"> ▪ Insufficient seeds. ▪ Quality and cost of acquiring seed. ▪ Inadequate access to seeds. ▪ Farmers' lack of awareness on improved seeds and best practices on improved seeds. 	<ul style="list-style-type: none"> ▪ Develop early-maturing finger millet varieties (taking palatability into consideration) to mitigate drought impacts. ▪ Address resistance to improved seed varieties through extension. ▪ Increase the budget for seed multiplication; strengthen the seed distribution system; and link mandates of research institutions and private companies to ensure timely distribution of quality seed. ▪ Involve farmers in seed development to ensure that farmer preferences are met. 	<ul style="list-style-type: none"> ▪ Research institutions. ▪ Extension system. ▪ Central government. ▪ MAAIF.



TABLE 1 (cont.) Recommendations for improving millet production in Soroti district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Mechanization	3	<ul style="list-style-type: none"> ▪ Inadequate access to mechanized tools limits large-scale farming. ▪ Labour-intensity of millet and small plot sizes are not conducive to mechanization. ▪ Lack of spare parts, knowledge, and skills to manage and maintain the tractors. 	<ul style="list-style-type: none"> ▪ Promote low-cost mechanization technologies adapted to the needs of farmers, including hand tractors, weeders, harvesting machines and storage facilities. ▪ Build the capacity of local people to repair and maintain equipment. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ Research institutions. ▪ Development partners.
Fertilizers	4	<ul style="list-style-type: none"> ▪ Limited access to fertilizers. ▪ Negative perception of the use of fertilizers. ▪ Declining soil fertility. 	<ul style="list-style-type: none"> ▪ Train farmers in soil fertility management practices. ▪ Reduce negative perception of fertilizer use through extension. ▪ Ensure that fertilizers are available and affordable. 	<ul style="list-style-type: none"> ▪ Extension system. ▪ MAAIF. ▪ Local government.
Irrigation	5	<ul style="list-style-type: none"> ▪ Prolonged drought in the region during last two/three years. ▪ Cost of equipment prevents adoption of irrigation technology. 	<ul style="list-style-type: none"> ▪ Introduce low-cost irrigation technologies adapted to the needs of small farmers. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ Development partners.
Roads	6	<ul style="list-style-type: none"> ▪ Roads need maintenance to suit all weather conditions. 	<ul style="list-style-type: none"> ▪ Ensure regular maintenance of community roads. 	<ul style="list-style-type: none"> ▪ Uganda National Roads Authority (UNRA).
Research and development	7	<ul style="list-style-type: none"> ▪ Adoption of improved varieties was lower than expected. ▪ Farmers do not benefit from knowledge generated at research stations. ▪ Research agenda is seen as too donor-driven and not always suited to the context. 	<ul style="list-style-type: none"> ▪ Determine soil suitability for improved varieties. ▪ The R&D system should strengthen links between research institutions, extension and farmers. ▪ Increase budget allocation to research institutions to make them more effective in reaching farmers. 	<ul style="list-style-type: none"> ▪ Research institutions. ▪ Extension system. ▪ MAAIF. ▪ Development partners.



TABLE 1 (cont.) Recommendations for improving millet production in Soroti district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Electrification	8	<ul style="list-style-type: none"> Electricity is available but expensive and thus out of reach of small-scale farmers. 	<ul style="list-style-type: none"> Further increase the accessibility and affordability of electricity for millet millers. Explore alternative sources of energy, such as solar. Analyse options to reduce grid connection costs. 	<ul style="list-style-type: none"> Rural Electrification Agency (REA).

Source: Authors' own elaboration.

Priority investment areas for millet

1. Extension. Extension services for millet farmers are inadequate and very limited. When they occur, extension services are delivered at the start of the season only and focus on providing basic agronomic information on crops other than millet. Some private organizations, such as Marie Stopes and Catholic Relief Services, provide support to selected millet farmers. This combination of public and private extension is not sufficient, however, and the demand-driven approach has proven to be inefficient. Soroti district should switch to a supply-driven public extension model that caters for the needs of millet farmers in order to increase the frequency and quality of extension services.

2. Seeds. Short-maturity, high-yielding millet varieties are preferred by farmers but are not readily available, limiting their adoption.² While access to good-quality seeds was ranked as average,³ cultural factors, poor taste, and lack of inputs (e.g. fertilizer) for improved varieties were identified as factors explaining their low adoption. Local varieties were also preferred to improved varieties because they are readily available and can be recycled. There is a need for early-maturing finger millet varieties that meet farmer preferences (requiring farmer involvement in the development process). Research institutions must be equipped for the production and timely distribution of these varieties.

3. Mechanization. This was seen as deserving urgent attention given the labour intensity of millet. Mechanization rates in Soroti district were very low, owing to the subsistence nature of agriculture, land fragmentation and a lack of technologies that meet the needs of small-scale millet farmers. Available machinery was limited to tractors, which are expensive to acquire and/or hire and are more suitable for medium- and large-scale farmers. Farmers tended to use ox ploughs due to their small plot sizes, lower cost and fewer requirements in terms of technical knowledge. Stakeholders identified the need to promote low-cost technologies that suit farmers' needs, including hand tractors, weeders, harvesting machines, and storage aids. They also emphasized the need for capacity development to ensure that appropriate skills are available to maintain and repair the equipment.

4. Fertilizers. The adoption of inorganic fertilizer remains low and soil fertility is declining in the region due to continuous farming of the land, leading to the depletion of nutrients in areas where nutrients are not replenished by fertilizer use. The low use rate is due to the erroneous perception that millet does not require fertilizer for growth, as well as

² Available varieties include 224, seremi, and Naro millet 1 & 2. Atunduru, Ekama (red and white), and other indigenous varieties. Ekama variety is preferred because it has a short maturity period and yields are high.

³ Farmers have access to improved millet varieties from the National Semi-Arid Resources Agricultural Research Institution (NaSARI) research centre.

issues related to high costs, lack of knowledge, and negative perceptions towards inorganic fertilizers. Since the declining soil fertility will have to be addressed by farmers, at least partly, through the application of inorganic fertilizers, reducing the negative perceptions surrounding fertilizers will be important, as will be policies that make fertilizer more affordable and accessible.

5. Irrigation is not used by millet farmers in Soroti district for several reasons, including a perceived lack of need, non-availability of appropriate irrigation technologies, small plot sizes, and lack of water sources. However, irrigation is becoming increasingly necessary due to climate change-induced weather variability and the increasing frequency of prolonged droughts, such as Soroti has experienced for the past two to three years. However, for irrigation to be a successful area for investment, there is a need for simple, affordable, and appropriate irrigation technologies that particularly consider smallholder farmers, as current technologies are seen as too expensive.

6. Roads. Stakeholders ranked both feeder and main roads as good and accessible. The main market is approximately 20–25 kilometres away, which, according to farmers, is a relatively short distance. Nevertheless, there is a need to ensure regular maintenance of the roads, given the floods that frequently affect the district.

7. Research and development. Access to R&D is very limited and farmers observed that they mostly rely on indigenous knowledge, despite having a research institution nearby, NaSSARI, where new improved varieties of millet are tried and tested. Better access to improved, short-term maturing varieties (such as *Ekama*) and greater knowledge of millet management were seen as important needs. However, the exchange of information between research institutions and farmers is limited: the scale of seed multiplication is inadequate to cover all farmers and the links between extension and research are perceived as weak. Strengthening R&D and linked extension was therefore seen as crucial, as was ensuring the research agenda is aligned to the needs of the farmers.⁴

8. Electricity. While electricity is available, the costs make it unaffordable for agroprocessing, with the result that farmers rely on diesel and petrol as their main sources of energy for millet processing. If millet processing is to be further developed in the district, electricity will have to be made cheaper (e.g. through subsidies) or alternative sources of energy, such as solar power, will need to be adopted.

What stakeholders need to do

In the short term, three recommendations emerged as priorities:

1. Improve millet extension services. The government should improve the quality and frequency of extension services, including by motivating extension agents to deliver services to farmers.
2. Access to and distribution of improved seeds. There is a need to link the mandates of research institutions and private seed companies in the areas of seed production and distribution. Lack of access and the untimely distribution of seed are important reasons for low adoption rates and force farmers to use grain as seed.
3. Promotion of low-cost irrigation and mechanization technologies. Affordable and appropriate low-cost mechanization and irrigation technologies are key to productivity improvements. These include hand tractors, weeding equipment, harvesting machines, storage aids, small-scale irrigation systems and recyclable seeds.

⁴ The research agenda of some government institutions was perceived as overly skewed towards the needs of development partners.

3.2 Maize production in Serere district

Serere district is in the eastern part of Uganda and has a total land area of 1 494.8 km². It borders Pallisa (southeast), Soroti (north), Kaberamaido (west) and Ngora (east). Administratively, Serere district is composed of eight subcounties and seven town councils.

Maize cultivation here is mainly done by smallholder farmers, who own between a half and one acre of land. These farmers face several challenges, including quality and quantity of available improved seeds, inadequate extension services, weak links between research institutions and farmers; and poorly mechanized systems for the production and processing of maize.

Respondents prioritized the intervention areas as follows: i) seeds; ii) mechanization; iii) fertilizers; iv) extension; v) R&D; vi) irrigation; vii) electricity; and viii) roads. The rank of the prioritized intervention areas, their related constraints and proposed solutions are summarized in Table 2.

◆ **TABLE 2** Recommendations for improving maize production in Serere district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Seeds	1	<ul style="list-style-type: none"> ▪ Available improved seed is too costly, leading farmers to replant improved seeds, which results in lower yields. ▪ Limited/delayed supply of improved seed. ▪ Farmers believe yields from improved varieties are not stable and require more inputs. ▪ Declining soil fertility and limited access to fertilizers have limited the adoption and use of improved seeds. 	<ul style="list-style-type: none"> ▪ Increase availability and access to improved seed and ensure timely distribution. ▪ Strengthen extension services and provide training on adopting and using improved seed, and good agronomic practices around planting, pesticide and herbicide use, and post-harvest handling. ▪ Disseminate information on improved seed varieties. 	<ul style="list-style-type: none"> ▪ Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). ▪ Non-governmental organizations. ▪ Farmer cooperatives. ▪ Seed companies.



TABLE 2 (cont.) Recommendations for improving maize production in Serere district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Mechanization	2	<ul style="list-style-type: none"> ▪ Agricultural machinery (e.g. tractors, walking tractors) are not readily available. ▪ Ox ploughs are expensive (due to cattle feeding requirements) and are prone to theft. ▪ Few good quality agricultural machines (especially ox ploughs and milling machines), due to a shortage of technicians that can repair them. ▪ Limited access to electricity; reliance on diesel-run generators for mills is expensive. 	<ul style="list-style-type: none"> ▪ Provide machinery at subsidized prices ▪ Provide information on the use and maintenance of machinery. ▪ Train more agroengineers and technicians to support repairs of agricultural machinery. ▪ Enforce quality standards for machinery. ▪ Increase access to and use of electricity for production and processing. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ Development partners. ▪ Academic and technical institutions.
Fertilizers	3	<ul style="list-style-type: none"> ▪ Fertilizer is too costly for most farmers. ▪ Farmers have limited knowledge of fertilizer application, partly due to the lack of extension services. ▪ Fertilizer is not readily available to all farmers because of the limited number of agro-input dealers. ▪ Prevalence of fake fertilizers on the market. 	<ul style="list-style-type: none"> ▪ Provide subsidized fertilizers. ▪ Invest in the delivery of extension services and provide information on the use of fertilizer. ▪ Promote the establishment of input sales outlets to increase the availability of fertilizer. ▪ Invest in the delivery of information on using fertilizer (e.g. through extension). ▪ Enforce quality standards for fertilizers to ensure fake products do not enter the market. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ Development partners.



