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SOUTHERN AFRICA

UGANDA

Agriculture Background Note: Improving Livestock Productivity and Resilience

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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UGANDA

Agriculture Background Note
Improving Livestock Productivity and Resilience to Climate Change in Uganda: Technological and Policy Options

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Acknowledgments

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Abbreviations and Acronyms

AAS	Annual Agriculture Surveys
AI	Artificial Insemination
CSLP	Climate Smart Livestock Practices
CSLT	Climate Smart Livestock Technologies
GDP	Gross Domestic Product
GHG	Greenhouse gas
GOU	Government of Uganda
MDA	Mass Drug Administration
MMY	Meat Milk Yield
NAGRC & DB	National Animal Genetic Resources Centre and Data Bank
NDC	Nationally Determined Contribution
NLS	National Livestock Census
PDM	Parish Development Model
SLM	Soil and Land Management
SPIA	CGIAR Standing Panel on Impact Assessment
UBOS	Uganda Bureau of Statistics
UHIS	Uganda Harmonized and Integrated Programme
UNPS	Uganda National Panel Survey

Abstract

Background: There is ample evidence that climate change-related shocks are negatively affecting livestock productivity and resilience in Uganda. However, the extent of uptake of mitigative measures, including Climate Smart Livestock (CSLT) Technologies, practices, and their impacts on livestock productivity and resilience are not well understood.

Objective: We examined the structure and investigated the extent of adoption of CSL practices for livestock, with a focus on cattle, and their impact on livestock productivity and resilience. We propose technological and policy options to promote increased and sustained application of these technologies and practices to improve livestock productivity and resilience in Uganda.

Methodology: We undertook an extensive documentation review and analyzed relevant nationally representative data sets generated by the Uganda Bureau of Statistics (UBOS), including the Annual Agriculture Surveys (AAS), the Uganda Livestock Census, and the Uganda National Panel Survey (UNPS), among others. Picking a few selected livestock enterprises, we used regression analysis to model the effect of selected CSL practices on the key outcome variables of livestock productivity and resilience. We also present the results from the IEc climate change impact model on livestock productivity, and we synthesize the results to inform us of our proposed technological and policy options to enhance livestock productivity and resilience.

Results: Our findings confirm increased occurrence and damage from climate change-related shocks. Climatic shocks have become more prevalent than economic shocks. Based on several nationally representative survey data, Ugandan households face several shocks, but the survey data analysis has shown that climatic shocks are more reported than economic shocks by Ugandan households at both community level and household level. Among the climatic shocks, the survey data trend analysis has shown that floods are becoming more prevalent than drought in the recent past.

Eighty-four percent of the communities surveyed by the (UHIS) reported increased occurrence of floods between 2015 and 2022. Our analysis has shown that floods reduce the live weight of the animal by 19 percent (9 kgs per animal) and milk productivity per cow per week by 67 percent (8 liters). Although negative, drought had no significant effect on the live weight of the animal but had a significant negative effect on milk productivity of 22 percent (3.4 liters). Heavy rains on the other hand are correlated with an increase in live weight per animal by 8 kgs (19 percent) and a reduction in milk yield by 3.3 liters per cow per week. Animal diseases are responsible for loss of 7 litres of milk per animal per week (14 percent) and the loss of live weight of 8 kgs per animal (37 percent).

Floods have a comparable impact on both small and large livestock herders, reducing daily milk production per cow by 49 percent (1.7 liters per day) for small herders and 46 percent (1.8 liters per day) for large herders. The most significant discrepancy in yield is attributed to droughts, which adversely affect small livestock herders more severely, resulting in an 80 percent reduction in milk yield per cow compared to a 34 percent reduction for large herders. Hailstorms harm large herders more than small ones. These findings indicate that climate adaptation and mitigation interventions are necessary for both small and large livestock farmers to improve livestock production, with a particular emphasis on implementing climate-smart practices for small herders to mitigate the effects of drought.

The key drivers of adoption of popular climate-smart livestock practices such as rearing of improved breeds, grazing management (proxied here as livestock feeding systems), and access to veterinary services like vaccination, treatment, and deworming among others are gender, labor availability, household size, land availability, and herd size. The results suggest a strong association between the adoption of Climate Smart

Livestock practices (CSLP) and household wealth. We also show that livestock productivity measured in the form of milk productivity and the live weight of animals is driven by feeding, water source, and disease control practices as well as social and economic characteristics. We quantitatively demonstrated that the negative impacts of climate shocks on crop productivity are less severe with adoption of CSL technologies and SLM practices.

Policy options: We recommend a "technical policy" package comprising livestock breed improvement, strengthening water infrastructure (especially dams), promoting livestock intensification management systems, strengthening land tenure security, enhancing access to veterinary services, improving animal feed production, and supporting value addition and export of livestock products to mitigate the effects of climate change shocks on livestock productivity and resilience.

