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Systematic review of herd health research in the pig value chain in mid-northern Uganda: Constraints, gaps and opportunities

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Report

Contents

Authors: Peter Oba, Emily Ouma, and Michel Dione

International Livestock Research Institute

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Summary

The pig sector in Uganda is growing rapidly, partly driven by increase in human population, urbanization and changing consumption habits. The demand for pork is projected to outpace supply in the coming decades, yet production remains low. To bridge this projected supply gap, pig production and productivity needs to increase significantly, combined with increased efficiency in production and value chain performance. The current production and market systems in the country are inefficient, with diverse constraints.

This systematic review was conducted to provide (1) an analysis of the pig herd health research situation in Uganda's mid-northern (Acholi and Lango) subregions; (2) summarize key challenges and constraints faced by pig value chain actors and (3) highlight major herd health research gaps with a view to inform future interventions. A comprehensive literature search was done using *Harzing's Publish or Perish* software tool (*version 8. 18.5091*). The search used key words: *Pigs, pork, value chain, livestock policy, northern Uganda, pig markets, veterinary services, pig feeds, reports, practitioners, herd health, diseases, African swine fever, parasites, respiratory pathogens, antimicrobial use, antimicrobial resistance, food safety, cysticercosis, artificial insemination, antimicrobial resistance, antimicrobial use and zoonoses.*

Results revealed that while significant opportunities exist in the region, the pig value chain faces a diversity of constraints, which if addressed could potentially transform the sector. The growing demand for pork and other related products, backed by rising population and increasing per capita incomes provide immense opportunities for all actors involved in the value chain. However, endemic diseases remain a major threat and setback to the development of the value chain, particularly African swine fever (ASF), and parasitic and zoonotic diseases such as *Taenia solium* cysticercosis. This review highlights the following key herd health constraints and gaps to the growth and productivity of the pig industry in the region:

- Weaknesses in national livestock sector policies and institutional arrangements of VC actors for collective action
- Structural and organizational gaps in inputs' supply, quality, poor funding and delivery of veterinary services
- High incidence of economically important diseases such as African swine fever (ASF), gastro-intestinal (GI) parasites, *Taenia solium* cysticercosis and bacterial diseases
- Gaps in technical knowledge and information on herd health, welfare and biosecurity practices of farmers and value chain (VC) actors
- Poor or inadequate infrastructure for pork production, processing and value addition
- Weak institutional linkages with other VC actors - such as feeds, breeding services and marketing (in transportation, value addition and processing node)
- Hazards in the pork value chain including zoonoses, food safety and antimicrobial resistance (AMR)

Background and context

In Uganda, over 70% of the national population depend on livestock as a source of livelihoods and accounts for about 18% of the agricultural gross domestic product (GDP). Its contribution to national GDP increased from 3.8% in FY 2017/18 to 3.9% in 2020/21 (UBOS, 2021), signifying the growing role of livestock. Of all livestock species raised in Uganda, pig production is the fastest growing subsector with a greater potential to uplift many people out of poverty. Pigs play a significant role in the livelihoods of many people, contributing to food security, incomes and employment. The latest 2021 national livestock census shows that there are over 7.2 million pigs in Uganda produced by over 2.2 million households (UBOS, 2024). The increase in demand for animal source foods is expected to be due to growth in human population (UBOS, 2025), urbanization and increased per capita gross domestic product (GDP) from USD ~1,034 in 2025 to ~1,900 in 2050 (FAO, 2019). With changing consumption patterns, the demand for pork has grown substantially in the last one decade (Ouma et al., 2014).

The Food and Agriculture Organization of the United Nations projects that annual demand for pork in Uganda will rise from 277,500 tons in 2030 to 606,600 tons in 2050 (increase of 218.6%), while supply is projected to increase by 225% during the same period (FAO, 2022). Currently in Uganda, the low level of pork production coupled with inefficiency in supply chains does not satisfy the rising domestic demand. This deficit presents favorable economic and business opportunities for all actors in the pig industry. Despite existence of such opportunities, the current government policy does not seem to consider sustaining or improve pork production in the country (Mutua et al., 2020; Twine and Njehu, 2020), as more attention is placed on the dairy, poultry and beef value chains. While pig production is mentioned in some policy frameworks, there is no specific strategy aimed to address existing challenges in the value chain.

However, while research and business prospects exist, the sector faces several challenges and constraints. The predominance of smallholders means that production is highly inefficient, and that production systems are

vulnerable to shocks from existing constraints such as diseases and climate change effects. Because structural and institutional arrangements to enable farmers access better inputs and markets are weak or non-existent, they remain vulnerable to market dynamics such as unfair pricing by aggregators, as has been previously reported (Ouma et al., 2017). Their ability to influence the market for pigs, pork and other products is diminished, particularly during supply and demand fluctuations. This is exacerbated by low uptake of technologies, limited access to information, knowledge and affordable finance. To transform the pig sector in northern region, the government of Uganda, research and other development partners need to design approaches and interventions that can address existing constraints faced by farmers and other value chain actors with their active participation in the co-design process.

Objectives of the situational review

This review aims to provide a comprehensive overview of pig production systems' context, constraints, gaps and opportunities available to guide design of herd health research interventions in Uganda's mid-northern region. Specifically, the review aims to:

1. Provide an overview and summary of pig herd health research situation over the past two and a half decades (from 2000 – 2025) in Uganda's mid-northern subregion
2. Highlight existing herd health challenges, constraints faced by value chain actors and opportunities to improve the pig sector in the region
3. Identify key herd health gaps to inform future research interventions

This review highlights key issues in the pig value chain, and covers aspects of production systems context, the status of veterinary services' provision, roles of the various public and private institutions in the development of the pig value chain, institutional arrangements, gaps, challenges - endemic diseases, antimicrobial use (AMUSE), antimicrobial resistance (AMR) and food safety issues and available opportunities in the region. A key output from this study is a synthesis of research findings, constraints, gaps, opportunities and recommendations that will inform the design of future research interventions.

Geographical and temporal scope of the review

While previous value chain assessment studies on porcine cysticercosis (PCC) work by a team of ILRI scientists were conducted in four districts - Lamwo, Kitgum, Pader and Agago (Ngwili et al., 2025a, 2025b), this study was expanded to cover all districts (19) in the mid-northern (Acholi and Lango) subregions of Uganda to provide a comprehensive overview of the pig value chain. These comprise 9 districts in Acholi subregion - Gulu, Gulu city, Amuru, Nwoya, Lamwo, Omoro, Kitgum, Agago and Pader; and 10 districts in Lango subregion - Amolatar, Dokolo, Apac, Kole, Lira, Lira city, Oyam, Alebtong, Kwania and Otuke. The review compiles all studies conducted and reports produced on the pig value chain in the region and covers years from 2000 to 2025.

It comprises published research articles, official documents and reports. Documents were retrieved from archives of government and non-governmental organizations (NGOs), international development agencies and private sector players in the region.