TABLE 2 (cont.) Recommendations for improving maize production in Serere district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Extension	4	<ul style="list-style-type: none"> ▪ Inadequate facilitation for extension officers limits the effectiveness of services. ▪ Not enough extension officers. ▪ Extension officers rely heavily on rudimentary methods in their activities. 	<ul style="list-style-type: none"> ▪ Provide training on using good agronomic practices and improved seed. ▪ Increase the number of extension officers, improve their skills and provide incentives (e.g. materials, transport, tools, etc.). ▪ Enhance the capacity of extension officers at the district and subcounty levels, focusing on current and relevant skills. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ Development partners.
Research and development	5	<ul style="list-style-type: none"> ▪ Limited access to information on new seed varieties and technologies for some farmers. ▪ Research generated by research stations does not reach most farmers. This indicates weak R&D–extension services linkages. ▪ Limited supervision of seed multiplication by private companies, leading to lower quality standards. 	<ul style="list-style-type: none"> ▪ Engage research institutions and promote a prison-based agriculture production model (i.e. prisons use their land and labour for seed multiplication). ▪ Strengthen links between R&D, extension and farmers. ▪ Increase government funding for R&D. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ Development partners. ▪ Research institutions.
Irrigation	6	<ul style="list-style-type: none"> ▪ The use of Lake Kyoga as a potential source of wide-scale irrigation has not been exploited. ▪ Available water sources are not sustainable. ▪ Some irrigation facilities in the district have stopped operations. ▪ Irrigation equipment is too expensive to purchase and maintain for most maize smallholders. 	<ul style="list-style-type: none"> ▪ Revive the Ojama Valley dam to increase water for production. ▪ Invest in affordable microirrigation schemes that farmers can easily utilise. ▪ Provide irrigation support systems to ensure the sustainability of irrigation investments. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ Development partners. ▪ Ministry of Works and Transport (MoWT). ▪ Ministry of Water and Environment (MWE).



TABLE 2 (cont.) Recommendations for improving maize production in Serere district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Electrification	7	<ul style="list-style-type: none"> ▪ The cost of electricity is too high to support post-harvest value addition activities such as processing. ▪ The cost of connecting to the national grid is very high for farmers ▪ Alternatives sources of energy, such as diesel and solar power, are expensive. 	<ul style="list-style-type: none"> ▪ Increase access and subsidize the cost of electricity. ▪ Increase availability of electricity by minimizing load shedding and power outages. ▪ Create an industrial park to ensure services needed to enhance value addition are provided at an affordable cost. 	<ul style="list-style-type: none"> ▪ Electricity Regulatory Authority (ERA). ▪ UMEME Ltd.*
Roads	8	<ul style="list-style-type: none"> ▪ Some farming communities do not have easy access to all-weather roads. ▪ Feeder roads in some areas are not properly maintained and become impassable during heavy rains. 	<ul style="list-style-type: none"> ▪ Construct and maintain all-weather roads in farming communities. 	<ul style="list-style-type: none"> ▪ Uganda National Roads Authority (UNRA). ▪ MoWT.

Note: * UMEME Ltd is Uganda's largest energy distributor, distributing about 97 percent of all electricity used in the country.

Source: Authors' own elaboration.

Priority investment areas for maize

1. Seeds. Access to high quality seed was ranked as the biggest challenge for maize farmers in Serere. Despite efforts by the government, improved seed adoption remains low for several reasons. First, improved seeds are too costly to purchase every planting season, which leads to the seeds being reused over multiple (typically three) seasons and leads to lower yields. Second, the supply of improved seeds is either limited or untimely, especially around planting season.⁵ Third, some farmers believe that improved seeds have unstable yields, require more effort to grow, and require more inputs (especially fertilizer) and/or fertile soils.

Overall, respondent farmers rank both access and the quality of their seed as average. Farmers cited delays in receiving seeds and an inadequate number of seed dealers as critical factors limiting their access. They noted that fake improved seeds, which are prevalent in the market, often have poor germination and low yields. Respondents identified three action areas: i) timely access to sufficient, high-quality planting seed; ii) improved extension services to provide training on best agronomic practices for improved seeds; and iii) stronger research–farmer links to ensure that improved seed varieties meet the needs of farmers.

⁵ According to participants, the main maize seed types include hybrid varieties (Longe 5H and Longe 7H) and open-pollinated varieties (Longe 4 and Longe 5). They are obtained from a variety of sources, including markets, input dealers, farmer exchanges, cooperative societies, replanting of grain, as well as non-traditional sources such as the government (Operation Wealth Creation/NAADS) and NGOs.

2. Mechanization. Adoption of mechanized equipment is still minimal and predominantly used for land preparation. The hand hoe is the main tool used for maize farming.⁶ The cost associated with post-harvest machinery discourages its widespread use. Currently, machinery is obtained mostly from farmer cooperatives and agro-input dealers (in the Mayuge district), and ploughs can be obtained from Operation Wealth Creation (OWC). A rental market also exists for tractors, ox ploughs and threshers, although few farmers rent equipment due to access and quality issues. Rental services are costly and few tractors and ox ploughs are available for hire. Most of the available machinery is outdated and substandard. The lack of availability of machinery and qualified staff to maintain it, together with the high cost⁷ and quality issues, have largely curtailed on-farm agricultural mechanization efforts in Serere. Limited access to electricity and reliance on diesel-run generators for milling was seen as a key constraint to off-farm mechanization (e.g. processing). Cost and knowledge were the two main constraints identified by respondents. Improving agricultural mechanization in Serere will require a greater availability of high-quality machinery (tractors, walking tractors, ox ploughs and milling machines) at lower (e.g. subsidized) prices. It will also be necessary to attract qualified technicians to repair machinery and to train farmers on the use and maintenance of agricultural machinery.

3. Fertilizers. Few farmers apply organic or inorganic fertilizer to their maize fields and those that do, source it from input dealers with outlets in Serere (e.g. ACILA Enterprises Ltd.).⁸ Fertilizers are appreciated in Serere and fertilizer quality is considered to be good. However, farmers reported that a lack of knowledge about impacts and best practices prevent effective use and that access to fertilizer is very poor. This is due to high prices and the need to travel to urban centres to procure supplies, which leads farmers to use suboptimal quantities of fertilizer. Wider adoption and use of fertilizer will require both a larger number of input dealers as well as extension and/or awareness campaigns to improve farmer knowledge. In addition, investments in soil testing could provide important information on soil nutrients, which would contribute to improving the effectiveness of fertilizer use. Finally, it will be important to maintain fertilizer quality and to ensure that adulteration does not compromise quality standards.

4. Extension. Maize farmers mostly receive extension services from district extension officers, cooperatives and input dealers. However, coverage is extremely low due to the limited number of extension staff. Currently, the ratio of district agricultural extension officers per household is 1:1 400, while the ratio per farmer is 1:5 000. As a result, farmers rank their access to extension services as poor. However, they assert that extension services are relevant to maize farming, which explains why quality of the extension services is perceived as average. Constraints to extension include inadequate payment, transportation (motorcycles and fuel), materials and tools, the rudimentary practices espoused by some extension agents,⁹ and outdated knowledge of agronomic practices. Respondents cited the need to increase the number of extension staff and to provide incentives for delivering extension services. It is also important to build the capacity of extension officers and equip them with more current and relevant skills. Finally, changing the modality of extension from one-on-one to using groups and cooperatives would ensure that the extension officer reaches more people at a lower cost.

⁶ Other common types of mechanization include ox ploughs, handheld hoes, tractor services, shelling machines, ox-drawn weeders, ox-drawn harvesters, mills and threshers.

⁷ High costs are not limited to tractors. Farmers also noted that oxen have heavy feeding requirements and can be stolen, making them costly and risky to own.

⁸ Some have also received fertilizers from other sources, including government programmes, non-governmental partners (aBi Development Limited & Finance Limited and SNV Netherlands Development Organisation).

⁹ Extension officers indicated that extension has gone digital, although some still use paper.

5. Research and development. Only a very small number of farmers had access to information on the availability of innovations in their community. Farmers obtain such news from a variety of sources (e.g. television and radio programmes, publications, field days, demonstrations and agro-input dealers), with most information being supply- rather than demand-driven. Overall, farmers perceived that they had adequate access to agricultural technology/varieties and that the quality was average. However, most of the research and innovations produced by research stations (new seeds and machinery) never reach the farmers, indicating weak linkages between R&D and extension services. Participants also reported that some seed companies compromised the quality of seed during multiplication in an attempt to increase their profits. They identified stronger links between research institutions and farmers and better oversight of the quality of seed multiplication as two solutions. This will require increased funding for research and development.

6. Irrigation. While irrigation was perceived as necessary for maize farming and farmers have ready access to water from Lake Kyoga, adoption rates are very low. This is explained by three factors. First, irrigation equipment is expensive to purchase and maintain and farmers believe that the benefits are unlikely to exceed investment costs. Second, land tenure is communal, which tends to discourage private investments. Finally, a negative experience with the abrupt closure of an irrigation facility has also been a disincentive. Overall, participants argued that there is an urgent need to invest in irrigation in Serere district, for example through a revival of the Ojama valley dam or by supporting communities that have already invested. They observed that small and micro-irrigation schemes could have potential for small-scale farmers, but warned that investments in irrigation should be complemented by investments in support systems, such as regular maintenance, technical and financial support, to ensure their sustainability.

7. Electrification. Despite efforts by the government through the rural electrification programme, very few farmers are connected to the national grid or have access to electricity. Overall, farmers rate their access to electricity as very poor, citing high costs (of both connection and consumption) as the main reason. Farmers also indicated that the quality of electricity is poor, due to an unstable supply because of load shedding. As a result, maize farmers mainly use solar, diesel and petrol-based energy in maize farming. In addition, the high cost of electricity limits post-harvest value addition activities, such as milling and grinding. Respondents suggested increasing the availability of electricity or minimizing load shedding and power outages to support processing and reduce the damage to milling machinery due to incessant outages. This could be supplemented by investing in more transformers to facilitate the distribution of electricity to distant places. Finally, farmers and district officials raised the potential of an industrial park model for maize processors, where the services needed to enhance value addition, such as affordable power and electricity, could be provided.

8. Roads. For the most part, maize farmers indicated that they have access to sufficient main roads (all-weather roads) and feeder roads. Most roads are passable throughout the year and are well maintained and farmers ranked access to the roads as good. However, some farming communities reported not having access to all-weather roads. Moreover, a small number of farmers indicated that in some areas, culverts are weak and/or in poor shape and others pointed out that the feeder roads in some areas are not properly maintained and become impassable in heavy rains. Investing in the construction and maintenance of more all-weather roads in these farming communities could improve access and utilization of roads.

What stakeholders need to do

Short term. To enhance maize production and productivity, the government, development partners and the private sector need to invest in providing improved seeds, fertilizers,

pesticides and herbicides to farmers. This should be complemented by broad-based awareness campaigns and demonstrations on planting improved seeds and using fertilizer. The government needs to ensure regular seed inspection services and the compliance of commercial seed companies with regulatory quality standards. The enforcement of standards for pesticides and herbicides is also critical since the influx of fake pesticides and herbicides has affected yields.