Introduction

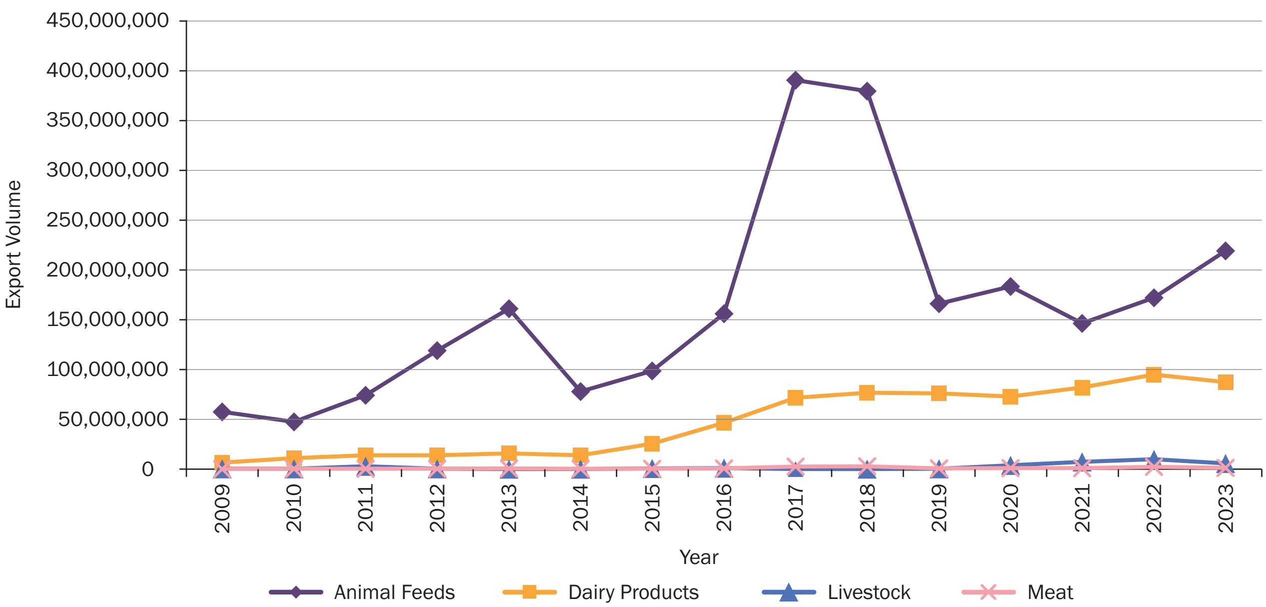
Livestock plays a critical role in economic development, especially in developing countries. It is a source of income and employment, contributes to food diversity and nutrition (Enahoro et al. 2018; Herrero et al. 2013), contributes to foreign exchange earnings, and provides manure used as organic fertilizer, improving soil fertility and crop yields (Enahoro et al. 2018; Smith et al. 2013). In addition, livestock constitutes a form of wealth or savings, acts as insurance against crop failure or economic shocks, plays a role in traditions, ceremonies, and even serves as status symbols. When managed properly, livestock can contribute to sustainable agriculture, climate-smart farming, and ecological balance (Herrero et al. 2013; Ilukor 2017; Smith et al. 2013).

In Uganda, the livestock sector contributes 4 percent to Uganda's GDP and as much as 17 percent to agricultural GDP. In 2021, over 72 percent of all the households in Uganda owned at least one type of livestock, representing 6.8 million households, with the eastern region taking the lead (UBOS 2024b).

The main livestock export products are animal feed, dairy, live animals, and meat. In 2023, Uganda exported 219 million kilograms of animal feed, almost 6 million cattle, 87 million litres of milk, and 1.5 million kilograms of meat (Figure 1). As a result Uganda earned about $72 million from animal feed, over $21 million from livestock export, $96 million from dairy exports, and $2.5 million from meat exports.

The animal feed export market has grown by an average of 5 percent per year and it is expected to grow at an annual rate of 4 percent to reach 336 million kilograms by 2028. The main destination of animal food exports from Uganda are Kenya, Rwanda, Tanzania, Burundi, and Pakistan. Meanwhile, the livestock and meat markets are expected to grow annually by 11.33 percent (CAGR 2024–2029). The leading destination to which Uganda exports livestock include South Sudan, Kenya, Hong Kong SAR, China, China, Belgium, Congo, DRC, and Myanmar. The leading destination of milk exports from Uganda are Kenya, Rwanda, Democratic Republic of Congo, Tanzania, and Burundi. The milk market is expected to grow annually by 8.08 percent.