Brief description of the study area

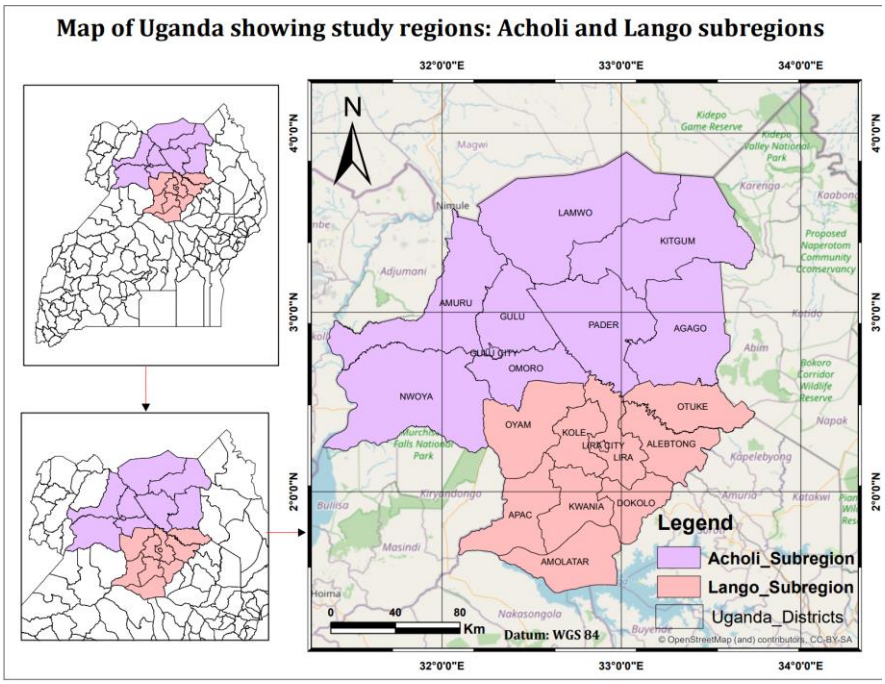
The mid-northern sub region comprises of nineteen (19) districts in Acholi and Lango subregions of Uganda. The sub-regions occupy a total land area of 29,174 km2, which is about 12% of Uganda's total land area (Kasusse et al., 2015; Uganda Bureau of Statistics, 2018). The mean altitude of the region is 1,078 m (range 900 – 1300 m) above sea level (UBOS, 2021). The region's annual temperatures range from 18 – 30.5 °C (UNMA, 2022) and the mean annual rainfall is 1,350 mm, with significant variation between seasons and districts. The region's vegetation is characterized as a typical tropical savannah grassland with woodland, forests and wetlands.

The mid-northern region suffered long periods of political insurgency in the 1990s where many people were internally displaced. With return to relative peace following the end of insurgency, people returned to their ancestral lands in 2006/07 (Bourgeois, Wright and Crisp, 2007, UNHCR, 2007). During insurgency, many people lost their sources of livelihoods – agricultural production and businesses collapsed as they could no longer engage in productive activities. This led to widespread poverty and disrupted many livelihoods in the region. While the region is gifted with vast fertile lands and a relatively good climate, current indicators show the region suffers high rates of poverty and unemployment especially among the elderly, youth and women.

Latest data shows that most chronically poor people are found in the northern region (15.1%), followed by eastern region (7.2%), which are both higher than the national average of 7.1% (UBOS, 2021). The proportion of the employed population compared to the region's total population stood at 19.1%, which is lower than the national average of 21.5% (UBOS, 2021). Efforts by government and development partners to revive the region's

economic performance through pig production have not yielded anticipated results due to various socio-cultural, institutional and economic factors. Figure 1 shows a map of the study areas, which covers Acholi and Langa subregions.

Figure 1. Map of Uganda showing mid-northern study regions – Acholi and Langa subregions



Source: drawn from ArchGIS, 2025

Study methodology

Systematic literature review

This review involved a systematic desk study of published literature on the pig value chain in Uganda's mid-northern region, with a focus on identity, roles and responsibilities of value chain actors, their interrelationships, structure and roles of relevant institutions, gaps, challenges and opportunities available in the region. The study used primary data collection from officially published document sources.

The following search engines (*Google Scholar, PubMed Central, Crossref, Semantic Scholar),* were used to search for published articles, reports and other documents from public agencies – the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), National Agricultural Advisory Services (NAADS); Northern Uganda Social Action Fund (NUSAF); office of the prime minister; Uganda National Meteorological Authority (UNMA); national livestock policy frameworks: the National Development Plan IV (2025/26 – 2029/30) and related livestock sector policies, Uganda Bureau of Statistics (UBOS); research institutions: International Livestock Research Institute (ILRI), National Agricultural Research Organization (NARO); national public universities (Makerere, Kyambogo, Busitema, Gulu), international development agencies: Food and Agriculture Organization of the United Nations (FAO), United Nations High Commissioner for Refugees (UNHCR), district local governments, non-governmental organisations (NGOs) engaged or working in the pig sector in Uganda and media reports.

Harzing's Publish or Perish software (Harzing, 2007) https://harzing.com/resources/publish-or-perish/windows (*version 8. 18.5091*) was used to retrieve documents on the pig value chain in northern Uganda. The search methodology included one or more of the following terms in combination (using Boolean operators *"AND"* and "*OR*"): *Pigs, pork, value chain, livestock policy, northern Uganda, pig markets, veterinary services, pig feeds, reports, practitioners, herd health, bacterial, diseases, African swine fever, parasites, respiratory pathogens, cysticercosis, artificial insemination, antimicrobial resistance, antimicrobial use and zoonoses.*

Inclusion and exclusion criteria

The inclusion criterion was that an article(s), report, brief or any document should contain information on pig diseases, health, zoonoses, breeds, feeds, artificial insemination, antimicrobial resistance (AMR) and antimicrobial use (AMUSE) in pigs in mid-northern Uganda. All documents retrieved were read to check if the content matched

the inclusion criteria. The search was limited to the years from 2000 to 2025. Duplicate articles were checked and removed. Articles, briefs and reports that did not meet the inclusion criteria (e.g. reported studies in other regions, countries, other diseases or livestock species) were excluded. Due to their significance for the pig value chain, the national livestock sector policies and development framework documents from official government agencies were included. The search was conducted from 19-23 September 2025.

Results

Documents retrieval, analysis and presentation

All documents retrieved from online literature sources were saved as a CSV file and transferred to MS Excel for review, correction of errors and analysis. All document files from the search engines were subsequently checked for cites (number of citations for relevance), year of publication, title of document, source title (journal, report, book, website or other source), publisher name, author(s), a digital object identifier (DOI) and article link (URL). Of all literature sources obtained, a total of 706 documents (published articles, reports and media sources) were retrieved. Of these, 577 (81.7%) were published journal articles, 101 (14.3%) were official reports, briefs and posters while 28 (3.9%) were other information sources from print and electronic media. Table 1 shows a summary of results of the literature search. Out of the 795 documents retrieved, only 15.5% (n = 123) met the eligibility criteria and were included in the systematic review. Table 1 provides a summary of the number of documents retrieved.

Table 1. Summary of literature search, number and type of documents included and excluded

Search engine/ websites used	Document types retrieved			Total	Included	Excluded
	Published research articles	Official reports, briefs, posters	Other sources e.g., media			
Cross Reference	376	36	7	419	17	402
Google Scholar	176	43	15	234	25	209
Semantic Scholar	25	14	3	42	21	21
PubMed	201	0	0	201	38	163
Official websites	-	22	3	25	25	0
Totals	**577**	**101**	**28**	**708**	**125**	**795**

Of the 123 documents that met the eligibility criteria, 39 (31.2%) were found to be duplicates and were removed. Finally, a total of 86 (68.8%) documents were retained for the systematic review.

Uganda's national policy framework for the livestock sector

This review was guided by the fourth (4th) national development plan and related livestock sector policies including the following:

1. The 4th National Development Plan (NDP IV) – FY 2025/26 – 2029/30
2. Agriculture sector Ministerial Policy Statement for the FY 2025/26
3. The Infection Prevention and Control Plan (IPC) for the agricultural subsector
4. The Animal Diseases Act (Cap. 38, amended 2006)
5. The National Delivery of Veterinary Services Policy (2001)
6. The National Veterinary Drugs Policy (2006)
7. The Veterinary Practitioners Act (2024)

The 4th National Development Plan (NDP IV 2025/26 – 2029/30)

The NDP IV is a government of Uganda national development strategy and investment plan aimed to transform the national economy from subsistence to a resilient, self-sustaining economy by 2029/30. The NDP IV (MFPED, 2025) emphasizes increasing production and productivity as a means to achieve poverty alleviation. Achieving these strategic objectives requires increasing public investments in infrastructure and building the capacity of value chain actors. Under the NDP IV, the agro-industrialization component aims to increase production and productivity and harness opportunities existing in regional markets. The pig sector is a strategic subsector for northern region, given ample opportunities for local and export markets in neighboring countries, the Democratic Republic of Congo and South Sudan. For the livestock sector under NDP IV, government plans to strengthen the extension services system. Under the NDP IV, the following were the proposed intervention areas for the period FY 2025/26 – 2029/30:

- Conduct specialized training program for extension workers in specific livestock value chains
- Equip and facilitate extension workers to support the Parish Development Model (PDM)
- Roll out the ICT-enabled extension system in all subcounties in the country.