Medium term. Providing support services to farmers will require collaboration among all actors (farmers, the government, development partners and the private sector) and strengthening R&D and extension linkages. A lot of innovations (e.g. information, new technologies and varieties) have been developed by research institutions and stations, but these have often failed to reach farmers. There should therefore be a focus on disseminating this information using various platforms in affordable and easy-to-understand ways – through radio, television, demonstration farms and pamphlets, among others. In addition, research should take a bottom-up approach that obtains views from farmers on their priorities in terms of variety features and special attributes. Lastly, investing in quality maize milling stations and storage facilities will increase in importance as the government moves to commercialize agriculture and promote value addition.

Additional areas of concern to maize farmers

In addition to the eight priority areas detailed above, the farmers highlighted two further areas of interest:

- ◆ Pest and disease management. Maize production has been greatly affected by the re-emergence of pests like the African armyworm. Government efforts to inform farmers about suitable pesticides were very not very successful and the pesticides were often not subsidized, limiting their adoption. In addition, fake pesticides and herbicides have become prevalent in area markets. Participants recommended that the Uganda National Bureau of Standards and the National Drug Authority strengthen pesticide regulations to ensure that quality products are sold on the market.
- ◆ Marketing. Farmers reported that government efforts to boost production were appreciated, but that there was limited support for marketing. They noted that farm-gate prices were often lower than expected due to the presence of middlemen. Price volatility was also identified as a constraint, especially during bumper harvest seasons when prices are low and volatile. Participants recommended that the government invest in storage facilities and design programmes to purchase maize from farmers at above-market prices during bumper harvests to minimize losses.

3.3 Cassava production in Lira district

Lira district is located in the Lango subregion (part of the Northern Agro-Ecological Zone or NAEZ) in northern Uganda with an area of 1 369 km². The district has a population of 408 043. It is bordered by the districts of Agago (north), Otuke (northeast), Alebtong (east), Dokolo (south), Kwania (southwest), Lira City (west), Oyam and Gulu (northwest). The district comprises four counties and is further divided into ten subcounties, 64 parishes and 623 villages.

Over the past few years, cassava production in Lira has been constrained by poor weather conditions, poor farming skills, lack of quality seed cuttings, and pests and diseases (especially the cassava mosaic and cassava brown streak diseases). Farmers ranked the priority investments needed to increase cassava production in Lira as follows: i) seeds; ii) mechanization; iii) extension; iv) R&D; v) electrification; vi), roads vii) irrigation; and viii) fertilizers as shown in Table 3. The emphasis on seeds reflected the need for

improved cassava varieties that are fast-maturing, high-yielding and resistant to diseases and pests. Mechanization was also seen as important for improving production and post-harvest handling and processing. Extension services were important for improving agronomic practices and address disease outbreaks. R&D was considered crucial for providing improved cassava varieties. Electrification, roads, fertilizers and irrigation were seen as less important, with farmers noting that the available road infrastructure was adequate for producing and marketing their products. The main investment areas, constraints, recommendations and responsible entities are summarized in Table 3.

♦ **TABLE 3** Recommendations for improving cassava production in Lira district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Seeds	1	<ul style="list-style-type: none"> ▪ Inadequate disease-free planting materials. ▪ Inadequate supply of high-yielding, disease-resistant improved cassava varieties. ▪ Cassava disease outbreaks. ▪ Late delivery of planting materials (cassava cuttings) from government agencies and programmes. ▪ High cost of purchasing cuttings. 	<ul style="list-style-type: none"> ▪ Support research to continue developing high-yielding, drought- and pest-resistant cassava. ▪ Assist farmers and farmer groups to undertake cassava seed multiplication. ▪ Train farmers in cassava agronomic practices and promote dissemination of improved varieties. ▪ Avoid middlemen in distribution of cassava cuttings by linking multipliers, who are responsible for increasing the supply of seeds) to farmers. 	<ul style="list-style-type: none"> ▪ Local government. ▪ Private sector. ▪ Non-governmental organizations. ▪ Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). ▪ National Agricultural Advisory Services (NAADS). ▪ Operation Wealth Creation (OWC) ▪ Ministry of Trade Industry and Cooperatives (MTIC)
Mechanization	2	<ul style="list-style-type: none"> ▪ Limited access to mechanization for processing. ▪ Available tractors in the district are insufficient to serve all farmers, are low horsepower and do not always function properly. ▪ Lack of capacity to manufacture, maintain and repair machinery. 	<ul style="list-style-type: none"> ▪ Train local entrepreneurs to maintain, repair, design and manufacture machinery. ▪ Establish a service centre for maintaining tractors in the district. ▪ Provide machinery (tractors, walking tractors, etc) at subsidized prices to farmers' associations or groups. ▪ Establish cassava mills in each subcounty. ▪ Revive the cassava processing plant in Lira district. 	<ul style="list-style-type: none"> ▪ Namalere Agricultural Referral Mechanisation Centre. ▪ Local government. ▪ MTIC. ▪ Ministry of Works and Transport (MoWT). ▪ Private sector. ▪ Uganda National Bureau of Standards (UNBS).



TABLE 3 (cont.) Recommendations for improving cassava production in Lira district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Extension	3	<ul style="list-style-type: none"> ▪ Infrequent and inadequate contact with extension services. ▪ Poor motivation and capacity of extension officers (e.g. lack of transport and equipment). ▪ Absence of information in the local language. 	<ul style="list-style-type: none"> ▪ Increase the number of extension staff. ▪ Incentivise and facilitate more frequent extension visits with adequate material and equipment. ▪ Use channels preferred by farmers for effective dissemination of information (e.g. radio). ▪ Zonal Agricultural Research and Development Institute (ZARDI)* to invest more in demonstrations to cassava farmers on value-added technologies, marketing and post-harvest handling. 	<ul style="list-style-type: none"> ▪ National Agricultural Research Organisation (NARO).
Research and development	4	<ul style="list-style-type: none"> ▪ The links between research and extension is weak. ▪ The flow of information between farmers and research institutions is poor due to weaknesses in extension services. This leads to low adoption of technologies and a research agenda that may not be aligned to farmers' needs. ▪ The research agenda is driven by donors rather than the needs of the farmers. 	<ul style="list-style-type: none"> ▪ Support research institutions in developing new improved and better varieties (high- yielding, disease- and drought-resistant) of cassava. ▪ Train farmers on cassava post-harvest handling practices and processing technologies. ▪ Strengthen mechanisms for joint operations of NARO, ZARDI and districts. ▪ Revive the district research adaptive teams and the subcounty level demonstration farms. ▪ Revive multistakeholder innovation platforms to guide cassava-related innovation processes. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ Namulonge Research Centre. ▪ Development partners. ▪ Local government. ▪ ZARDI.
Electrification	5	<ul style="list-style-type: none"> ▪ Poor access to electricity due to low coverage and high costs of connection and consumption. 	<ul style="list-style-type: none"> ▪ Increase the availability of electricity by expanding coverage to ensure that all townships in are connected. ▪ Create an industrial centre for cassava processors where load shedding and power outages are minimized, and electricity fees subsidized. 	<ul style="list-style-type: none"> ▪ Rural Electrification Agency (REA). ▪ Uganda Free Zones Authority (UFZA). ▪ Uganda Investment Authority (UIA).



TABLE 3 (cont.) Recommendations for improving cassava production in Lira district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Roads	6	<ul style="list-style-type: none"> ▪ Some feeder roads are impassable during the rainy season. ▪ Road maintenance equipment and machinery are provided to the district, but funds to operate them are not available. 	<ul style="list-style-type: none"> ▪ Invest in establishing more all-weather roads. ▪ Build stronger culverts to control and manage overflows and spillage during the rainy season. ▪ Provide sufficient resources to operate road maintenance equipment. 	<ul style="list-style-type: none"> ▪ MoWT. ▪ Uganda National Roads Authority (UNRA). ▪ Local government.
Irrigation	7	<ul style="list-style-type: none"> ▪ Irrigation equipment is expensive to install, maintain and use. 	<ul style="list-style-type: none"> ▪ Develop cassava varieties that are well adopted to semi-arid marginal areas, with special emphasis on drought tolerance to minimize investments in irrigation. 	<ul style="list-style-type: none"> ▪ NARO. ▪ Namulonge Research Centre. ▪ Development partners.
Fertilizers	8	<ul style="list-style-type: none"> ▪ Negative perceptions of fertilizer use and belief that it is not required for cassava. ▪ Cost of fertilizer is high. ▪ High risk of fertilizer adulteration as there are implementation and enforcement gaps related to fertilizer policy, legal and regulatory frameworks. ▪ Inadequate soil testing kits to identify required fertilizer types. 	<ul style="list-style-type: none"> ▪ Invest in regional soil testing labs that handle both soil and diseases. ▪ Decentralize the provision of soil testing equipment to the districts and subcounties. ▪ Raise awareness and build the capacity of farmers in soil testing and fertilizer use. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ NARO. ▪ Local government. ▪ Private sector.

Note: * Uganda has nine ZARDI under the National Agricultural Research Organisation (NARO).

Source: Authors' own elaboration.

Priority investment areas for cassava

1. Seeds. Although farmers ranked both quality and access to improved varieties as average,¹⁰ the availability of high-yielding, disease-resistant improved cassava seed was still seen as their most important constraint. They reported additional challenges: i) extreme weather events (droughts and occasional floods); ii) late delivery of free cassava cuttings; and iii) the

¹⁰ Quality was ranked as average because varieties sometimes yield bitter tubers and sometimes do not survive long dry spells.

high cost of purchased cuttings. Currently both indigenous and improved varieties are used¹¹ and cuttings are mostly procured from government sources (improved and traditional; usually free of charge) or purchased from fellow farmers. Seed multiplication and interventions to increase farmer access to improved cassava cuttings would increase the availability of planting material. Another option could be to support farmer groups and cooperatives that are trained in cassava agronomic practices and engage them in the multiplication of cuttings. Stronger linkages are needed between farmers involved in multiplication and distributors to ensure a constant supply of cuttings. This could be done through partnerships between farmers and big buyers of cassava, a model that is already being piloted in the field.¹² Finally, research is needed to develop high- yielding, drought- and pest-resistant varieties of cassava.

2. Mechanization. Currently, mechanization is mainly used in land preparation. However, most farmers use handheld hoes or ox ploughs because they are cheaper and easier to access, repair and maintain. Tractors in the district are of good quality, but their use is limited to large- and medium-scale farmers, as there are few tractors and few tractor-rental services. Machinery is not used for harvesting, although it is sometimes used for post-harvest handling and processing (e.g. cassava chipper), which helps to reduce losses and improve the quality of cassava supplied to the mills. Farmers cited the lack of local capacity to manufacture, maintain and repair equipment for planting, harvesting and processing cassava as a key constraint, with tractor maintenance often performed by providers in Kampala. Respondents identified several recommendations to address mechanization challenges. Capacity building could enable local entrepreneurs to repair, maintain, manufacture, and possibly even design machinery. Another recommendation was to establish a machinery and equipment service centre in the district to carry out maintenance. Providing machinery (tractors, walking tractors, milling machines, etc.) to farmer associations or groups through subsidies or credit at low interest rates would increase farmers' access to mechanized tools. Finally, establishing cassava mills and reviving the cassava processing plant would facilitate value addition and the marketing of cassava products.

3. Extension. Respondents identified several constraints related to extension, ranging from infrequent extension visits to inadequate extension services. The infrequent visits were mostly blamed on the insufficient number of extension officers assigned to households (1:1 400) and farmers (1:5 000). In addition, extension staff lacked the equipment needed to facilitate their visits, demonstrations and workshops (transport, equipment, information to support farmer decision-making¹³ and other tools). As a result, farmers ranked the radio and other farmers ahead of government extension as the more accessible (if not the most preferred) source of information.