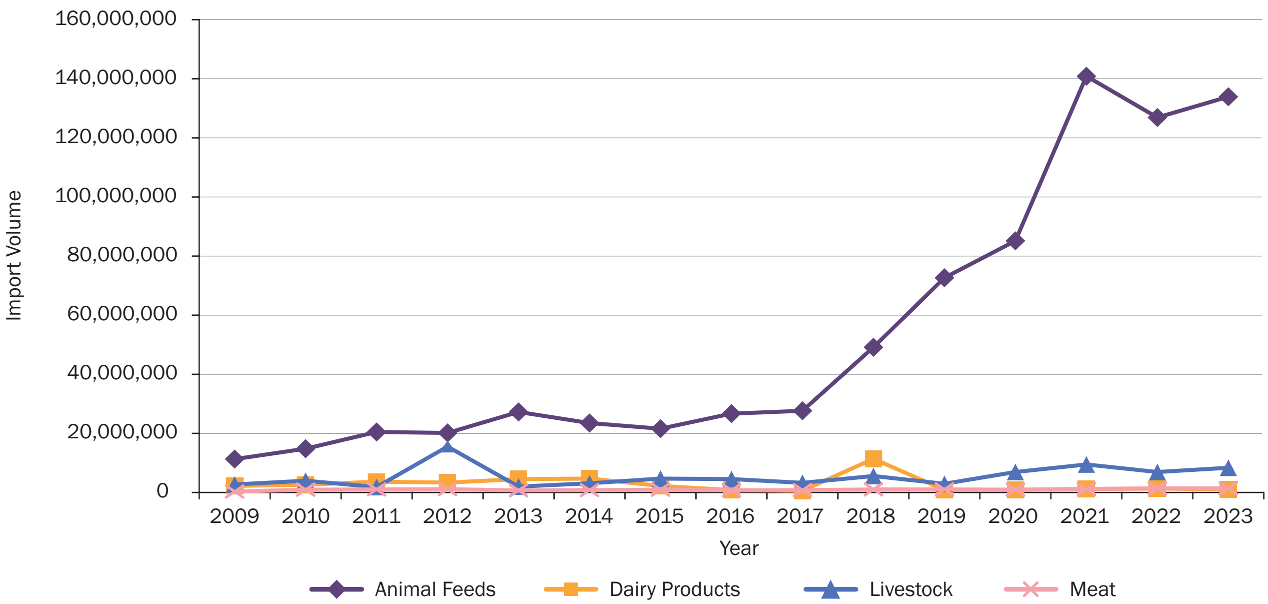
Figure 1: Uganda Livestock Products Exports Between 2009–2023



Source: UBOS.

The main imported livestock products are animal feed, dairy, live animals, and meat (Figure 2). In 2023, Uganda imported 134 million kilograms of animal feed, almost 8.4 million animals, one million litres of milk, and 1.4 million kgs of meat. As result Uganda spent about $101 million on animal feed, over $10.6 million dollars on livestock export, $3 million on dairy exports, and $5.6 million on meat exports. The primary partner countries where Uganda imports animal feed from are Egypt, Tanzania, the Netherlands, Belgium, and Kenya.

Figure 2: Livestock and Livestock Product Imports 2009–2023



Source: UBOS.

Uganda imports milk mainly from the United Arab Emirates, Denmark, Kenya, Poland, and the Netherlands, and the volume of milk imported has been increasing by 9 percent since 2009 to 2023. Animals are imported from Kenya, Tanzania, Netherlands, Belgium, and Türkiye with a growth rate of 6 percent annually. Meat imports come mainly from China, Kenya, and the United Arab Emirates with a growth rate of 7 percent annually from 2009 to 2023.

The overall picture from the trade in livestock products shows that Uganda has positive trade balance in dairy and animal trade, and a negative trade balance in animal feed and meat products. A positive trade balance in dairy and animal products is a good indicator that the dairy livestock sector has great potential to increase Uganda's foreign exchange earnings, boosting economic growth and stability. In addition, it is a signal of Uganda's strong domestic productivity and competitiveness in these sectors. While a positive balance indicates the country's ability to export these products and generate revenue, climate change threatens this advantage by impacting production, potentially increasing costs and reducing supply (Godde et al. 2021). The negative trade balance in animal feed is problematic because a significant import reliance on feed can make livestock products more expensive, potentially hindering competitiveness in the global market (Godde et al. 2021; Guyomard et al. 2013). Moreover, feed production is vulnerable to climate change (Wheeler and Reynolds 2013).

The vulnerability of animal feed (forage and crop production for animal feed) to climate change makes livestock farming in Uganda more vulnerable to climate shocks. Livestock productivity in Uganda remains far below the potential that could be achieved, and available evidence shows wide yield gaps.

In the dairy subsector, for example, the average milk production per dairy cow is around 4 to 5 liters per day, although the average potential yield per cow can be up to 45 liters per day (UBOS 2024b). Low livestock productivity is a major cause of poverty and unemployment and is exacerbated by climate shocks and low adoption of modern inputs and sustainable land management practices (ILRI 2009).