The Agriculture Ministerial Policy Statement for the FY 2025/26

The Agro-Industrialization program of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) aims to increase agricultural production and productivity. Under this policy, farmers with a small acreage of land are advised to engage in high value enterprises such as pigs. In the financial year (FY) 2024/25, the ministry of agriculture procured and distributed to farmers countrywide a total of 4,397 fast growing piglets of farmer-preferred breeds (Duroc, Large white, Landrace and Camborough). No information was available on the allocations of piglets by district and impacts of this program's intervention could not be established.

However, specific interventions (in herd health, welfare, nutrition and genetics) to achieve increased production, productivity and improved efficiency of the pig value chain were not spelt out. This probably left gaps and weaknesses in the ministry's intervention (in technical and management capacity of farmers). In addition, due to staffing gaps and funding limitations, the capacity of district veterinary services to provide the necessary advisory services and information to farmers is insufficient. Such gaps could have led to losses in production as farmers were inadequately prepared to properly manage pigs.

The National Delivery of Veterinary Services Policy (2001), the Animal Diseases Act (Cap. 38, amended 2006), the National Veterinary Drugs Policy and the Infection Prevention and Control Plan (IPC) for the agricultural subsector

The policy on *National Delivery of Veterinary Services* seeks to improve quality, coordination between public and private veterinary services and regulation of veterinary services to ensure effective control and prevention of livestock diseases. The *Animal Diseases Act* seeks to improve control and prevention of animal and zoonotic diseases, while the *National Veterinary Drugs Policy* seeks to regulate drug importation and distribution and monitor drug adverse effects in livestock in Uganda.

The *Infection Prevention and Control Plan (IPC)* for the agricultural sector (MAAIF, 2022) was designed to improve livestock health through enhancing biosecurity, develop the technical capacity of veterinary extension workers in disease surveillance, infection prevention and control of diseases, including antimicrobial resistance/ antimicrobial use (AMR/AMU). In addition, the plan aimed to equip farmers with knowledge to implement good farm biosecurity measures (MAAIF, 2022). This review is conducted to inform future interventions, which should align with the national policy and development framework of the government of Uganda over the coming years. It also provides a basis for the design of initiatives and interventions by development actors.

Besides the above development plan and policies, other policy instruments and byelaws by mandated government agencies and departments on livestock and food safety exist. For example, under the Local Government Act (LGA, 1997), districts are legally authorized to generate their own local development plans and mobilize local revenue. However, these must be within the broader national policy framework, laws, guidelines and regulations. At local level, a district may develop and impose local byelaws and ordinances on live animal movements (within the MAAIF guidelines and standard operating procedures for live animal movements), food hygiene and wastes management in pig slaughter facilities.

This review is part of the Sustainable Animal and Aquatic Foods (SAAFs) program *Area of Work* one (AoW1) designed to achieve the long-term vision of sustainably transforming agri-food systems in developing countries. It aligns with the NDP IV goal of increasing production, productivity and to enhance access to markets. The SAAFs program was designed to fit with the *CGIAR Impact Areas* that aim to improve (1) nutrition, health, and food security; (2) reduce poverty, improve livelihoods, and create more jobs; and (3) contribute to climate adaptation and mitigation.

Support programs to the pig sector by national public and non-governmental organizations

Several development programs are being implemented by public and NGOs in the region. For example, the Northern Uganda Social Action fund (NUSAF IV) under the office of the Prime Minister supports livelihood programs in livestock production and is being implemented in districts in northern Uganda. Its program objective is to improve livelihoods through increasing livestock productivity, incomes, enhance youth employment and mitigate against climate change (OPM, 2021). New innovations in herd health that increase pig productivity and reduce methane emissions align with these national support programs, government of Uganda (GoU) and the World Bank's climate mitigation strategy (World Bank, 2025). A few NGOs working in the region aim to improve people's livelihoods through pig production, but are constrained by low funding, technical, institutional and logistical challenges in the delivery of inputs and advisory services to farmers.

Pig production systems context in the mid-northern region

The 2021 national livestock census indicates that Lango and Acholi subregions of Uganda had a total population of 1,632,522 pigs, with 330,083 (32.3%) households involved in pig rearing (UBOS, 2024). The increase in the number of households that raise pigs (average 5 pigs/household), suggests a growing role of the pig sector to local household economy (UBOS, 2024). Local breeds are the most predominant breeds of pigs raised in rural areas under free range and free-range systems, while crossbreeds are raised under semi-intensive or intensive production systems. Table 2 shows a summary of the proportions (%) of farmers who raise pigs by subregion. It shows that in northern region overall, Teso subregion had the highest proportion of farmers who raise pigs (37.3%), followed by Lango and Acholi subregions.

Table 2. Proportion (%) of farmers keeping pigs and other livestock species by subregion

Subregion	Cattle	Goats	Sheep	Pigs	Chickens	Other poultry	Rabbits
Teso	56.6	58.8	31.4	37.3	83	19.4	3.4
Karamoja	67.8	66.3	50.9	9.8	76.7	8.8 2	0.3
Lango	47.3	53.9	12.4	**25.8**	87.1	12.4	2.2
Acholi	42.1	54.3	6.9	**22.0**	87.2	9.9	1.8
West Nile	26.6	68.9	23.1	19.6	76.8	11.5	4.2

Source: UBOS 2024

Table 3 shows pig management (rearing) systems and the proportion of farmers who practice each system in the region. In both Acholi and Lango subregions, only about 11.6% of pig farms were fenced, highlighting potential weaknesses in biosecurity practices.

Table 3. Summary of pig management systems and percent of farmers in each system

Region	Management system (% of households)			% of fenced farms
	Intensive	Semi-intensive	Free-range	
Central	41.8	30.4	15.1	33.0
Eastern	26.9	31.0	34.0	19.5
Northern	**9.4**	**20.4**	**27.5**	**11.6**
Western	48.0	34.4	16.1	24.6
Karamoja	17.1	18.0	54.5	17.3
UGANDA	**36.5**	**30**	**21.7**	**23.8**

Source: UBOS 2024

In this region, pigs are raised under three main (3) management systems: intensive, semi-intensive and free-range systems (Ngwili et al., 2025, Ouma et al., 2014). Most producers (> 70%) raise pigs in free range or semi-intensive systems, with little focus on use of improved production technologies (Ouma, 2017). It was reported that in Gulu and Omoro districts, 89% of households kept pigs as the main livestock species, and that income generation was

the primary reason for keeping pigs. However, the major constraints faced were high feed costs and endemic diseases, with up to 93.6% of farmers using local feedstuffs (Kasima et al., 2021). Another study showed that 38.8% of pig farmers practiced farrow-to-weaner production system, while significant predictors of weaner-to-slaughter system were market proximity and access to extension services (Adewale et al., 2025). Supporting farmers in extension services such as breeding management, feeding and marketing; and traders in transportation facilities was recommended.

This partly explains the low growth and productivity rates of pigs in the region, with adult pigs reaching market weights at 10 months or more. The average adult (7–10 months) live weights of slaughter pigs ranges between 50 –80 kg (*author's personal experience*). This is lower compared to developed countries where fattened pigs reach 105–115 kg live weight per pig at 6 months (~180 days). Extensive systems are associated with high risks and incidence of diseases as pigs easily get into contacts with other roaming pigs. Under these production systems, farmers' ability to prevent or contain disease outbreaks is hampered by knowledge and information gaps on health and biosecurity practices (Chenais et al., 2017) and limited investments in associated infrastructure.

Infrastructure for pig production, transportation processing and value addition

The 2021 livestock census showed that the region's infrastructure for pig production, slaughter, processing and value addition is poor and underdeveloped. This reflects poor production, productivity and efficiency of the sector. Other reports show that infrastructural facilities for pig production in the region are inadequate, and where available, are in a poor condition (MAAIF, 2022). The national livestock census report shows that only 22.8% of households in the region had provided housing to their pigs (UBOS, 2024). But even among those who did, most pig shelters available were improperly designed and constructed as they lacked basic facilities for optimal productivity and welfare of pigs (Ngwili et al., 2025). In this region, infrastructure for proper pig housing, heat stress mitigation, water supply, feeding, storage and associated equipment are limited or lacking (Okello et al., 2020, Gertzell et al., 2021 and Mutua et al., 2020), suggesting that welfare issues are likely compromised. A recent study that mapped regions of heat stress in pigs shows that most of the northern region of Uganda already experiences heat stress (Mutua et al., 2020). Key elements of housing, welfare and comfort (floor, roof, walls, space allowance, drainage and wastes management systems, heat stress mitigation, piglet care and comfort are often not factored during designs and construction, suggesting that these are often compromised (Zaake, 2019).