Other issues were related to language and content. Extension materials were often in English, which most farmers cannot understand, and the visits focused on crop production (e.g. row cropping, soil management, etc.), while the farmers really needed information on improved varieties, diseases and pests, market information, processing and value addition. As a result, farmers ranked government extension services as between poor and average. Several potential solutions were proposed, including: i) improving the ratio of extension workers to farmers by recruiting more extension workers; ii) motivating extension workers to increase the frequency of their interactions with farmers; iii) making training more hands-on and focusing not only on production, but also on cassava value-addition technologies; iv) ensuring effective dissemination of information by using a wider array of information

¹¹ The most common improved varieties were NAROCAS1, NAROCAS2, NASE14 and NASE19 and the most common indigenous varieties were Bao, Gulu, Dero, Chek Iyitu, Apac.

¹² The model is being tested by civil society organisations and faith-based organizations such as Afrill, the Catholic Church and the Adventist Development and Relief Agency.

¹³ For example, information about varieties, practices, diseases, etc.

sources, including radio and demonstration sites; and v) investing in more demonstrations and workshops to brief cassava farmers on the latest technologies.

4. Research and development. The main entity responsible for cassava R&D in Lira is the Ngetta ZARDI, which is one of Uganda's NARO institutes. ZARDI is responsible for the generation, adaptation and promotion of high-yielding and disease-resistant cassava varieties¹⁴ and practices. It works in partnership with relevant stakeholders (farmers, NGOs, extension staff, extension officers, etc.) to conduct outreach activities, including exhibitions, agricultural shows, farmer exchange visits and field visits.

Respondents identified several key constraints around R&D. The most important was the poor flow of information between research organizations and farmers. As a result, new technologies often fail to reach the farmers and information on farmers' needs often fail to reach researchers.¹⁵ This is due to weak links between R&D and extension, which deteriorated further following the collapse of the NAADS. A second issue related to the farmers' need for practical assistance. While they appreciated the information, they complained about not receiving inputs, such as cassava cuttings, following training sessions. Respondents highlighted the need for formal programmes and financing instruments to facilitate more effective linkages between researchers and other stakeholders (farmers, extension, processors, etc.), with a strong focus on R&D–extension linkages. This would require formal mechanisms for joint operations by NARO, ZARDI and districts and joint activity frameworks for these agencies (planning, budgeting, monitoring and evaluation, etc.).

5. Electricity. Farmers generally ranked access to electricity as inadequate. Few were connected to the grid (due to poor infrastructure coverage) and those who were, cited the high costs of installation and power usage. Farmers mostly use electricity for small-scale processing (due to the high cost) and rely on a variety of energy sources, including electricity, solar, diesel and petrol. Respondents pointed to the need to expand electricity coverage through distribution (poles, transformers), with a focus on townships in the subcounties since that is where most mills and processing facilities are located. Participants also mentioned the creation of industrial centres for cassava processors where load shedding and power outages are minimized, and electricity fees subsidized.

6. Roads. The roads were considered to be good: they are well maintained by the central and local governments and community members, despite constraints related to road maintenance.¹⁶ However, accessibility measured as poor because feeder roads are impassable during the rainy season. Respondents proposed that the government continues to invest in all roads and use stronger construction materials for longevity and resistance to floods during the rainy season.

7. Irrigation. None of the farmers participating in our study used irrigation in their cassava production. Irrigation is a costly investment that farmers would only consider if the equipment were made available at a subsidized price. This perception was corroborated by the district production team, which argued that irrigation was not necessary, given the ability of cassava to adapt to drought and poor soils and the small size of landholdings (2–5 acres), where cassava is often intercropped with other crops. The development of drought-resistant varieties and varieties that are adapted to semi-arid marginal areas was seen as more important than investing in irrigation.

¹⁴ Among the varieties adapted and promoted by the Ngetta ZARDI are NASE14, NASE19, NAROCAS1 and NAROCAS2.

¹⁵ Participants observed that sometimes research seemed to be more driven by donors than by the needs of farmers.

¹⁶ Participants noted that the central government had provided road maintenance equipment and machinery to the district, but the district could not afford to fuel them.

8. Fertilizers. The use of fertilizer in cassava production is virtually non-existent, with farmers preferring to use fertilizer on other crops since cassava is drought-resistant and can adapt to poor soils. Respondents also cited the non-availability or untimely availability of fertilizers, poor packaging, counterfeit fertilizers (in which the chemical composition is altered), poor yield responses during dry periods, and negative perceptions of fertilizers (e.g. due to the fear that inorganic fertilizer use could lead to loss of soil fertility or create dependency, implying higher costs in the future). Stakeholders called for stronger enforcement of fertilizer policy, legal and regulatory frameworks.¹⁷ In addition, respondents recommended increasing investments in soil testing laboratories and equipment and raising awareness among farmers of the benefits of fertilizer use.

What stakeholders need to do

Short term. Lack of access to high-yielding, disease- and drought-resistant planting material was by far the most important problem cited by cassava farmers. Increasing access will require investments in the multiplication of improved varieties during the planting season, and to expedite the transformation of cassava from a food crop to a cash crop.

Medium term. Once cassava production reaches a certain level, its industrial potential should be exploited. This can be done by investing in processing plants and tools, such as dryers, chippers, graters and extruders. This will facilitate the production of high-quality cassava flour and other by-products that can be used as raw materials by paperboard and biscuit manufacturers, the brewing industry, and animal feed and textile companies. Another medium-term action would see investment in technologies to extend the shelf life of fresh cassava, which could lead to an increase in the income of various stakeholders along the value chain.

Additional areas of concern to cassava farmers

Post-harvest handling, processing and marketing are critical for boosting the productivity of cassava farmers. Most farmers have an interest in cassava processing and marketing processed products, given their higher market prices. Yet the district has few processing machines and farmers lack processing skills.

Access to affordable credit. Farmers also highlighted the need for affordable credit to enable them to purchase tractors and engage in value addition, especially milling. This will require credit institutions to provide suitable loan facilities to farmers or farmers' groups that are willing to invest in the value chain.

Product development and marketing. The farmers expressed interest in developing new products and accessing new markets but were constrained by lack of appropriate marketing channels, poor market information and the uncompetitive prices of fresh cassava.

3.4 Goat rearing in Kibaale district

Kibaale district is in the midwestern part of Uganda and is bordered by the districts of Kagadi (northwest), Kakumiro and Mubende district (east), Kyegegwa and Kyenjojo (south). It covers a total area of approximately 1 170 km². In 2014, the population of the district was 40 947, projected to increase to 198 200 people in 2020. The district has a favourable climate and is a conducive place for producing both animals and crops. The major crops include maize, bananas, beans, rice, coffee, tea, groundnuts and cassava. Cattle, goats, poultry, pigs and sheep are among the most common livestock.

¹⁷ Although the fertilizer policy for Uganda was endorsed by the Cabinet (Government of Uganda) and launched in 2016, it has not been implemented.

Goat rearing in Kibaale is practised by many farmers on both small and large scales. Challenges include poor access to improved quality breeds; limited extension services; inadequate staffing of extension agents; poor facilitation; adulterated drugs; lack of goat management skills; among others. Table 4 summarizes the ranked investment areas, starting with the most critical, and includes constraints, recommendations and responsible entities.

♦ **TABLE 4** Recommendations for improving goat rearing in Kibaale district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Breeds	1	<ul style="list-style-type: none"> ▪ Cost of improved quality breeds and absence of goat breeders in the community limits access. ▪ The government supplied high-quality Boer goats to farmers but not in adequate numbers, which delayed the process of goat multiplication in the community. 	<ul style="list-style-type: none"> ▪ Assist the district to establish goat breeders in the community. ▪ Subsidize the initial stock of breeds for farmers and increase the number of improved goats. 	<ul style="list-style-type: none"> ▪ Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). ▪ Local government. ▪ Dairy Development Authority (DDA). ▪ National Animal Genetic Resources Centre and Data Bank (NAGRC & DB).
Extension	2	<ul style="list-style-type: none"> ▪ Only 14 extension officers in the district. ▪ Inadequate training of extension workers. ▪ Lack of specialized equipment for veterinary services. 	<ul style="list-style-type: none"> ▪ Establish demonstration centres in every subcounty to improve knowledge of improved breeds. ▪ Increase the number of livestock extension service providers at subcounty level to at least four. ▪ Build extension capacity on technologies and the management of new diseases. ▪ Equip livestock extension workers with appropriate tools and livestock equipment (e.g. vaccine refrigerators). ▪ Train farmers in goat management skills to support other farmers in the community. 	<ul style="list-style-type: none"> ▪ MAAIF. ▪ DDA. ▪ NAGRC & DB. ▪ Local government.



TABLE 4 (cont.) Recommendations for improving goat rearing in Kibaale district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Veterinary drugs	3	<ul style="list-style-type: none"> ▪ High cost of acaricides. ▪ Spread of adulterated drugs on the market. ▪ Lack of knowledge and skills to use available drugs. 	<ul style="list-style-type: none"> ▪ Enforce regulations for the distribution and use of livestock drugs. ▪ Use an accreditation mechanism for input dealers in the district. ▪ Provide subsidized animal drugs. ▪ Train farmers to manage drugs and acaricides. 	<ul style="list-style-type: none"> ▪ National Drug Authority (NDA). ▪ MAAIF. ▪ Uganda National Bureau of Standards (UNBS).
Research and development	4	<ul style="list-style-type: none"> ▪ Poor flow of information among research and other government institutions, with information on goat-related innovations often not reaching farmers. 	<ul style="list-style-type: none"> ▪ Strengthen links between research institutions, the extension service system and farmers. ▪ Strengthen the extension outreach for propagating information. 	<ul style="list-style-type: none"> ▪ Research institutions. ▪ Local government.
Mechanization	5	<ul style="list-style-type: none"> ▪ Most farmers raise indigenous goats on a small scale and are not aware of mechanized goat-rearing techniques. 	<ul style="list-style-type: none"> ▪ Conduct a campaign to create awareness about the benefits of mechanization. ▪ Assist farmers to acquire machines at a subsidized rate. 	<ul style="list-style-type: none"> ▪ Local government. ▪ NAGRC & DB. ▪ Hoima Zonal Agricultural Research and Development Institute (ZARDI). ▪ Namalere.
Electrification	6	<ul style="list-style-type: none"> ▪ Most communities lack transformers and transmission lines. ▪ The cost of electricity is prohibitively high. 	<ul style="list-style-type: none"> ▪ Increase access to electricity by installing transformers and lines for pumping water and processing goat products. 	<ul style="list-style-type: none"> ▪ Rural Electrification Agency (REA).
Roads	7	<ul style="list-style-type: none"> ▪ During the rainy season, some roads are impassable. 	<ul style="list-style-type: none"> ▪ Maintain all-weather roads to be all weather. 	<ul style="list-style-type: none"> ▪ Local government.
Water for livestock production	8	<ul style="list-style-type: none"> ▪ Farmers do not have the capital to acquire irrigation systems and rely on natural sources. 	<ul style="list-style-type: none"> ▪ Enable farmers to acquire low-cost water equipment, such as water pumps, pipes and tanks for watering livestock. 	<ul style="list-style-type: none"> ▪ Local government. ▪ Development partners. ▪ MAAIF. ▪ Ministry of Water and Environment (MWE).

Source: Authors' own elaboration.

Priority investment areas for goats

1. Breeds. The production of improved breeds of goats in Kibaale is still a challenge due to the limited access to quality breeds, such as the Boer, Savana, and Mubende breeds, which can only be found in the Hoima ZARDI and beyond. There are no goat breeders in the community and farmers prefer to raise local/indigenous breeds rather than to incur major expenses to purchase and transport improved breeds. In 2020 and 2021, the government provided some farmers with high-quality Boer goats, but there were too few goats to enable rapid multiplication in the community. The Emesco Development Foundation¹⁸ and private organizations have also supplied farmers with improved goat-breeds, but these were of poor quality, according to farmers.