The objective of this paper is to determine the drivers of livestock productivity and livestock resilience to climate shocks in order to tease out technological and policy-level entry points for climate action, and to provide relevant support to the government of Uganda to improve the resilience and productivity of livestock and rural economies in the face of climate change.

This report will focus mainly on cattle and the assessment will examine: (i) the structure of livestock production in Uganda; (ii) the adoption of climate-smart livestock technologies (CSLT) and sustainable land management (SLM) practices; (iii) the effect of adoption of climate-smart livestock technologies and practices on livestock productivity; (iv) the effect of adoption of climate-smart livestock technologies and practices on the resilience of dairy and beef value chains to climate shocks; and (v) technological and policy options to promote increased and sustained use of CSLT technologies and SLM practices for sustainable dairy and beef production.

The following section presents the methods used and the study limitations. Subsequent sections present the assessment of productivity, changing trends in production, and market volumes and drivers with regard to livestock in Uganda. The next section presents the results of the assessment focusing on the five areas noted above. The final section presents technological and policy options/recommendations that the government of Uganda could deploy to improve the resilience and productivity of the agricultural sector.

Material and Methods

Data and sources

The study used the secondary data from the Uganda Bureau of Statistics (UBOS) and analyzed existing UBOS data sets, especially the National Livestock Census (NLC) complemented by the Uganda National Panel Survey (UNPS). The NLC data was used to assess the drivers of adoption of climate-smart livestock production practices on livestock productivity, effects of climate shocks on livestock productivity, and the impact of the selected climate-smart practices on livestock productivity and resilience. The UNPS was used specifically to assess trends or changes in livestock production systems, climate shocks, livestock production, and productivity.

Data analysis and empirical approaches

Descriptive analysis: Based on the three nationally representative UNPS data surveys of 2010, 2015 and 2020 of about 6000 households, we estimate trends and changes in prevalence of climate weather shocks, adoption of CSL practices, beef and milk productivity trends, and changes in livestock commercialization, land use, and other welfare indicators. These are reported as percentage point changes for the short term (2010–2015) or for the long term (2010–2020) where the data permits. We also present the results from the IEc climate change impact model on livestock productivity. IEc modeled impact of heat and water stress for a BAU scenario on milk and meat productivity by 2040.

Multivariate structural econometric analysis: The regression estimations included discrete choice regression analysis and structural crop production functions regression analysis. Discrete choice regression analysis was intended to test the drivers of adoption of the different CSL practices, especially focusing on the role of land tenure security, farm size, plot size, rural wages for men and women, access to rural services (credit and extension), household wealth, gender, human capital, and others. The CSL practices were used as dependent variables in this discrete choice of regression models. The CSL practices include pasture production, animal breeding or rearing of improved breeds, grazing management proxied here as livestock feeding systems, and access to veterinary services like vaccination, treatment, and deworming. Because of the bounded binary nature of the outcomes as use or non-use of the CSL-SLM practice, using the least squares estimator would result in biased and inconsistent estimates. We therefore used the probit regression estimator to estimate the discrete choice regressions. We estimated two probit regression versions for each of the CSL-SLM practices: (a) Fixed effects probit regression with agro-ecological zones fixed effects and (b) a non-fixed effects probit regression without agro-ecological zones fixed effects. Results remained robust with and without controlling differences in agro-ecological conditions. We report only the results without agro-ecological zone fixed effects in the results section. The two models are specified below.

Model 1 Discrete choice regression without fixed effects

Y (adoption CSL SLM) = $\pi_0 + \pi_1$ *HHD controls, +* π_2 *Plot controls + error term*

Model 2 Discrete choice regression with fixed effects

Y (adoption CSL SLM)= $\pi_0 + \pi_1$ *HHD controls, +* π_2 *Plot controls, +* π_3 *AEZ fixed effects) + error term-------- model 2*

Model 1 describes the fixed effects probit regression, and model 2 the non-fixed effects probit regression. Y is the dependent variables measure, taken as 1 if the farmers adopted the CSL or SLM practice on the plot and 0 if not adopted. HHD controls is a vector of household-level characteristics to measure household-level heterogeneity (farmer characteristics of age, education, family size, herd size, access to extension and access to credit).