In addition, the supply of safe and clean water for pigs is often inadequate. Most farms use ordinary water troughs, plastic containers or cement structures inside pens to provide water for pigs. Such water supply systems are frequently prone to contamination, which compromises the welfare and health of pigs. Confinement of pigs with a specific focus on providing improved housing, water supply and welfare conditions reduces the risks and severity of diseases. Improving the health and welfare of pigs reduces the need for antimicrobial medications, thus potentially contributing to food safety and reduced AMR. It is a well-known fact that improved housing enhances health and welfare of pigs, enabling them to perform well under given conditions. Improving the livelihoods of smallholder pig farmers requires focusing attention to health and welfare – which integrates aspects of good nutrition, housing, health and biosecurity practices, as these are critical factors for the sustainability of pig production in the region.

Institutions and institutional arrangements in the pig value chain

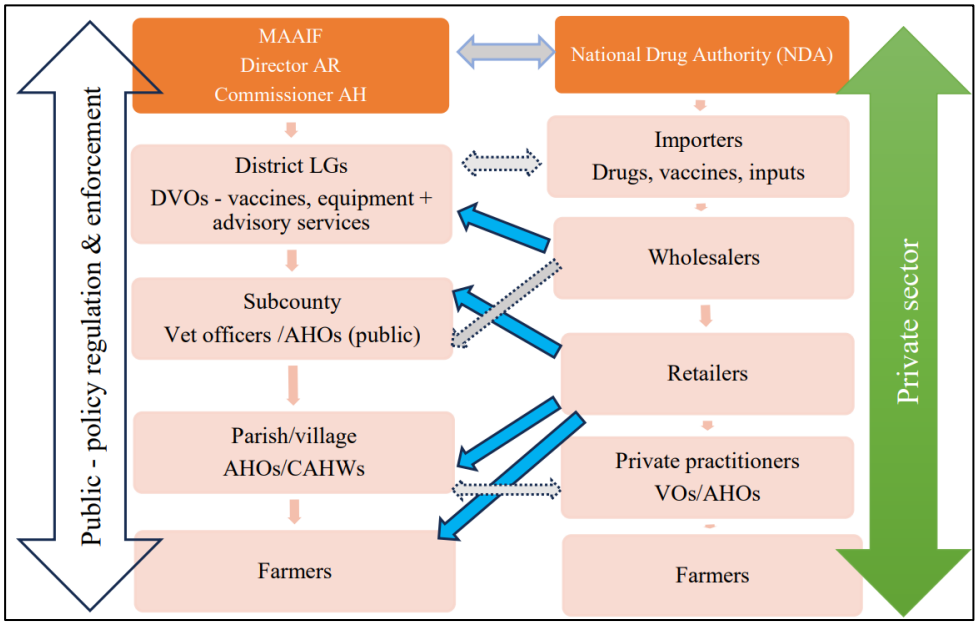
Structure, organization and quality of veterinary services

At national level, veterinary services are under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), headed by director animal resources (DAR). Under the DAR is the commissioner animal health (CAH) who oversees policy implementation and enforcement. At district level are district veterinary officers (DVOs). Under the district veterinary officer (DVO) are veterinary officers (VOs) and animal husbandry officers who oversee sub counties and parishes. Veterinary workers provide extension services to farmers at a cost recovery basis, as most diseases are by policy, the responsibility of the farmers. While government provides some logistical infrastructure such motorcycles and fridges for storage of vaccines, these are generally ill equipped and often inadequately maintained due to poor funding (Arvidsson et al., 2022; Ilukor et al., 2015). This organizational structure is summarized in Figure 2.

In terms of staffing, the number of veterinary extension officers is low compared to the number of farmers they serve in each area (MAAIF, 2022). Veterinary practitioners can be veterinarians, paraprofessionals or community animal health workers (CAHWs) with varying levels of training and competencies. Due to a low ratio of veterinary extension workers to farmers, those in practice often get overwhelmed by too much workload. Partly due to such human resources gaps, some untrained practitioners take advantage of farmers by selling low quality or expired veterinary inputs or unduly charge high service fees. One such practitioner claimed to vaccinate pigs against African swine fever in Lira District, despite no existence of such a vaccine to-date (author's personal experience). This is exacerbated by the lack of specialized training of veterinary students and paraprofessionals on pig herd health and production, a component that has not received much attention in public training colleges and universities in Uganda. Many private practitioners are inadequately trained in pig health and welfare, and as such

are ill equipped to provide technical support to farmers. This has been observed in Mukono, Wakiso, Karamoja and other northern Uganda districts (FAO, 2021; Arvidsson et al., 2022). NDA is a public agency that regulates the manufacture, importation and monitors adverse effects of drugs and vaccines. In Figure 2, the blue arrows show stronger relationships; grey arrows show weak relationships between VC actors. The figure illustrates the structure of veterinary services, its relationship with national drug authority (NDA); the flow of inputs from importation to farmers and the role of other private sector players.

Figure 2. Structure and organization of veterinary services (left) and a supply chain of inputs – drugs, vaccines, tools and equipment from importers to farmers (right) in mid-northern Uganda.



In this figure, the flow of services and inputs to farmers is determined by the number of active practitioners, the social relationships (and cooperation) between public and private veterinary practitioners, and the costs, as well as quality of inputs and services. Other factors such as distance travelled, number of farmers in each area, affordability of inputs and services and social relations determine the level of delivery of veterinary services. In some cases, farmers buy drugs and other inputs directly from drug shop retailers and administer to their pigs. However, most drug shop attendants are untrained and technically unable to provide proper technical advice on pigs to farmers, leading to possible drug misuse as reported elsewhere (Ouma et al., 2021). A study recommended that extension services tailored to pig production systems should be made available to farmers to enhance productivity, efficiency and to bridge the information gap between research institutes and farmers (Adewale et al., 2025).

Another challenge faced by veterinary services in the mid-northern region is weak enforcement of regulations in the supply and distribution of veterinary inputs such as drugs and vaccines. It was reported that within a week of October 2019 alone, 23 illegal veterinary drug shops were closed by the National Drug Authority (NDA) out of 92 shops inspected in northern Uganda (*Daily Monitor, 19 October 2019*) due to noncompliance with regulations and employing unqualified personnel. This demonstrates the level of unethical conduct and potential abuse in the veterinary drugs market in the region. In the IGAD region, it was reported that in the border areas of Uganda and South Sudan, the most frequently illegal (expired, understrength, diluted, adulterated or fake) veterinary medicines as perceived by supply chain stakeholders were *antibiotics, anthelmintics, trypanocidals, acaricides* and *vaccines* (ICPALD, 2021). The estimated prevalence of illegal drugs reported by different supply chain stakeholders in Uganda ranged from 1-33% (ICPALD, 2021). The sale and distribution of poor-quality veterinary drugs, coupled with ill trained personnel illustrates the magnitude of possible drug misuse and abuse by value chain actors in the region, which could have adverse implications for animal and public health. To enhance the contribution of the pig subsector to improved incomes among pig producers, the quality of, and access to veterinary services in rural areas is important (Arvidsson et al., 2022, Ilukor et al., 2015, Arvidsson et al., 2023).