Improving access to quality breeds calls for the establishment of goat breeders at the subcounty level and subsidized improved goat breeds. Farmer outreach may require setting up a demonstration centre in every subcounty to enable farmers to access practical knowledge on raising improved breeds.

2. Extension. The extension system is poorly equipped to effectively undertake its duties and responsibilities. Extension officers lack specialized tools and are only equipped with hoof trimmers, burdizzo,¹⁹ and spray pumps.²⁰ Also, the district vaccine refrigerator has been out of operation for months, hampering vaccination services. The extension system is inadequately funded and understaffed; there are only 14 extension officers providing services for both crops and animals. They share one motorcycle, which makes it very difficult to reach all of the farmers in the community.

The district clearly needs more livestock extension services providers. Extension officers should receive periodic training to strengthen their capacity and knowledge around the management of new diseases. They should be equipped with tools such as protective gear, drenchers, hoof trimmers, ear tag applicators, restrainer tools and basic drugs. It is also essential to establish breeding centres in the communities.

3. Veterinary drugs. Access to quality drugs in the district is very poor due to high cost, the presence of substandard acaricides and drugs on the market, and farmer ignorance around their use. On the one hand, the use of substandard products has totally compromised the quality of the drugs that contribute to tick and disease resistance. On the other, farmers do not have the knowledge and skills to handle the drugs that are available, yet they do not reach out to qualified extension officers, whose services are usually demand-driven. The result is farmers may use acaricide and medication mixes that can be lethal for the animals.

There is a significant need to regulate and enforce the provision of agroveterinary drugs in Kibaale. Dealers should be registered, accredited and monitored by the relevant district authorities and farmers should be extensively trained on the application of drugs for their livestock.

4. Research and development. Despite the presence of research organizations in the district, they have poor links with other government institutions in the region, such as Kabanyoro Agricultural Research Institute, the National Agricultural Development Company (NADEC), National Animal Genetic Resources Centre (NAGRC), and ZARDI. This has seriously limited new technology transfer to beneficiary farmers. Consequently, farmers have inadequate access to information, particularly about improved breeds, breeding centres and

¹⁸ The Emesco Development Foundation is a local non-government organization in Kibaale district, located in Karuguza.

¹⁹ Burdizzo is a metal instrument that severs or crushes the cords and associated blood vessels leading to the testicles during castration.

²⁰ Tools for livestock care and treatment.

disease management. Hoima ZARDI is breeding improved goats for multiplication, but this information rarely reaches farmers. NAGRC is breeding improved varieties to provide farmers with superior stock for increasing productivity. It has established community breeding farms at satellite centres in different regions, including the midwestern region (Hoima). These initiatives are not well known to farmers who thus do not benefit from them. There is an urgent need to strengthen the linkages among the different R&D institutions and the extension services system to ensure the dissemination of information and technology to farmers.

5. Mechanization. Goat rearing in Kibaale is not mechanized; most farmers raise indigenous goats on small plots of land and lack capital investment and machinery. Indeed, the growing population and consequent land fragmentation in the district prevents large-scale goat-keeping. One farmer noted that, “even getting thirty acres of land is very difficult these days, so we cannot rear goats on a large scale.” Moreover, farmers lack awareness of the concept of mechanized goat farms. A communications/awareness campaign to popularize mechanization in the district could start addressing this constraint.

6. Electricity. Rural electrification has had limited impact in the district. Even when transmission lines are available, transformers are not. Most importantly, the cost of acquiring electricity is prohibitively high for local farmers. This implies that the processing of goat products is a virgin area for investment. The current programmes of rural electrification should target Kibaale district, among others by extending transmission lines, providing transformers and lowering the cost of connection to enable household access to electricity.

7. Roads. The roads in Kibaale were ranked highly in terms of access and quality. Road maintenance is handled by both the central and the district governments. Nevertheless, during the rainy season, some roads are impassable and farms situated on hills cannot be reached by vehicles or motorcycles. Interventions should target road maintenance throughout the year and under different weather conditions.

8. Irrigation. Although water is a necessity for livestock production, farmers in Kibaale do not have the capital needed to invest in irrigation systems and must completely rely on natural water sources. Government intervention, minimal until now, is needed in the form of training on the importance of irrigation and demonstrations on farmed pastures.

What stakeholders need to do

Short term. There is a need to identify, train and equip community-based extension services providers with skills in goat management to support farmers at a minimal cost. There is also a need to integrate indigenous knowledge on goat rearing with improved and modern practices.

Medium term. Livestock production and productivity, especially goat-keeping, should be given priority in government plans. Goat-breeding centres should be established in the district to supply farmers with improved breeds at a subsidized cost. The enforcement of rules and regulations is also critical to minimize the adulteration of drugs. Approved policies need to be implemented in collaboration with the community support system.

Long term. An increased budget allocation is needed to improve the adoption of improved breeds. A higher budget will also allow the establishment of improved breed multiplication and technology transfer centres. This will ensure the dissemination of new technologies to the right beneficiaries. Strengthening institutional coordination is also key and will require streamlining the roles of the government agencies responsible for research and extension services. This could also strengthen the linkage between district extension workers and other government institutions like ZARDI, NAGRC and NADEC.

Additional areas of concern to goat farmers

Value addition and marketing were highlighted as matters of concern. There is local demand for goat products but not streamlined to benefit the local farmers. This calls for the government's support in marketing to benefit even local farmers in the subcounties.

Enable access for farmers to external markets farmers by assisting them to meet necessary quality standards of goat by-products such as milk and skin. This will further improve the income and livelihoods of farmers in Kibaale.

3.5 Coffee growing in Masaka district

Coffee is one of Uganda's major cash crops and the top foreign exchange earner, representing about 15 percent of total exports and supporting over 500 000 households (UCDA, 2012). The dominant types of coffee grown in Uganda are Arabica (15 percent) and Robusta (85 percent). Coffee is a perennial crop, with two main harvest seasons: March–June and September–November. The case study district for coffee was Masaka, located in the central region of Uganda, about 140 kilometers from Kampala City. In the 1990s, coffee production in the district was greatly affected by coffee wilt disease, which destroyed most of the Robusta coffee trees and caused severe losses to farmers.

The farmers and other stakeholders in Masaka's coffee sector identified the main production constraints as the high prices and scarcity of organic and inorganic fertilizers. In addition, farmers lack access to certified coffee seedlings and to adequate extension services. Proposed solutions include further subsidization of the fertilizer costs, establishing seed nurseries in each parish, and recruitment and training of more extension officers. Table 5 shows a summary of the ranked investment areas, constraints, proposed solutions and responsible entities.

◆ **TABLE 5** Recommendations for improving coffee production in Masaka district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Fertilizers	1	<ul style="list-style-type: none"> ▪ High prices of inorganic and organic fertilizers. ▪ Inorganic fertilizer is not readily available; there are counterfeits on the market. ▪ Lack of knowledge on the application of inorganic fertilizers. 	<ul style="list-style-type: none"> ▪ Subsidize the price of fertilizers to increase uptake. ▪ Enforce fertilizer regulations to reduce adulteration. ▪ Train farmers on the benefits and identification of authentic inorganic fertilizer. 	<ul style="list-style-type: none"> ▪ Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). ▪ Uganda National Bureau of Standards (UNBS).



TABLE 5 (cont.) Recommendations for improving coffee production in Masaka district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Seeds	2	<ul style="list-style-type: none"> ▪ Farmers do not have access to certified sources of coffee seedlings. ▪ Seedling price is determined by the private dealers, who are unable to meet demand. ▪ Seed distribution by Uganda Coffee Development Authority (UCDA) is unreliable. 	<ul style="list-style-type: none"> ▪ Establish certified nurseries in each parish to provide improved access to quality seeds. ▪ Use existing farmer groups and associations to provide seeds at a reduced cost. ▪ Train farmers on certified seedlings and good agricultural practices. ▪ Devote more human resources to monitoring the use of certified seeds and the adoption of good practices. 	<ul style="list-style-type: none"> ▪ UCDA. ▪ Operation Wealth Creation (OWC). ▪ Private sector.
Extension	3	<ul style="list-style-type: none"> ▪ Low ratio of extension officers to farmers and poor capacity of extension agents. ▪ Farmer groups are not specialized given the heterogeneity of farming practices, complicating access to coffee-specific advice. 	<ul style="list-style-type: none"> ▪ Conduct awareness campaigns on the roles of the different stakeholders in the coffee value chain. ▪ Update the extension curriculum to reflect recent institutional and technological developments. ▪ Recruit more extension officers and ensure they have access to adequate equipment. ▪ Ensure systematic monitoring and evaluation of extension programmes. 	<ul style="list-style-type: none"> ▪ UCDA. ▪ MAAIF. ▪ Local government.
Research and development	4	<ul style="list-style-type: none"> ▪ Weak research–extension links, undermining the flow of information about new technologies. ▪ Agricultural practices are not well absorbed or correctly implemented by farmers. 	<ul style="list-style-type: none"> ▪ Strengthen links between research institutions, extension and farmers. ▪ Conduct more research on pests and diseases and resistant varieties. 	<ul style="list-style-type: none"> ▪ Research institutions. ▪ Local government.



TABLE 5 (cont.) Recommendations for improving coffee production in Masaka district

Investment area	Rank	Constraint	Recommendation	Responsible entity
Irrigation	5	<ul style="list-style-type: none"> ▪ Farmers lack knowledge and information on irrigation. ▪ High cost of irrigation equipment. 	<ul style="list-style-type: none"> ▪ Invest in low-cost irrigation technologies and provide them to farmers. ▪ Leverage existing irrigation programmes to demonstrate use of irrigation in coffee production. ▪ Raise farmers' awareness of the need for irrigation to increase resilience against climate change and long dry spells. 	<ul style="list-style-type: none"> ▪ Ministry of Works and Transport (MoWT). ▪ Ministry of Water and Environment (MWE). ▪ MAAIF.
Roads	6	N/A	<ul style="list-style-type: none"> ▪ Ensure investment in road maintenance. 	
Electrification	7	<ul style="list-style-type: none"> ▪ The cost of accessing the electricity for domestic and industrial use is high, despite improvements in coverage. ▪ Load-shedding is very common. 	<ul style="list-style-type: none"> ▪ Subsidize the cost of industrial power connection and consumption to promote value addition. ▪ Introduce alternative affordable sources of energy (e.g. solar). 	<ul style="list-style-type: none"> ▪ Rural Electrification Agency (REA).
Mechanization	8	<ul style="list-style-type: none"> ▪ Minimal use of mechanization for coffee growing due to land fragmentation and high costs of renting equipment. ▪ Harvested beans are usually sun-dried (kiboko) and the processes are sometime compromised, sometimes affecting quality. 	<ul style="list-style-type: none"> ▪ Support access to suitable machinery for wet processing, grading, grinding and roasting coffee. ▪ Build local capacity for repair and maintenance of machines. ▪ Offer support to cooperatives to acquire processing machinery. 	<ul style="list-style-type: none"> ▪ Research institutions.

Source: Authors' own elaboration.