We used the structural livestock production functions regression analysis to empirically test three relationships. **First**, we test the impact of adopting of CSL-SLM practices on livestock productivity (milk productivity and live weight of animal) of cattle in Uganda. **Second**, we further test the independent effect of weather shocks (floods and droughts) on productivity of Livestock productivity. **Third**, we test the potential of CSL-SLM practices to mitigate and protect milk and weight losses. The econometric estimations are specified as below (models 3-5):

Model 3: Test the effect of CSL-SLM on livestock productivity

Y (milk/beef productivity)= $\pi_0 + \pi_1$ *SLM +* π_2 *Plot and HHD controls + error term---------------model 3*

Model 4: Test the effect of climatic shocks on livestock productivity

Y (milk/beef productivity)= $\pi_0 + \pi_1$ *Climatic Shocks +* π_2 *Plot and HHD controls + error term------model 4*

Model 5: Test the effect of CSL-SLM to mitigate climatic shocks on livestock productivity

Y (Milk/beef productivity)= $\pi_0 + \pi_1$ *SLM +* π_2 *Climatic Shocks +* π_3 *SLM x Climatic Shocks +* π_4 *Plot and HHD controls + error term--------model 5*

Regression models 3, 4, and 5 were all estimated using the classical least squares estimator due to the unbounded continuous distribution of the dependent variables' outcomes (Freedman 2009; Gujarati & Porter 2009; Wooldridge et al. 2009). In models 3, 4, and 5, livestock yields were estimated in both untransformed form and transformed logged form and results for both are reported in the tables. Regression results appeared robust across the two estimations. Logging variables have several statistical advantages. It reduces heteroscedasticity, minimizes outliers, and lowers and removes skewness (Mukherjee et al. 1998).

Structure of Livestock Systems in Uganda

Number of Households keeping cattle

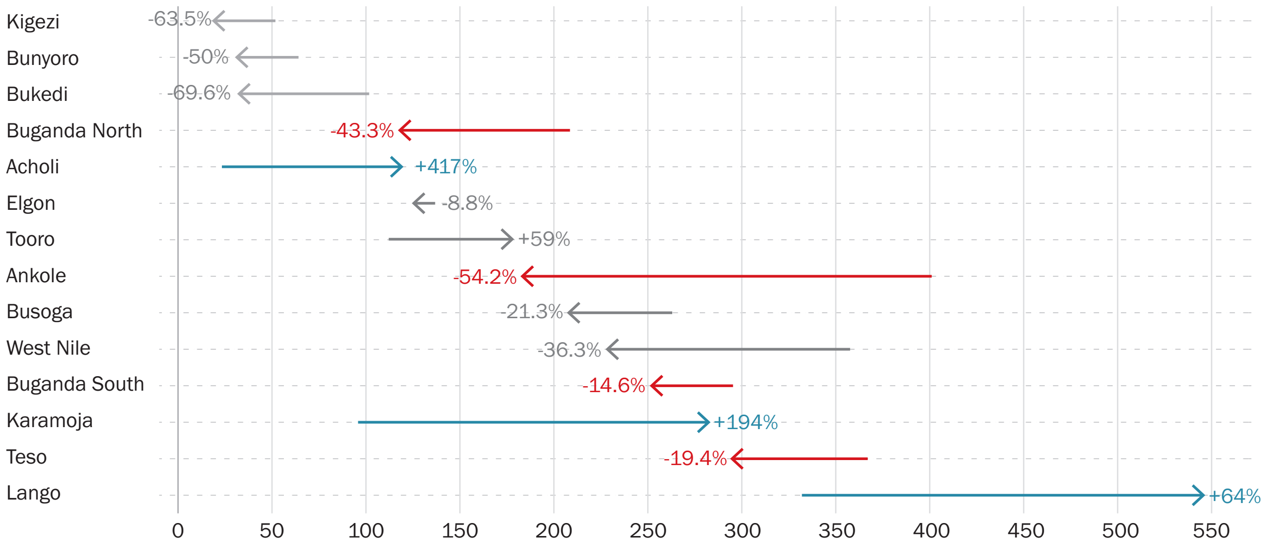
The number of households keeping cattle in 2021 was estimated to be 2.3 million, representing an increase of 37 percent from 2008. The main breeds tended by farmers remain largely indigenous breeds. However, the number of households with indigenous breeds declined by 12 percent and the number of households keeping improved breeds increased by 8 percent between 2008 and 2021. The national average herd size is about six heads of cattle with Karamoja (17) and Ankole (12) reporting the highest herd size. The cattle population increased from 11.4 million in 2008 to 14.5 million by 2021, representing an increase of 27 percent. About 77 percent of the cattle are indigenous and 23 percent are improved. Most of the improved animals are dairy cattle (3 million) and improved beef animals are estimated to be 0.3 million. The number of exotic dairy cows increased five times (500 percent) and that of beef increased 300 percent from 2008 to 2021. Out of the 11.2 million indigenous cattle, 78 percent are Zebu and 22 percent are Ankole cattle. The results also reveal that long-horned Ankole cattle declined from 3.2 million to 2.4 million while the zebu increased from 7.5 to 8.7 million between 2008 and 2021.