Access to veterinary extension services

The 2021 national livestock census reported that a majority (71.5%) of livestock keeping households received livestock extension services from private veterinarians (UBOS, 2024). For the pig sector, up to 70% of farmers access veterinary services from private veterinarians. Because veterinarians are fewer, the provision of veterinary

services in the region is poor for profitable pig production. As a result, when faced with animal health problems, farmers employ various strategies such as self-administering antibiotics, deworming, use of local herbs to treat pigs and burying dead pigs and resorted to other means of treating sick pigs (Okello et al., 2022, Gertzell et al., 2021). In Lira District, it was reported that farmers had less access to veterinary services, used less disease preventive measures and used more antibiotics (Nohrborg et al., 2022). Similar findings were reported in Karamoja subregion where effectiveness of veterinary services delivery was hampered by limited access to logistics such as cold chain facilities, vaccines, a poor road network and inadequate training of para-veterinarians (Abebe, 2016). A study reported that access to extension services and credit were key determinants of innovation behavior among pig farmers in northern Uganda (Mugonya et al, 2019). This reiterates the role of credit and extension services in adoption and adaptation of new innovations by farmers. In short, there is poor organization of the pig value chain, and a weak veterinary extension services system, which explains knowledge and information gaps among farmers on improved methods of pig production. Accordingly, we strongly recommend building the technical and institutional capacity of public and private veterinary practitioners to enhance the success of development programs. From a synthesis of VC assessments, we present a supply chain map of veterinary drugs, vaccines and related inputs from importation to farmers. Figure 2 also illustrates the inter-relationships of various actors involved and their roles in the supply chain.

Current animal disease surveillance systems

By policy, disease surveillance is the mandate of the directorate of animal health at the agriculture ministry. Working with district veterinary staff, DVOs are mandated to report outbreaks to the ministry, which then institutes investigations. However, logistical constraints of poor funding and inadequate staffing limit effectiveness of disease surveillance systems. Preparedness and outbreak response capacities at both national and district levels are weak and inefficient. Because of this, disease detection takes time, limiting the ability of district veterinary departments to promptly detect and respond to disease outbreaks. In the context of African swine fever (ASF) which is highly endemic in the region, quarantines imposed by the commissioner animal health are often ineffective to contain further spread of outbreaks partly due to weak enforcement of regulations. As a consequence, disease outbreaks often spread to more districts and sub counties, and take longer to be contained, subsequently leading to heavy devastation to farmers and traders.

Key actors, structure and organization of the pig value chain

Several actors are involved in the pig value chain in the two northern subregions. Key node actors in the value chain include inputs and services providers, producers (farmers), aggregators, transporters, butchers, retails agents and consumers (Ngwili et al., in press). Linkages between nodes and actors are informal, implying weaknesses exist with each node having unique gaps, constraints and challenges. The pig sector in the region is not organized and characterized by limited institutional arrangements (Ouma et al., 2017). Forward and backward linkages between the value chain actors are weak or non-existent, suggesting value chain inefficiency. It has been reported that actors have limited access to knowledge and technical information required for production. For example, the provision of veterinary services is inadequate (Ilukor et al., 2015), and coupled with limited access to production inputs, the sector remains underdeveloped. Studies show that pig production in the region, slaughters and marketing occur in informal channels. In these settings, pork inspections by public veterinary workers to ensure the safety of pork for consumers are often inadequate or non-existent. To transform the pig sector, effective institutions, technical and logistical capacity of actors, and efforts to develop viable market systems are needed for an efficient and sustainable value chain.

Support services – production inputs and service providers

This review found that while various inputs and service providers were operational in some districts, their scope and extent of services provided to pig farmers were limited. For example, all community breeding ranches under the National Animal Genetic Resources and Data Bank (NAGRC & DB) in northern Uganda (Aswa ranch in Pader/Lamwo districts, Got-Apwoyo ranch in Nwoya District and Maruzi Ranch in Apac District) provide artificial insemination (AI) services and feeds for cattle and goats, but not for pigs. For feed producers, most businesses were engaged in the production and sales of poultry feeds and ingredients. While feed business traders are engaged in buying and selling of ingredients such as maize bran, cotton and soya seed cakes, fish meal, concentrates and mineral supplements, their numbers and scope of business could not be established due to lack of information. Similarly, we could not establish the number of actor(s) engaged in forage seed business(es) in the region. No information or evidence of business linkages between actors was found, suggesting gaps in access to required inputs and services by farmers. Improving access to production inputs by farmers requires strengthening business linkages between the different value chain actors – feed producers and artificial insemination service providers). A summary of identified constraints and suggested interventions at each value chain node is presented in Table 4.

Table 3. Summary of key constraints and suggested interventions for each level of value chain node

Value chain node and actors	Key constraints	Suggested interventions
Inputs and services • Animal health services • Feeds & forages • AI services	• Weak institutional linkages with other actors, especially farmers • Insufficient technical capacity in pig health, biosecurity and welfare • Limited ability to provide required production inputs to farmers	• Build the capacity of service providers through training • Co-design a business model to improve the delivery of herd health services with stronger linkages with other value chain actors
Production farmers	• Knowledge and information gaps on pig health, biosecurity and welfare • Limited access to production inputs and services	• Co-design, test and evaluate context-specific herd health innovations
Aggregation • Aggregators • Transporters	• Low technical capacity in pig health, welfare and biosecurity • Lack of formal business arrangements with farmers	• Build the capacity of farmers and advisory services providers
Slaughters • Butchers • Pork traders • Retailers • Transporters	• Gaps in knowledge on zoonoses, food hygiene and safety • Gaps in knowledge of pig health, biosecurity and welfare	• Co-design, test and evaluate food safety interventions targeting private public and sector players • Capacity building
Consumers	• Gaps in knowledge on food hygiene and food safety risks/hazards	• Quantify public health, economic and financial costs of food-borne hazards • Co-design, test and evaluate impacts of interventions on incidence of zoonoses and food-borne diseases

Structure and organization of the marketing node of the pig value chain

In the region, there are no formal organizational arrangements for the marketing of pigs and pork products. Individual traders buy pigs from farmers from local markets or at farmers' homesteads, increasing the risk of diseases such as ASF as most farms do not have, or even implement any farm biosecurity procedures. No contractual arrangements are made between traders and pig farmers, which creates a power imbalance during price negotiations to the disadvantage of farmers.

Regarding processing facilities, most districts do not have designated and standard slaughter facilities for pigs. Pig slaughters occur in informal settings (backyard slaughters) that are not usually inspected by veterinarians. Under such conditions, uninspected, unhealthy pork may end up in the human food chain, potentially exposing consumers to food borne hazards. The lack of inspections during slaughters poses significant risks of diseases such as porcine cysticercosis and trichinellosis. This calls for context-specific interventions to reduce the risk of food-borne hazards along the pork value chain.

Under the current agro-industrialization (AGI) program, government promises to support cooperatives or associations to construct processing and value addition facilities (subject to funding availability). Because such cooperatives or associations in the region are lacking or are poorly organized, such opportunities may not be tapped to improve the supply, quality and marketing of pork. A policy brief by the Economic Policy Research Centre (EPRC) recommended strengthening of livestock associations, support coordination and partnerships between value chain actors (EPRC, 2021).

Current research efforts on endemic pig diseases

Parasitic diseases – Taenia solium cysticercosis

Studies show the region is endemic for porcine cysticercosis (Kungu et al., 2019; Ngwili et al., 2021, Ngwili et al, 2025a). Porcine cysticercosis is a zoonotic parasitic disease of pigs and humans that is endemic in Uganda. The World Health Organization (WHO) reports that cysticercosis is a neglected zoonotic disease (WHO, 2019). In a study in four districts of northern Uganda (Kitgum, Lamwo, Agago and Pader), the seroprevalence of porcine cysticercosis was reported to be 17.4% (95% CI 15.1 – 19.7). Older pigs and free roaming of pigs were identified as risk factors for the infection. The presence of a toilet in a household was protective against infection (Ngwili et al., 2025a). The findings agree with another study in Amuru and Gulu districts which identified free ranging of pigs as a risk factor for porcine cysticercosis (Alarakol et al., 2020). Confinement of pigs is a recommended practice to curb disease spread (Hasahya et al., 2021). While *T. solium* infection in pigs remains a major public health hazard in the region, it also contributes significant economic losses to farmers since traders often reject (to buy) affected pigs when they detect cysts under the tongue. As a leading cause of pork condemnation, it adversely affects livelihoods of farmers (Ngwili et al., 2025a).