Priority investment areas for coffee

1. Fertilizers. Very few coffee producers in Masaka use fertilizers, due to their extremely high prices and limited availability, which have been exacerbated by the war in Ukraine. Moreover, the presence of counterfeit fertilizers in the market leads to lost investments for coffee producers without the expected returns. Lastly, a lack of knowledge on the use of inorganic fertilizers has affected coffee yields in the area. Most coffee farmers use cow dung and compost from food scraps rather than applying fertilizers on a seasonal basis. A few

farmers use inorganic fertilizer, such as DAP, NPK and urea, which are sourced from private dealers. In the recent past, subsidized inorganic fertilizers were provided by the Agriculture Cluster Development Project (ACDP),²¹ which led to an increase in the use of fertilizers and a greater awareness about the effectiveness of certified fertilizers. The project is currently on hold but is expected to resume operations soon.

Government-subsidized fertilizers will enable farmers to access them at affordable prices. In addition, the government should regulate the fertilizer supply chain to mitigate the malpractices endemic in the acquisition, supply and application of the product and protect farmers from the dynamics of the private sector. Finally, an education campaign on the application of inorganic fertilizers could further improve productivity at farm levels.

2. Seeds. The inability of farmers to recognize certified coffee seedlings and to procure them on the market are two major constraints in the coffee sector. Confirming that coffee seedlings are genuine could take up to two years and the certified companies that supply seedlings often lack the capacity to enforce quality standards. Moreover, the mother nurseries do not have the capacity to meet the demand for coffee seedlings and they are often located far from the coffee farms, meaning that coffee farmers need additional resources to acquire seedlings.

Establishing seed nurseries in each parish would improve farmers' access to seedlings and address the problem of poor-quality seeds. The Parish Development Model can be quite relevant in this case. In addition, the government should share the cost of acquiring seedlings and support the seed distribution through cooperatives.

3. Extension. Access to extension services in the district is minimal. Extension officers often do not have the capacity to train farmers effectively and they lack basic equipment, such as motorcycles, and supporting tools, such as soil-testing kits, meters and thermometers. Extension officers often encourage the organization of farmers' groups to ease access to extension services. However, these groups are not commodity based, making it difficult to focus on specific and tailored farming practices. As in other districts, the link between farmers and research institutions is very weak. Finally, although UCDA oversees all coffee activities in the region, there is a lack of coordination between the authority and the extension workers, who mainly come from the private sector and the NAADS.

Aside from recruiting and equipping more extension workers, there is a need to train them regularly on the most updated extension practices. It will also be important to strengthen the interaction between the extension workers and the UCDA regulatory and intervention activities.

4. Research and development. Coffee R&D is undertaken by the Coffee Research Centre (COREC), which is a programme of the National Crops Resources Research Institute (NaCRRI). Although a substantial investment in R&D has generated extremely useful information²² for the coffee sector, the gap between research institutions and the extension services system constrains access to most recent technologies by extension officers. This then further generates confusion among the farmers, who end up not properly implementing the suggested agricultural practices and jeopardizing any potential effectiveness of R&D technologies/knowledge. Improving the link between extension system and research institution would maximize the benefits for coffee producers.

²¹ The Agriculture Cluster Development Project (ACDP) is a partnership project of the MAAIF and the World Bank, financed by the International Development Assistance (see www.agriculture.go.ug/the-agriculture-cluster-development-project-acdp).

²² Information on pest and disease resistance; climate resilience; tolerance to low-soil fertility; yield improvement; pre- and post-harvest management; genetic resources conservation; value addition; and innovative bioscience research and training.

5. Irrigation. Although little seen in Masaka, irrigation is critical for coffee growing, especially at the flowering stage. Farmers in the district don't have much information on irrigation and the cost of irrigating coffee is quite high. Under the National Irrigation Policy, the government initiated a microscale irrigation project as part of the Uganda Intergovernmental Fiscal Transfers (Ug-IFT) programme. The project aimed to support irrigation by contributing 75 percent of the cost of off-farm water infrastructure that could be used to pump water from a nearby water source to the farmer's garden (Ug-IFT, 2022). The initiative is led by MAAIF at the district level.

However, although subsidized, the cost of the irrigation infrastructure is still out of reach for most farmers.

An alternative approach would be for the government to construct valley dams and design appropriate, reliable and affordable irrigation methods and tools. These, in principle, should be easily procurable or built by local craftsmen.

6. Roads. The road network in the area is good and farmers can easily access agricultural inputs and markets for their products. This is due to a decision to provide machinery for road maintenance at the district level and to hire local engineers, rather than rely on external engineering services.

7. Electrification. Despite efforts by the Electricity Regulatory Authority (ERA) to connect rural areas to the national grid, many farmers and other coffee value chain participants still do not have access to electricity due to its high cost. In some communities, access to industrial power is also a challenge because of the lack of transformers and the frequent load shedding. There is a need to subsidize the cost of industrial power to enhance value addition processes and introduce alternative but affordable sources of energy, such as solar, for domestic use.

8. Mechanization. Mechanized coffee production in the district is minimal, partly due to land fragmentation, which does not permit the intense use of farm equipment such as tractors. Most farmers use hand hoes to weed their fields, making the production process extremely labour-intensive. Farmers who do use tractors usually hire them from private owners. During the initial processing stage, coffee beans are handpicked, sun-dried (kiboko) on the farm and sold to intermediaries and then to exporters. With government support, farmers acquired coffee hullers through their cooperatives; the equipment was not operational at the time of data collection due to a lack of electricity. There is a need to assist cooperatives to acquire more processing machines and to connect coffee processing plants in the district to the national grid.

What stakeholders need to do

Short term. Many farmers still embrace traditional farming practices (such as rainfed agriculture) and are unwilling to adopt new approaches since they do not recognize their value. The government should create district-level information centres where farmers could acquire knowledge on fertilizers and irrigation methods and learn from the experiences of other farmers.

Medium term. The government should empower extension officers to bridge the gap between research and farmers. Many more officers are needed. Institutional coordination of different research mandates is critical.

Additional areas of concern to coffee farmers

Value addition and cost benefit analysis. Extension officers stress the need to increase farmers' awareness of potential acreage growth, inputs and machinery use. This would help farmers to conduct a sort of cost-benefit analysis of the production process and gauge how much they benefit from agriculture.

Markets. Over 90 percent of Ugandan coffee is exported by processing companies since exporting is more profitable than selling on the domestic market. Yet, the price received by producers is very low, discouraging farmers from growing coffee. Coffee growers emphasize the need for market-related investments to ensure a stable and profitable domestic market that would give sustainability to the whole sector.

Storage. Adequate storage facilities are very critical for maintaining the quality of coffee. Currently UCDA's role as a regulatory agency leaves gaps in terms of ensuring that storage is adequate and up to the expected standards. This arises from the gap left after cooperative unions were liberalised, as the latter had a chain of storage facilities and ensured quality standards were adhered to. Individual farmers store coffee in unsupervised and unregulated facilities exacerbating the problem. The current cooperatives are not structured to fill this gap and hence adulteration and poor-quality coffee persists. Given such a situation, respondents suggested the revival of the cooperative unions to handle storage and value addition of coffee.

4 Conclusion and ranking of priority investment areas and actionable recommendations

Table 6 summarizes the ranking of the priority investment areas identified in this study. It shows that the top three priorities are seeds/breeds, extension services and fertilizers/veterinary drugs, although some of the commodities have different priority rankings. The table indicates that the respondents did not perceive roads, electrification and irrigation as requiring major investment. Roads were not given a high priority due to the heavy investments that the government has made in infrastructure development over the past last ten years. As a result, most roads are passable and suitable for all weather. Electricity was of less concern because respondents were more interested in production aspects, which do not require as much electricity as processing.

◆ **TABLE 6** Ranking of the priority investment areas across the commodities and districts

Priority investment area	Millet in Soroti	Maize in Serere	Cassava in Lira	Goats in Kibaale	Coffee in Masaka	Average	Rank
Seeds/breeds	2	1	1	1	2	1.4	1
Extension	1	4	3	2	3	2.6	2
Fertilizers/veterinary drugs	4	3	8	3	1	3.8	3
Mechanization	3	2	2	5	8	4	4
Research and development	7	5	4	4	4	4.8	5
Irrigation	5	6	7	8	5	6.2	6
Roads	6	8	6	7	6	6.6	7
Electrification	8	7	5	6	7	6.6	8

Source: Authors' own elaboration.

Overall, the outstanding actionable recommendations include:

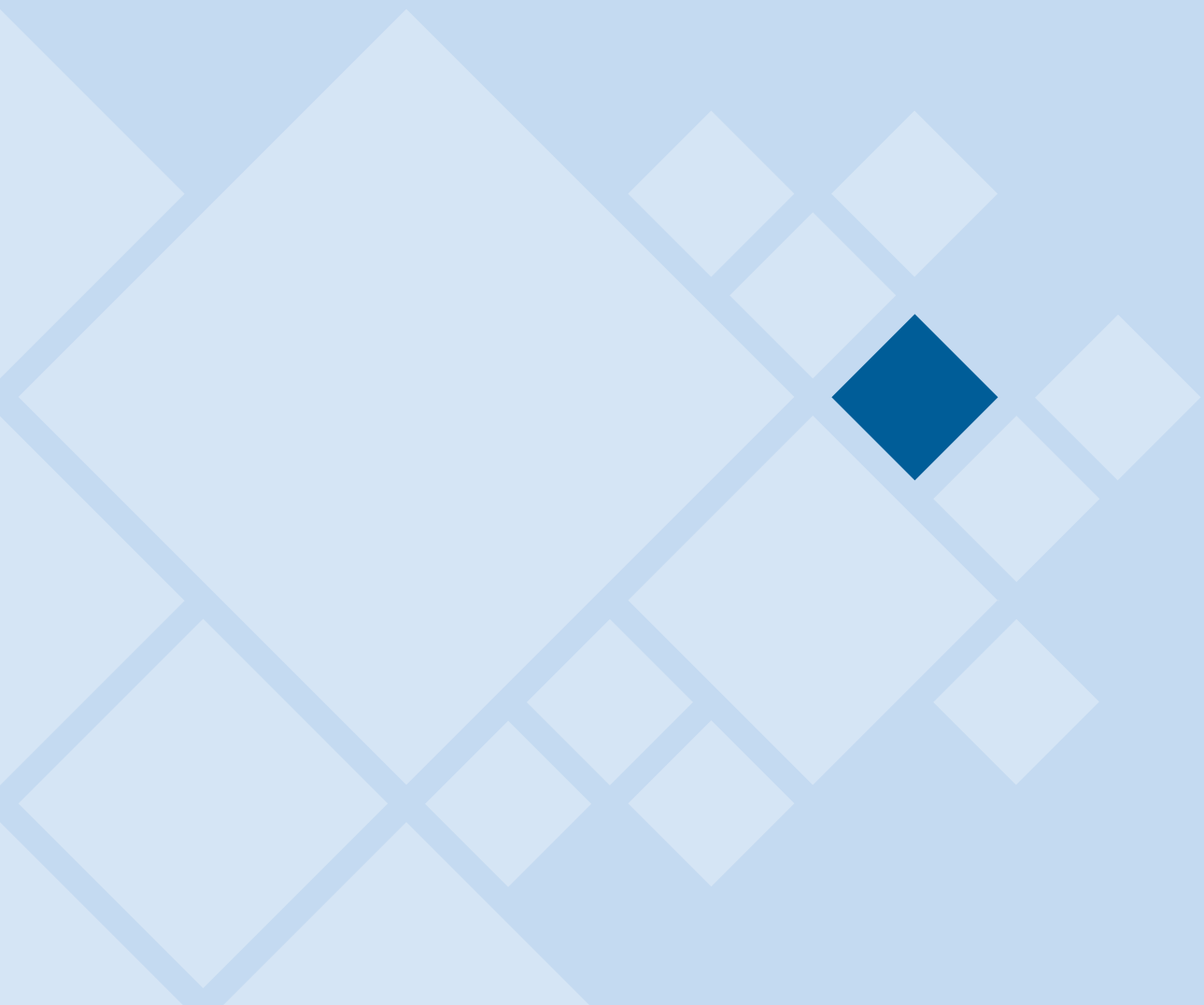
1. Facilitated access to improved seeds/breeds should be accompanied by complementary support services, such as effective development, certification, regulation, inspection and distribution, to ensure that certified commercial seeds/breeds meet the quality standards. Provide support for the districts to establish community goat breeding centres to supply farmers with improved breeds at a subsidized cost.
2. Recruit, train and motivate extension workers to deliver services to farmers; this may require an increase in budget allocation.
3. Ensure effective, widespread and accessible dissemination of extension information through radio, television, demonstration farms, pamphlets, etc.