In the past 20 years, the main objectives of keeping local breeds of cattle and large herds of animals were mainly social and cultural. However, changing demographic trends, declining land size, and market demand have driven farmers to adopt improved cattle breeds. Most of the improved cattle breeds being adopted are for diary. However, some beef breeds such as Brahmans, Boran, Brown Shorthorn and dual-purpose Sahiwal are being promoted by government and demand among elite farmers is very high. The only limitations are the high acquisition and maintenance costs of improved beef cattle breeds, low adaptability to local environmental conditions, and calving difficulties. Farmers point out that the price of a single exotic heifer would buy 5 to 8 indigenous cattle such as African Zebu and Sanga. Nonetheless, almost all cattle farmers are motivated to improve their breeds for purposes ranging from cultural and social status to income generation. To improve their animals, farmers are adopting bull services or use of high-quality breeding males. Artificial insemination was also adopted but farmers are abandoning this method and the use of high-quality breeds because of high cases of dystocia due to oversized calves. As a result, controlled mating using local selected bulls is increasingly being preferred and has increased from 5 percent in 2011 to 8 percent in 2020.

Dynamics of the number of farms keeping cattle

The dynamics of the number of households keeping cattle reveal that the highest increase or change in livestock population is in Acholi, Karamoja Lango and Tooro. Significant reduction in the number of cattle farmers is recorded in Ankole, and Buganda north between 2010 and 2019 (Figure 3). The change in conflict situation in northern Uganda has led to an increase in livestock in Acholi, Karamoja, and Lango. People have gradually regained their wealth (livestock), pastures are available, and migrations from the south to the north and east have occurred. The reduction in number of animals can be associated with limited pasture and land availability, and a desire to shift to production of high-quality animals (breed improvement) to improve quality or value of animals. The increased number of livestock in Acholi, Karamoja Lango, and Tooro is mainly an increase in indigenous livestock. In Buganda South the number of improved animals increased while Ankole registered a decline in improved and indigenous animals. The decline in Ankole is linked to migrations south to north and east, as well as pasture availability.

Figure 3: Cattle in Ugandan Farms by Region, 2010–2019

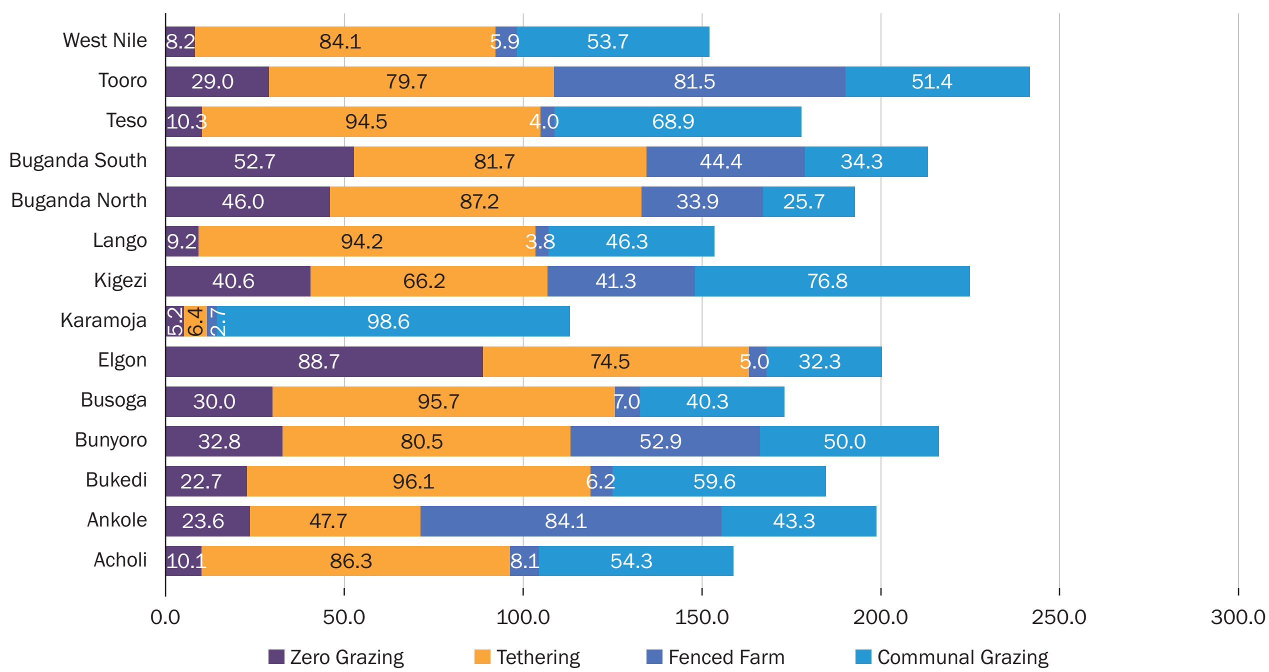


Source: SPIA, UBOS, UNPS.