Studies reveal that socio-cultural, economic and environmental factors play a role in perpetuating the transmission of the parasite. The northern region was identified as an epidemiological hotspot for *T. solium* due to three factors: low latrine coverage, high pig density, improper cooking of pork and extensive production system (Ngwili et al., 2025b). Other sociocultural factors such as local beliefs and open defecation in communities expose pigs to risks of *Taenia solium* infection (Ngwili et al., 2025b).

In Lira District, the sero-prevalence of *Taenia spp.* serum antigen was found to be 6.9% (95% CI 2.9 – 13.9). This compares with findings in Kamuli and Hoima districts where the pig-level seroprevalence of porcine cysticercosis was reported to be 4.8% (95% CI 2.7 – 7.1) using a commercial enzyme-linked immunosorbent assay (Ngwili et al., 2022). The same study reported co-infections of *Taenia solium* in pigs with other gastro-intestinal parasites. In Lira District, co-infections of gastro-intestinal parasites with respiratory pathogens were reported (Oba et al., 2023). In the Lake Kyoga region (Lira, Apac districts), using *HP10* Antigen ELISA, the prevalence of PC in pigs was found to be 25.7% (95% CI 21.0 - 30.0%) (Nsadha et al., 2014). In Oyam District, a study determined overall prevalence to be 27% by lingual examination and 33% by cysticercosis *Ag ELISA* (Were et al., 2025), suggesting widespread presence of the parasite in pigs in the region.

Control of *Taenia solium* cysticercosis

Control of this parasite relies on breaking the transmission cycle in pigs through confinement, treatment of pigs, vaccination and public health education to encourage social behaviour change on practices such as open defecation (Ngwili et al., 2023, Kungu et al., 2019). In recognition of the disease burden particularly in resource limited settings, the FAO, WOAH and WHO agreed to work together (under the One Health framework) to control neglected parasitic zoonoses (*Taenia solium*, Trichinella, Echinococcosis and Fasciola) through improving coordination and collaboration between the different sectors (WHO, 2019).

In a study to understand the willingness to pay for the *T. solium* TSOL18 (Cysvax™) vaccine, farmers were willing to pay up to USD 2.31 (approx. UGX 10,000) if that resulted into a higher price for vaccinated pigs (Ouma et al., 2021). In addition, they demanded for a vaccine viability detector as a quality assurance mechanism, while pig traders demanded for a higher carcass weight produced by oxfendazole. A related study conducted in Bukedea and Kumi districts in eastern Uganda found that three-monthly concurrent vaccination of pigs with TSOL18 (Cysvax™) vaccine and oral treatment of pigs with oxfendazole eliminated *T. solium* transmission (Nsadha et al., 2021). These findings suggest that unless incentives for better prices for vaccinated and treated pigs are established, farmers are unlikely to adopt vaccination as a preventive measure against the parasite.

Apart from cysticercosis, no detailed studies have been conducted in the region for other zoonotic parasitic diseases. Given the socio-cultural context of community practices in the region, the occurrence of other zoonotic diseases such as brucellosis, trichinosis and echinococcosis cannot be ruled out, since veterinarians often overlook these zoonoses (Dione et al., 2014). The predominant practice of free ranging of pigs is associated with zoonotic infections such as *Taenia solium* (Ngwili et al., 2025b, Kungu et al., 2019), *Trichinella spp* and *Toxoplasma gondii* as reported in eastern and central Uganda (Roesel, 2018). There exists knowledge and information gaps on epidemiology of other important zoonoses in pigs in the region, which justifies further investigations.

Research efforts on other parasitic diseases

In addition to zoonotic *T. solium* infections, other external and internal parasites are highly endemic in the region. The critical role of management in the growth and productivity of pigs in the region is documented (Gertzell et al., 2021, Oba et al., 2023a, Roesel et al., 2018) and that infection with PRRSv and *Ascaris spp* nematodes reduced

weight gains although non significantly (Oba et al., 2023b). Co-infections with *Ascaris spp* and *Strongyles spp* helminths were identified as risk factors for porcine circovirus and *M. hyopneumoniae* infections (Oba et al., 2021, Oba et al., 2023a). These reports highlight the problem of parasitic infestations and their potential impacts under current production systems in the region and underscore the need for scalable interventions.

Research on infectious diseases of pigs

African swine fever (ASF)

ASF causes severe social and economic impacts both in high income and low-income settings (Sanchez-Vizcaino et al., 2013). In the northern region ASF is endemic, with outbreaks reported annually in various districts (Chenais et al., 2017, Okello et al., 2022; Dione et al., 2014). In the last five years alone, ASF outbreaks have been reported in Gulu, Amuru, Nwoya, Lira, Apac, and Kitgum districts (MAAIF, 2022, Barongo et al., 2015). In Uganda, only genotypes *IX* and *X* have been described (Okwasiimire et al., 2023; Masembe et al., 2018, Kabuuka et al., 2023). A study reported that ASF outbreaks were more prevalent in border districts and that pig movements due to trade (OR 15.5, CI 4.9–49.1) and restocking (OR 6.6, CI 2.5–17.3) were major risk factors for ASF transmission (Atuhaire et al., 2013). Elsewhere in Uganda, routine cleaning of pens and perimeter fences were protective against ASF outbreaks (Dione et al., 2017).

The economic effects of ASF range from mortalities, lost business, control measures imposed such as quarantines and reduced value of sick pigs (Dione et al., 2017, Arvidsson et al., 2022). In a study in northern Uganda, a reduction of 48% in pig population was reported in ASF-positive households, compared to a reduction of 2 % in the ASF-negative households (Chenais et al., 2025). During ASF outbreaks, farmers were the most affected with foregone income from unsold pigs, increased costs of feeding sick pigs and biosecurity measures (Aliro et al., 2023). Reduced pig numbers also imply lost business for butchers as they are compelled to travel longer distances and spend more time in search of pigs to slaughter. Pig traders in Pallisa, Kumi and Soroti districts report similar challenges after ASFV outbreaks (*personal observation*).

Prevention and control measures against ASF

As currently there is no vaccine or drug against ASF infection, farmers frequently employ various strategies to contain outbreaks or minimize the effects of the disease. These include selling sick pigs (panic sales), burying dead pigs, slaughtering sick pigs and selling the pork in a nearby butcher or giving out to other people (Chenais et al., 2017, Okello et al., 2022). While these strategies are adopted in attempts to recover part of the costs incurred in raising pigs, these may inadvertently aid in spreading the disease. This is understandable as by policy, there are no government compensation mechanisms to farmers whenever outbreaks occur. Research to identify socio-cultural barriers to adoption of biosecurity practices for the control of ASF to enable design of interventions are needed (Aliro et al, 2021).

At national and local level, when an ASF outbreak is reported or suspected, the district veterinary officer through the chief administrative officer notifies the commissioner animal health at the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), who then instructs the national animal diagnostic and epidemiology centre (NADDEC) in Entebbe to make a field visit to the affected district or subcounty. During the field visit, the NADDEC team shall collect samples from pigs for laboratory testing to confirm or rule out the outbreak. This normally takes about one week, and if the outbreak is confirmed, the commissioner is legally authorized to institute control measure through imposition of a quarantine in the affected district(s) or sub counties for such a time until the outbreak is contained. During a quarantine period, no movements of pigs or pig products into or out of the district are allowed, and district veterinary staff, working with local law enforcement officers are required to enforce it. However, due to logistical challenges, poor funding and interference by some leaders, enforcement remains weak. Illicit trade in pigs and pig products by some traders and farmers continues in total violation of quarantine restrictions, potentially aiding further disease spread.

ASF remains economically disastrous and negatively impacts the livelihoods of farmers and other value chain actors. In Lira District, traders and butchers often reported traveling to other districts, covering distances of over 70 km in search of pigs to slaughter after ASF outbreaks(s) wipes out a significant number of pigs in the district. Acceptance of interventions to contain the spread of ASF was reported to depend on local community beliefs, farmer perceptions of effectiveness of biosecurity interventions, slaughter and consumption of ASF-infected pigs (Chenais et al., 2019). This conforms with previous studies which highlighted the role of people's behaviour in the adoption of ASF control measures (Dione et al., 2021). Farmers expressed a need for veterinary knowledge and information to help them control African swine fever and other diseases of pigs (Arvidsson et al., 2023). Measures to prevent ASF outbreaks and limit further disease spread will need to be contextualized to local socio-cultural beliefs, costs of interventions, and perceived benefits as critical factors for adoption of recommended biosecurity practices.