4. Subsidize the price of fertilizers to increase use and enforce fertilizer regulations to mitigate the negative effects of fake and adulterated fertilizers on the market.
5. Improve the links between district extension services and other government institutions such as ZARDI and NAGRC. This will require strengthening institutional coordination among the government agencies responsible for R&D and extension.
6. Invest in R&D technologies that extend the shelf life of fresh produce to increase market opportunities for traders, growers and consumers.
7. Enforce rules and regulations for (veterinary) drugs, pesticides and other agrochemicals to minimize adulteration of drugs and implement approved policies with support from the community support system.
8. Promote appropriate low-cost mechanized and irrigation technologies to improve productivity; these might include hand tractors, weeding equipment, harvesting machines, storage aids, small-scale irrigation systems, and recyclable seeds.

While these rankings should be viewed as specific to the context (district-commodity combination), they are nevertheless broadly aligned with existing evidence on the beliefs of sector experts in Uganda and CGE analyses. Mockshell and Birner (2020) and Mockshell and Birner (2015), who look at the agriculture development narratives of several stakeholders in Uganda, also find that some of the highest-ranking policy areas are the ones that are most frequently mentioned, including: 1) the quality and quantity of fertilizers and seeds; 2) modern farm equipment and affordable mechanization. In contrast, there were few mentions of roads and electricity. Similarly, simulations from economy-wide models further seem to suggest that an extension-heavy budget would lead to higher growth than a budget focusing on irrigation or roads (Pauw and Thurlow, 2015), which is consistent with the ranking presented in Table 6.

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Annexes

Annex 1. Focus group discussion tool

This tool will assist with the collection of primary data that can be used to conduct a qualitative and quantitative analysis of investment gaps and opportunities across eight priority investment areas, including: i) seeds; ii) fertilizers; iii) mechanization; iv) irrigation; v) extension; vi) research and development; vii) roads and viii) electrification.

Objectives of the study

- ◆ Examine and rank the most pressing gaps across eight priority investment areas.
- ◆ Recommend and justify specific investments.

A. INTRODUCTION

SECTION A: GENERAL INFORMATION	
Name of enumerator:	A2. County:
Date:	A3. Subcounty:
Time ended:	A4. Parish:
Time started:	A5. Village (local council one):
A1. District:	A6. Location of meeting:

Respondents' information

ID	Respondent's name	Gender	Age	No. of years spent as farmer/input dealer/...
1				
2				
No.				

B. SEEDS

1. What is the main source of seeds/seedlings (product/livestock) for planting in this district? Follow-up questions/areas to probe: Have you benefited from the seeds/seedlings that are distributed by government?

2. How did you acquire the seeds/seedlings? 1=cash; 2=on credit; 3=bartered; 4=free (gift). Follow-up questions/areas to probe: affordability.

3. What type of seed do you use? Improved or not? Why?

4. Do you access preferred varieties of seed/seedling in time for planting? Why? Follow-up questions/areas to probe: unsuitability, timeliness, distance.

5. How would you rank the overall access to seed/seedling varieties in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.

6. Are you satisfied with the quantity and quality of seed/seedling you were provided with? Give reasons for your response? Follow-up questions/areas to probe: information on the variety, viability.

7. How would you rank the overall quality of the seeds/seedlings available in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.

8. What are the main constraints to the adoption of improved (product) seed/seedlings in this community/district?

Constraints	Rank: 1 to 5 (1 being most important)

9. What are the main constraints to the use of improved (product) seeds/seedlings in this community/district?

Constraints	Rank: 1 to 5 (1 being most important)

10. Has the government supported seed interventions (development, multiplication, distribution) in this district? If so, explain how.

11. Have seed companies contributed to the seed system (uptake, distribution, quality, knowledge and information). If so, how?

12. To what extent has the government supported seed companies? Explain how the government has supported and why?

13. What needs to be done to improve investment in the seed system in your district? Follow-up questions/areas to probe: funding, technology, extension services, roads, electricity, R&D, mechanization, irrigation, fertilizers, timely access to quality seed.

Strategy (what needs to be done)	Rank: 1 to 3 (1 being most important). Give reason for your choice

14. What are the three most necessary investments to address deficiencies in the seed system?

Investments	Rank: 1 to 3 (1 being most important). Give reason for your choice

C. FERTILIZERS

1. Do most people in this community use fertilizer for crop production? If no, why not? (Clarify to the respondents the types of fertilizer).

2. If yes, what type of fertilizer do they use? Organic or inorganic? Give reasons for the choice of fertilizer.

3. How do the people in your community perceive fertilizer use?

4. What is the main source of the inorganic fertilizer used in this district? Follow-up questions/areas to probe: Have you benefited from the inorganic fertilizers that are distributed by government?

5. How did you acquire the inorganic fertilizer? 1=cash; 2=on credit; 3=bartered; 4=free (gift). Follow-up questions/areas to probe: affordability.

6. Do you access the preferred types of inorganic fertilizer throughout the farming season? Give reasons for your answer. Follow-up questions/areas to probe: unsuitability, timeliness, distance.

7. How would you rank the overall access to inorganic fertilizer types in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reasons for your answer.

8. Are you satisfied with the quantity and quality of inorganic fertilizer you received? Give reasons for your response. Follow-up questions/areas to probe: information on the variety, viability.

9. How would you rank the overall quality of the types of fertilizer available in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.

10. What are the main constraints to the adoption and usage of inorganic fertilizer in this community/district?

Constraints	Rank: 1 to 5 (1 being most important)

11. What are the main constraints to the effectiveness of inorganic fertilizer in this community/district?

Constraints	Rank: 1 to 5 (1 being most important). Give reason for your choice

12. Who is promoting fertilizer use in the district and what investments have been made to achieve this?

13. Has the government supported seed interventions (research and development, distribution, knowledge, regulation, enforcement of standards) in this district? If yes, explain how.

14. What needs to be done to improve investment in the fertilizer system in your district? Follow-up questions/areas to probe: funding, technology, extension services, roads, electricity, R&D, mechanization, irrigation, timely access to quality fertilizer.

Strategy (what needs to be done)	Rank: 1 to 3 (1 being most important). Give reason for your choice

15. What are the three most needed investments to address deficiencies in the fertilizer system?

Investments	Rank: 1 to 3 (1 being most important). Give reason for your choice

16. What are some of the opportunities available for leveraging fertilizer use in your community?

D. IRRIGATION

1. Do most people in this community irrigate their crops? If no, why not? (Clarify to the respondents the types of irrigation) Probe: land tenure system.

2. If yes, what type of irrigation method do they use? Give reasons for the choice of irrigation method.

3. What is the main source of water for irrigation in this district and does it influence the choice of irrigation method?

4. Are there government (and or private/NGO) irrigation schemes in your area that support (farmers of this particular product)? If so, where are they located and are they operational? Are there any efforts by the government/private sector/NGOs to restore/upgrade the existing irrigation system?

5. How do farmers acquire irrigation equipment or services (installation/maintenance/repair) in this community? 1=cash; 2=on credit; 3=bartered; 4=free (gift). Follow-up questions/areas to probe: affordability.

6. Do you access the preferred types of irrigation or irrigation services in your community? Give reasons for your answer? Follow-up questions/areas to probe: unsuitability, timeliness, distance.

7. How would you rank the overall coverage of irrigation in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.

8. Are you satisfied with the quantity (adequate) and quality of irrigation infrastructure/systems? Give reasons for your response? Follow-up questions/areas to probe: information on the variety, viability.

9. How would you rank the overall quality of irrigation infrastructure/systems available in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.

10. What are the main challenges associated with irrigation in this community/district? Follow-up questions/areas to probe: cost, distribution, adoption, quality, quantity, knowledge gaps, negative environment effects.

Constraints	Rank: 1 to 5 (1 being most important)

11. Who is promoting irrigation use in your district and what investments have been made to achieve this? Follow-up questions/areas to probe: research, training, mechanization, extension, road, electricity.

 Explain how so?

12. How can the private sector be supported to invest in irrigation systems or services in your community?

13. Is irrigation really necessary in this community? If so, what needs to be done to improve investment in the irrigation system?

Strategy (what needs to be done)	Rank: 1 to 3 (1 being most important). Give reason for your choice

14. What are the three most necessary investments to improve irrigation services for [product] in the district/community?

Investments	Rank: 1 to 3 (1 being most important). Give reason for your choice

15. What are some opportunities available for leveraging irrigation in your community?

E. MECHANIZATION

1. What is the common type of mechanization/agricultural machinery used in your community and what is it used for? Follow-up questions/areas to probe: production, processing, harvesting, storage, marketing.

2. What is the source of agricultural machinery used in this district and why? Follow-up questions/areas to probe: ZARDI, private, commercial farmers.

3. How do farmers acquire the agricultural machinery and associated services (installation/maintenance/repair) in this community? 1=cash; 2=hire/on credit; 3=bartered; 4=free (gift). Follow-up questions/areas to probe: affordability; where were they purchased from?

4. What is the average cost of purchasing or hiring agricultural machinery? Follow-up questions/areas to probe: How affordable is it?

5. Do you access the preferred types of agricultural machinery throughout in your community? Give reasons for your answer? Follow-up questions/areas to probe: unsuitability, timeliness, distance.
-

6. How would you rank the overall access to agricultural machinery or mechanization services in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.
-

7. Are you satisfied with the quantity and quality of agricultural machinery/mechanization services offered in your community? Give reasons for your response. Follow-up questions/areas to probe: cost, distribution, adoption, quantity, knowledge gaps, negative environment effects, terrain, energy, spare parts, after-sale services.
-

8. How would you rank the overall quality of machinery/mechanization services available in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.
-

9. What are the main challenges faced by farmers who use agricultural machinery in [district]? Follow-up questions/areas to probe: cost, distribution, adoption, quality, quantity, knowledge gaps, negative environment effects, terrain, energy, spare parts, after-sale services, capacity [skills], human resources to operate the machinery.

Constraints	Rank: 1 to 5 (1 being most important)

10. Who is promoting mechanization (or the use of agricultural machinery) in your district and what investments have been made to achieve this? Follow-up questions/areas to probe: research, training, road, electricity.
-

11. Has the government supported mechanization (or the use of agricultural machinery) in your community (research and development, training, extension, roads, electricity)? If so, explain how.
-

12. What needs to be done to improve investments in agricultural mechanization and related services in your district? (Indicate person/institution responsible for the investment).

Strategy (what needs to be done)	Rank: 1 to 3 (1 being most important). Give reason for your choice

13. What are the three most necessary investments to improve access and utilization of agricultural mechanization for [product] in the district/community?