Livestock feeding systems

The main livestock feeding system in Uganda is tethering and 85 percent of cattle farmers, 94 percent of goat farmers, and 88 percent of the sheep farmers practice tethering. Among cattle, tethering is the highest in eastern Uganda, followed by northern Uganda. Bukedi, Busoga, Teso, and Lango had the highest number of livestock farmers reporting tethering animals (Figure 4). Communal grazing systems are highest in Karamoja, Kigezi, and Teso, while fenced farming is highest in Ankole, followed by Tooro and Bunyoro. Zero grazing on the other hand is highest in the Elgon region followed by Buganda South and Buganda North.

Figure 4: Livestock Feeding Systems in Uganda



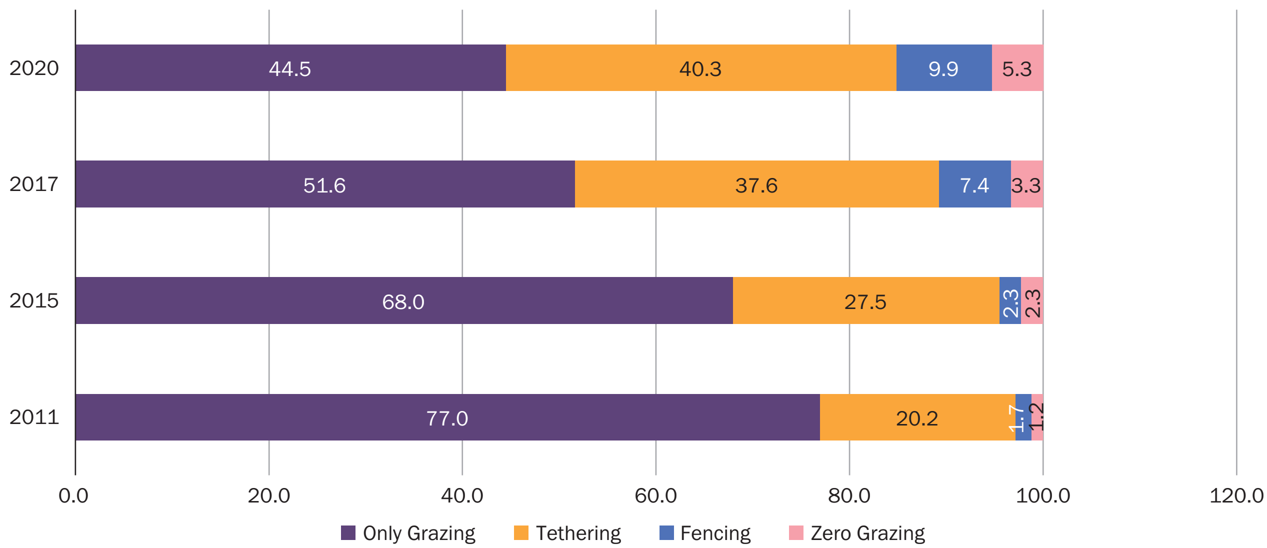
Source: UBOS, 2021 Census.

Dynamics of cattle feeding systems

More than 10 years ago, a great majority of cattle farmers still depended on extensive open grazing to feed the cattle because it was a cheap and a nearly affordable source of nutrients. However, this has changed, as tethering is becoming the main feeding system for cattle, with fencing or paddocking and zero grazing also gaining ground (Figure 5). The rise of tethering as the main cattle feeding system can be attributed to decreasing land size; increasing land disputes across communities, driven by population growth; and reduction in herd size. More farmers are now involved in crop farming and poultry than cattle. The data also shows that tethering is more pronounced for indigenous cattle, while zero grazing and feed supplementation is more common among exotics or crossbreeds.

In addition, with decreasing land size, increasing land disputes across communities, and increasing demand for land to produce food driven by human and livestock population growth, pasture availability is becoming an issue for cattle farmers. As a result, farmers are feeding cattle on locally available feed supplements such as jackfruit, pineapple pulp, cassava peelings, rice stalks, maize stalks, ground nuts, rice brands, and cabbage leftovers.