Bacterial diseases - enteric bacterial infections and other infections

Pig diseases account for significant economic losses to farmers and other value chain actors in the region. For example, total morbidity and mortality from five major diseases - that is, African Swine Fever (ASF); FMD, helminthiasis, mastitis, metritis, and agalactia complex and swine erysipelas - is estimated to account for about 31% and 23%, respectively (Tatwangire, 2014). While these are estimated direct losses, other indirect losses from reduced weight gains, increased costs of treatments (Oba et al., 2023) and biosecurity measures, low prices of affected pigs remain unknown or likely underestimated. A high incidence of piglet mortality, morbidity and stunting are documented in the region, but the probable causes are not fully known (Gertzell et al., 2021; Oba et al., 2023, Okello et al., 2022), as are poor welfare issues – in housing, heat stress, spacing and wastes management.

Non-typhoidal Salmonella (NTS): A study conducted in Gulu and Soroti districts reported a high prevalence of infection of piglets and weaners with diverse non-typhi Salmonella serovars (Ikwap et al., 2014). A related study reported occurrence of antibiotic-resistant *Staphylococcus spp.* and *Escherichia coli* in smallholder pig farms in Lira District (Ikwap et al., 2021). Another study revealed occurrence of NTS in pigs, pork, contact surfaces and slaughterhouse workers in Lira District (Kivali et al., 2024). The potential role of pork and pork products as sources of these organisms for humans may be significant (Ikwap et al., 2014, Roesel et al., 2018). Occurrence of NTS in slaughterhouse workers demonstrates the potential risk of spread of NTS from slaughterhouse workers to pork consumers, highlighting a need for enhanced public health measures, sanitation during pork processing.

Antimicrobial use (AMUSE) and antimicrobial resistance (AMR)

The use of antimicrobials to treat pigs is widespread in the region (Nohrborg et al., 2022; Dione et al., 2021). In a study that investigated the influence of geographic and socio-economic factors on the use of antibiotics, it was reported that farmers in Lira District used more antibiotics than farmers in Mukono District (Nohrborg et al., 2022). This suggests that the frequency and magnitude of AMUSE is closely linked to the production systems used, level of access to veterinary services, education level of farmers, local beliefs and perceived treatment outcomes. Increased use of antibiotics and other drugs raises the risk of antimicrobial resistance (AMR), a growing public health concern in many developing countries.

A recent study in Lira and Mukono districts in Uganda revealed that nearly 90% percent of drug retailers and veterinary practitioners had no specialized training in veterinary medicine, and most of them had been in the drug business market for more than 10 years (Dione et al., 2021). This study revealed that antibiotics and anthelmintics were the most stocked drugs, with antibiotics contributing about 33% of practitioners' profits. This study revealed factors associated with drug misuse that could drive AMR as low education level of supply chain actors particularly drug retailers, poor handling of drugs at purchase and usage, poor enforcement of policies and regulations and lack of awareness of stakeholders about policies that regulate drug use (Dione et al., 2021). Efforts to reduce the use of antibiotics and antimicrobials to minimize risks of AMR through capacity building of actors in herd health and biosecurity are needed. Such interventions could potentially improve food safety as less drugs end up in the human food chain.

Status of pig herd health and reproductive problems research

Most farmers use a boar for breeding, as access to artificial insemination services is still limited for most farmers. Often, a boar is shared between farms, which increases the risk of transmission of ASF and other infectious diseases between herds and pigs. A recent study (2021) conducted in Lira District reported that sows produced on average 1.6 litters per year and 8.2 piglets born alive per sow per litter and that the average daily gain (ADG) for growers was 101 grams/pig/day, while mortality in growers was 9.7% (Gertzell et al., 2021). This is comparable to our study in the same location, which reported the mean ADG in pigs to be 119 grams/pig/day (Oba et al., 2023). Stunting in weaner and grower pigs is prevalent in the region, and the potential role of vertically transmitted diseases (e.g. PRRSv, PCV2, parvovirus) and other infections cannot be overlooked. Infertility conditions such as abortions, stillbirths, prolonged dry days, and the low number of piglets born per sow per year have been reported in the region, but their possible association with health issues has not been established and need further investigations.

Pig manure, health and climate mitigation

The role of pig manure and its impact on the health of pigs, people and the environment has been highlighted. Pig manure emits gases such as methane, nitrous oxide and nitrogen to the atmosphere and this generates a foul smell (Wanyama et al., 2021). Apart from their contribution to global warming, the foul smell that emanates from pig rearing is a public health hazard and can cause social conflicts with neighbours. In the northern region, no studies have been conducted to understand manure management practices used by farmers and associated impacts. In a study by Chenais et al., 2017, an outbreak of ASF was reported in a farm with poor manure management practices. The role of manure in the transmission of ASF has been reported, as virus is able to survive in faeces at room temperature (21 °C) for at least 3 days, but less than 5 days (Davies et al., 2017). If improperly disposed of, manure can also become a transmission pathway for other infectious and parasitic agents.

One Health, zoonoses and food safety issues

Several zoonotic diseases have been reported in pigs in Uganda. Zoonotic *Leptospira spp* were detected in pigs slaughtered at Wambizzi abattoir in Kampala; however, the pigs were sourced from different districts in the country (Atherstone et al., 2020). Several zoonotic infections including anthrax, zoonotic influenza viruses, Crimean Congo hemorrhagic fever, rift valley fever, leptospirosis, tuberculosis, and brucellosis exist (Nannozi et al., 2022; Sekamatte et al., 2018). The detection of these zoonotic pathogens in pigs from different regions of the country suggests they may also occur in the northern region. A study documented the prevalence of *Brucella spp* antibodies in pigs from Lira District to be 2.8% (95% CI = 1.1-2.9%) when tested by the Rose Bengal Test (RBT) and Native Hapten (NH) immunoprecipitation tests (Bugeza et al., 2023).

Other than *Taenia solium* cysticercosis, limited or no studies on other zoonotic diseases have been conducted in the region and their potential importance in the health and welfare of pigs, and public health remains unknown. In a cross-sectional study of *Leptospira spp* in pigs, goats and sheep, pigs sourced from the northern region (Lira District) were more likely to be seropositive (OR = 3.56, 95% CI 2.52-5.02) when tested by the microscopic agglutination test suggesting exposure of pigs to pathogens (Alinaitwe et al., 2024).

The national One Health framework is a multi-sectoral framework involving different institutions established to strengthen early disease detection, surveillance and response capabilities in humans and animals, including environmental hazards (MAAIF, 2022). Building and sustaining strong partnerships is a key component of this initiative, as outlined in the national One health framework *(*Sekamatte et al., 2024*).* In this framework, the establishment, technical capacity and coordination mechanisms of the rapid response teams at district level is a key aspect for preparedness response capacity. In practice, such structures are weak or non-existent due to various factors.

To overcome identified herd health challenges, there is a need to design scalable interventions from production to the consumer node of the pork value chain: improving access to inputs, drugs and vaccines, veterinary services and information, as well as build technical capacity of actors to manage and control endemic diseases. A welfare-based herd health management approach will be vital in this respect.