Investments	Rank: 1 to 3 (1 being most important). Give reason for your choice

14. What are some of the opportunities available for leveraging mechanization in your community?

F. RESEARCH AND DEVELOPMENT

1. How do you access information and services on new seed varieties/breeds/agricultural machinery/technology for [product] in the community and from whom? Follow-up questions/areas to probe: extension agent (NAADS, OWC), extension agents, farmers in other villages, private sector, traders, public information (radio, etc.), ZARDI, SACCOs, farmer’s associations, MFIs).

2. What is the main source of information and services on new seed varieties/breeds/agricultural machinery/technology for [product] in the community and why?

3. What new seed varieties/breeds/agricultural machinery/technology are used in your community? Where are they obtained from?

4. What innovations have been developed by people in your community and why? Follow-up questions/areas to probe: machinery, technologies, breed, provision of extension, knowledge production and sharing.

5. What innovations do farmers access in your community and why? Follow-up questions/areas to probe: machinery, technologies, breed, provision of extension, knowledge production and sharing.

6. Do you access the preferred types of agricultural technologies and innovations? Give reasons for your answer.

7. How would you rank overall access to information on new agricultural technology/varieties/breed in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.

8. Are you satisfied with the quantity and quality of agricultural technology/varieties in your community? Give reasons for your response. Follow-up questions/areas to probe: cost, distribution, adoption, quantity, knowledge gaps, negative environment effects, terrain, energy, spare parts, after-sale services.

9. How would you rank the overall quality of new agricultural technology available in your district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.
-

10. What are the main challenges faced by farmers in accessing and utilizing information on new agricultural technologies/seed varieties/breeds in (district)?

Constraints	Rank: 1 to 5 (1 being most important)

G. EXTENSION

1. Do farmers receive extension services in your community? If yes, who provides these services? Follow-up questions/areas to probe: government NAADS, government OWC, private sector farms, CBOs, stockists, etc.).

Responsible institution or person	Type of services*

Note: * Information on new technology, access to inputs, access to credit, marketing assistance, establishing ownership rights.

2. How do you access extension services (agricultural extension centre, demonstration farm, radio, workshops, field days, meetings with farmers)?
-

3. What is your preferred source of extension services in this district and why? Follow-up questions/areas to probe: ZARDI, private, commercial farmers.
-

4. How would you rank the overall access to extension services in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.
-

5. How would you rank the overall quality and frequency [satisfaction] of extension services available in the district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.
-

6. What are the main challenges faced by farmers in accessing extension services in [district]?

Constraints	Rank: 1 to 5 (1 being most important)

7. What are the main challenges faced by farmers in using extension services in [district]?

Constraints	Rank: 1 to 5 (1 being most important)

8. Who is promoting extension services in your district and what are the investments made to achieve this? Follow-up questions/areas to probe: research, training, road, electricity.

Has the government supported extension service provision in your community? If so, explain how.

9. What needs to be done to improve investments in the provision of agricultural extension services in your district? (Indicate person/institution responsible for the investment).

Strategy (what needs to be done)	Rank: 1 to 3 (1 being most important). Give reason for your choice

10. What are the three necessary needed investments to improve access and utilization of extension services for [product] in the district/community?

Investments	Rank: 1 to 3 (1 being most important). Give reason for your choice

H. ELECTRICITY

1. What energy types do most farmers use in agriculture related activities? Follow-up questions/areas to probe: renewable/non-renewable/electricity/diesel/paraffin/solar/biogas. Who are the providers (government, farmers and private providers)?

2. Do most farmers in this community use electricity in agricultural activities? If no, why not?

3. If yes, how do farmers use electricity in agricultural activities? Follow-up questions/areas to probe: transforming agriculture value chain.

4. Is electricity affordable by the farmers? If yes/no, why? Follow-up questions/areas to probe: installation, maintenance.

5. Are there government (and or private/NGO) efforts to subsidize access to electricity to support agricultural related activities? If yes, what efforts? Follow-up questions/areas to probe: rural electrification.
-

6. How would you rank the overall access to electricity in your district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.
-

7. How would you rank the overall availability/quality of electricity in your district (excellent, very good, good, average, poor, very poor, non-existent)? Follow-up questions/areas to probe: outage, load shedding. Give reason for your choice.
-

8. What are the main challenges that limit the access and use of electricity for agricultural related activities in this community/district?

Constraints	Rank: 1 to 5 (1 being most important)

9. What alternative forms of energy are needed to improve agriculture [product]?
-

10. What should be done to increase access to rural electrification for agriculture [product] in your district? Follow-up questions/areas to probe: government/private sector/community/NGOs.
-

11. What are the three most necessary investments to address improve access and utilization of electricity for agriculture transformation [product] in the district/community?

Investments	Rank: 1 to 3 (1 being most important). Give reason for your choice

I. ROADS

1. What road types do most farmers use for agricultural activities? Follow-up questions/areas to probe: renewable/non-renewable/electricity/diesel/paraffin/solar/biogas. Are roads passable throughout the year? Give reasons for your answer.
-

2. Who is responsible for road maintenance in your community/district (subcounty/district/central government/non-state actors/community/political leaders)?
-

3. On average, what is the distance to the nearest input source/provider/market/extension services?

4. Are there government (and or private/NGO) efforts to improve road access to support agricultural activities? If so, describe them.

5. How would you rank the overall access to roads in the district in relation to agricultural activities (excellent, very good, good, average, poor, very poor, non-existent)? Give reasons for your choice.

6. How would you rank the overall quality of the available roads in your district (excellent, very good, good, average, poor, very poor, non-existent)? Give reason for your choice.

7. What are the main challenges that limit the access and road usage for agricultural related activities in this community/district?

Constraints	Rank: 1 to 5 (1 being most important)

8. What alternative forms of energy are needed to improve agriculture (product)?

9. What are the three necessary investments (public/private) to improve access and utilization of roads to support agricultural performance?

Investments	Rank: 1 to 3 (1 being most important). Give reason for your choice

Annex 2. Key informant interview tool

This tool will assist with the collection of primary data that can be used to conduct a qualitative and quantitative analysis of investment gaps and opportunities across eight priority investment areas, including: i) seeds; ii) fertilizers; iii) mechanization; iv) irrigation; v) extension; vi) research and development; vii) roads and viii) electrification.

Objectives of the study

- ◆ Examine and rank the most pressing gaps across eight priority investment areas.
- ◆ Recommend and justify specific investments.

Research and development (R&D)

Areas of R&D	<p>a. In what areas are the main investments in R&D? Production, processing, marketing?</p> <p>b. How integrated is the district into the ZARDI system?</p> <p>c. What technology transfer systems do you have in place for disseminating technologies developed by research institutions to farmers? Training, demonstration, modern or indigenous knowledge products?</p>
Extension service providers	<p>a. What kind of agricultural technology services do you offer to farmers/communities?</p> <ul style="list-style-type: none"> ▪ Community mobilization/awareness ▪ Soil fertility management ▪ Crop protection ▪ Farm management ▪ Improved produced variety/quality <p>b. Who is the main funder or investor in R&D activities?</p> <p>c. What is the level of investment in R&D in your organization?</p> <p>d. What are the priority investment/expenditure areas for R&D?</p> <p>e. What are the challenges to investment in R&D for (a given commodity)?</p> <p>f. How can investments in R&D be improved for (a given commodity)?</p>
Human resources	<p>a. Do you have adequate personnel to develop new agricultural technologies?</p> <p>b. If not what are deficits in human resources deployment?</p> <p>c. Do staff have the appropriate tools and are they sufficient?</p>
Investment	<p>a. Comment on the resources available for R&D and what is required to achieve the targets of your organization.</p> <p>b. What can be done to improve the uptake of new technology and varieties in your community?</p> <p>c. What is the perception of farmers towards adopting new technology/use of new improved seeds?</p>

Extension

Extension service providers	<p>a. What is the structure of agriculture extension services in your district/community/parish/village?</p> <p>b. What kind of farmers do you target for extension services?</p> <ul style="list-style-type: none"> ▪ Large commercial farmers ? ▪ Small/medium scale farmers? ▪ Farmers growing (special commodity)? ▪ Small scale subsistence farmers? ▪ Women farmers? ▪ Young adult farmers? ▪ Landless farmers? ▪ Rural youth? <p>c. What kind of services do you provide to farmers?</p> <ul style="list-style-type: none"> ▪ Extension planning and support activities, including conducting needs assessment, programme planning, preparing performance reports, in-service training, programme evaluation and related activities. ▪ Educational and advisory service activities: Including implementing educational programmes, such as farm visits, conducting on-farm demonstrations, training courses, workshops, field days etc. ▪ Non-educational activities: Including carrying out non-educational activities such as regulatory work, data collection (e.g. agricultural census, crop forecasting), working on other government programs (e.g. subsidies, credit, input supply) and assisting local government. ▪ Information materials: what type of information, advisory and or training materials are produced for extension services provision?
Human resources	<p>a. How many staff are involved in extension service delivery? Are there enough?</p> <p>b. Do they have the skills (capacity and abilities) to support farmers?</p> <p>c. Do they have the appropriate tools and are they sufficient?</p>
Main constraints	<p>a. What factors limit the provision of extension services to farmers (product) in (district)?</p>
Funding	<p>a. Who is the main funder or investor in extension services in your district/ community/organization?</p> <p>b. What are the priority expenditure areas for extension services?</p>
Investment	<p>a. How can investments in agricultural extension be improved in this district?</p>
Priority ranking	<p>a. What are the three most needed investments to improve access and utilization of extension services for (product) in the district/community? (Please rank these, 1=being most important to 3=less urgent).</p>

Annex 3. Overview of number of respondents by district and commodity

◆ **TABLE A1** Commodities, districts and number of respondents in each district

Commodity	District	No. of respondents	Type of respondents	No. of respondents	Type of respondents
		Focus group discussions		Key informant interview (KII) and in-depth interviews (IDIs)	
Maize	Serere	34	Farmers, extension officers	3	District production officer, director of the National Agricultural Research Organisation (NARO), input dealer (Green World)
Millet	Soroti	36	Farmers, extension officers	2	District production officer
	Moroto	32	Farmers	2	District production officer, extension officer
Cassava	Lira	33	Farmers, farmers union, extension officers	1	District production officer
Goats	Kibaale	26	Farmers, extension officers	6	District production officer, animal husbandry officer, veterinary officer
Coffee	Masaka	30	Farmers, farmer's unions	3	Extension officer, district water engineer
	Hoima			1	Research officer for animal nutrition NARO
	Kampala	0		8	Research institute director, agricultural research officer, veterinary officer, plant pathologist, engineer
Total		191		26	

Source: Authors' own elaboration.

Building on the previous work by the Food and Agriculture Organization of the United Nations (FAO) supporting the identification of priority agricultural sectors and possible locations with high agricultural transformation potential in Uganda, this technical study provides more granular information from Ugandan farmers and district agriculture officers on which investments are needed the most to increase productivity. It identifies and ranks the areas for investments in terms of seeds/breeds, fertilizers/veterinary drugs, mechanization, irrigation, extension, research and development (R&D), roads and electrification for five commodity-district pairs (millet in Soroti, maize in Serere, cassava in Lira, goats in Kibaale and coffee in Masaka).

The study found that improved seeds/breeds, extension and fertilizers were identified as critical investments across the board. Specifically, a lack of access to improved seeds/breeds, inadequate extension services and suboptimal use of fertilizer (owing to costs, lack of information, or fertilizer quality) were perceived as major constraints. Other important findings highlight a low level of mechanization throughout the value chains, poor R&D and extension linkages, and the high cost of irrigation. On other hand, access to roads and electrification were not considered as major areas needing investment. The study concludes with nine key recommendations for improving commodity-specific investments in selected locations.

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