Weaknesses in national livestock sector policies

Despite its growing role in incomes, employment and food security of many households, the pig sector does not receive sufficient attention from public sector actors. The NDP IV specifically targets increasing production and productivity by (1) strengthening agricultural extension systems (2) improving vectors, pests and disease control systems (3) increasing investments in agro-processing facilities. A Regulatory Impact Assessment (RIA) carried out in 2022 by the ministry of agriculture on animal disease prevention and control identified the following key issues and causes (MAAIF, 2022):

1. Inadequate, weak animal movement control and poor disease control infrastructure (laboratories)
2. The Animal Diseases Act (amended 2006) does not specifically address the emerging issues in the pig subsector. For example, under the current disease control policy, vaccines against diseases that are considered public goods (e.g., rabies, contagious bovine pleuropneumonia (CCBP), anthrax, contagious caprine pleuropneumonia (CCPP), peste des petits ruminants (PPR) and foot and mouth disease (FMD) are subsidized and are the responsibility of the public sector, leaving out vaccines for pigs (MAAIF, 2022).
3. The *Animal Diseases Act* which bans night-time transportation of animals does not address issues of heat stress in pigs. As proposed by ILRI, this *Act* be revised to allow night-time transportation of pigs to reduce heat stress and reduce associated mortalities (Mutua et al., 2020, Zaake et al., 2019).
4. Under the *Animal Diseases Act*, outbreaks of ASF in pigs are controlled through imposition of a quarantine. However, such blanket imposition punishes all farmers in an area regardless of their level of implementation of farm biosecurity practices. Such a policy does not incentivize farmers to adopt recommended biosecurity measures to curb further disease spread and discourages them from reporting outbreaks to authorities. Under the World Organization for Animal Health (WOAH, 2024) guidelines on zoning and compartmentalization, farms can be allowed to market their pigs provided they have implemented sufficient biosecurity compartments or partitions which ensure they remain disease-free even within a disease outbreak region (Costard et al., 2022). Such disease-free status is established by a competent veterinary authority (MAAIF/CAH). Such a policy change could motivate farmers to institute biosecurity compartments, demand and pay for diagnostic testing, which facilitates early disease detection and response (Costard et al., 2022; WOAH, 2024).
5. The RIA recommended that the National Development Plan (NDP IV) and agricultural sector strategic plan (ASSP) be revised to prioritize and increase public investments in the pig sector. While the NDP IV and the agricultural ministerial policy statement mention public support for investments such as pig processing facilities (e.g., abattoirs and slaughter slabs), farmers associations or cooperatives through which this support

can be channelled are still weak in terms of managerial capacity. There is a need to first build management capacity of farmers and traders to efficiently run their associations and cooperatives before such infrastructure is built, otherwise such efforts may fail. Findings from a recent study recommended institutionalisation of the pig value chain to take advantage of cooperative marketing (Ngwili et al., *in press*).

Summary of strengths, weaknesses, opportunities and threats (SWOT) analysis

It is clear from the above review that several constraints exist in the pig value chain in the region. While these constraints and challenges have adverse impacts on pig production and livelihoods of value chain actors, they also present significant opportunities for interventions. New and existing technology innovations that have proven effective elsewhere can have a dramatic effect on economic prospects of pig farmers in this region. These technology innovations, however, need to be contextualized to existing socio-cultural settings and practices obtaining in the region. The increased involvement of women and youth in pig production and other nodes in the value chain offer opportunities for reducing poverty in these segments of society. A summary of existing strengths, weaknesses, opportunities and threats (SWOT) identified in the pig value chain in the region is presented in Table 5.

Table 4. Summary of existing strengths, weaknesses, opportunities and threats (SWOT) identified

Strengths	***Weaknesses***
• Rapid growth in human population, providing a large market for pigs, pork and pork products • High demand for pigs and pork in and outside the region (DRC, South Sudan) • Changing consumption patterns of the population in preference for pork • Increased willingness and participation of actors to adopt new technologies, innovations and practices • Availability of vast, fertile lands for feeds and pig production • Willingness of farmers to increase pig production and use of improved technologies	• Lack of specific national supportive policy for the pig subsector • Weak institutional structures and arrangements for marketing of pigs and pork products • Low production and productivity of pigs – due to poor feeding and inferior genetics • Limited access to production inputs, drugs, equipment, quality feeds and breeding services • Poor infrastructure for processing and value addition
Opportunities	***Threats***
• Proximity to larger markets for pork in the DRC and South Sudan • Knowledge and information gaps among farmers, input dealers and veterinary practitioners • Lack of structural organization of the pig value chain • High levels of poverty and unemployment in the region • Availability of vast, fertile land and a good climate for production • Inefficient supply and delivery systems of inputs and services	• Endemic diseases, particularly ASF, zoonoses and other diseases • Land grabbing and social conflicts • Community attitudes, norms and practices that increase risks of disease spread e.g. free ranging of pigs, open defecation, et • Cultural, gender-related norms and practices that discourage investment in the sector

Conclusions and recommendations

Summary of research gaps identified to inform future studies

This review highlights the status of pig production, key herd health constraints, challenges and opportunities that can be tapped by value chain actors in the mid-northern region. Despite challenges of weak institutions, endemic diseases, limited infrastructure, information and knowledge gaps among actors, the region has immense potential to transform the livelihoods of people if targeted investments by government and development partners can be made. The success of pig production in the region should consider societal values which emphasize collective efforts to uplift everyone and not individuals in development programs. Other social factors such as jealousy, social welfare and community wellbeing need to be considered in designing interventions, as has been previously suggested (Arvidsson et al., 2022). The following is a summary of key gaps identified for possible interventions:

Gaps in herd health, welfare and biosecurity management

This is informed by a high incidence of endemic diseases, welfare and health challenges, accounting for low productivity. Context-specific and scalable interventions in health and biosecurity measures against ASF and other diseases at farm, transportation and marketing (slaughtering) node of the value chain are needed.

Gaps in the delivery and staffing of veterinary services at district local governments

Gaps and weaknesses exist in the delivery of veterinary services and inputs through interventions such as capacity development of veterinary practitioners and farmers; focusing on a herd health management framework, welfare issues such as pig housing, sow and piglet care and management aspects will be key to improve production and productivity of the subsector. While there is a need to recruit more veterinary extension workers to support farmers, our focus should emphasize capacity building and the use of digital tools to facilitate the delivery of veterinary services and technical information to farmers.

Gaps in institutional arrangements input supplies and services

Weaknesses are identified in the market systems for inputs, veterinary services and finished products. Using a market systems approach, an institutional framework needs to be established to enhance farmers' access to quality veterinary services, related inputs, pigs and pork markets by creating stronger linkages between actors. This would incentivize farmers to produce for the market and improve the safety of pork and its products.

Gaps in transportation, slaughter and pork processing node

This review highlights absence of formal pig slaughter and processing facilities, institutional arrangements and capacity of actors in this node of the value chain in the 2 subregions. While small-scale slaughter facilities exist in urban and rural areas, these are generally informal, often not regulated or inspected by health and veterinary authorities. Under the ministry of agriculture's ministerial policy statement for FY 2025/26, government committed to support farmer associations or cooperatives in the construction of value addition infrastructure such as processing facilities (MAAIF, 2022). This is feasible, but building the capacity of actors in this node is critical for sustainable operations and management.

Way forward / recommended research interventions

Based on key gaps, constraints and opportunities identified, the following herd health research interventions in the region are recommended:

Interventions to improve herd health, welfare and productivity

1. Co-design and evaluate with pig VC actors, a context-specific herd health intervention package for the subregion to improve herd productivity in farms. Under these, the focus should be on innovations to improve and optimize housing, health, biosecurity, nutrition and welfare management.
2. Contextualize factors to identify barriers to adoption of herd health and biosecurity measures against ASF and other infectious diseases.
3. Undertake studies to increase production efficiency and profitability in the value chain
4. Conduct research interventions on the control of *Taenia solium* cysticercosis and other parasitic infections

Interventions to improve farmer access to veterinary inputs and advisory services

1. Strengthen business linkages between VC actors: Co-design and evaluate a public-private partnership (PPP) using market systems approaches (business models) to improve the delivery of inputs, veterinary services and technical information to farmers.
2. Build capacity and improve regulation of various VC actors – herd health practitioners, improved genetics and semen suppliers, AI service providers, inputs, drugs & vaccines stockists, traders and feed producers
3. Implement institutional arrangements to improve the delivery of inputs and services to farmers

Interventions to improve facilities for pig slaughter, pork processing and value addition

1. Capacity building of actors in food hygiene and safety: co-design and evaluate impacts of hygiene and sanitation interventions on pork quality and safety.
2. Conduct interventions to increase investments, operation and management of processing and value addition infrastructure by public and private sector players – slaughter slabs, abattoirs.
3. Undertake policy interventions to increase public investments, infrastructure and build institutional capacity of actors in the pork value chain

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Contact: animal_aquatic@cgiar.org

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