Figure 5: Major Feeding Practices Over Years 2011–2020

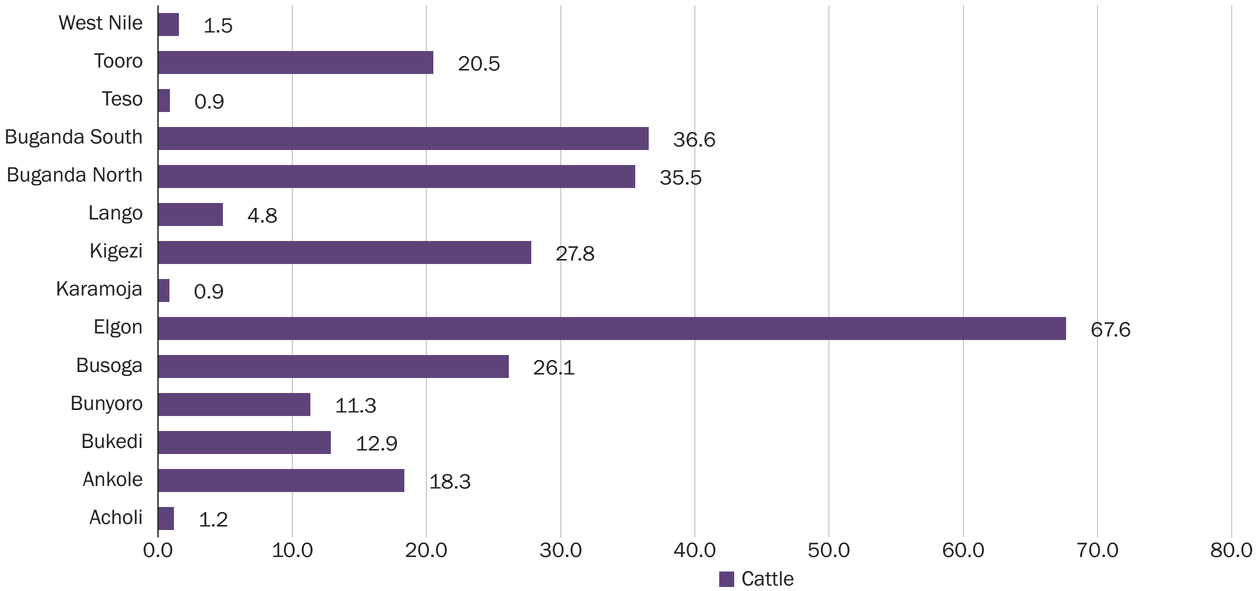


Source: UBOS, 2021 Census.

Pasture production and dynamics

Results from 2021 livestock census data show that only 14.5 percent of the livestock-keeping households in Uganda planted pasture. The largest percentage of livestock-keeping households who planted pasture in Uganda were reported in the eastern region with 37.2 percent, followed by the central region with 31.4 percent. The least was the northern region with only 6 percent. Within regions, the central region had the highest percentage of livestock-keeping households who planted pasture with 20.7 percent, followed by the eastern region with 18.9 percent. In the northern region, however, only 3.7 percent of livestock-keeping households are recorded as planting pasture. Across regions the largest percentage of cattle-keeping households who planted pasture in Uganda were reported in the Elgon subregion, followed by Buganda South and Buganda North, while the lowest was reported in Teso and Karamoja.

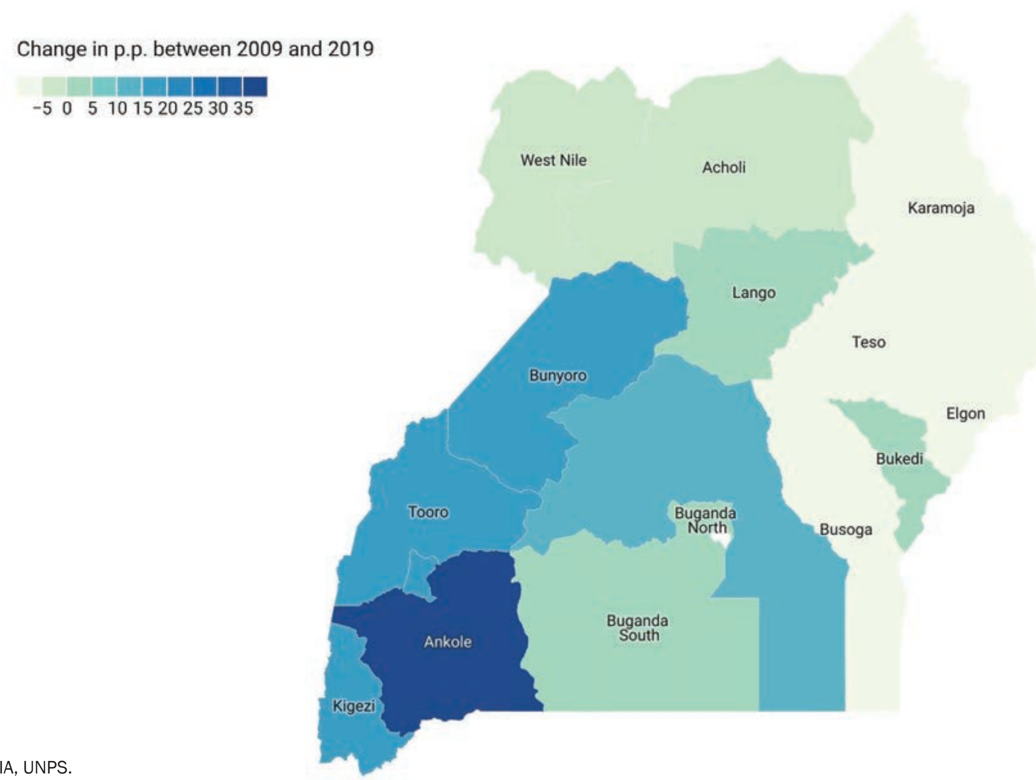
Figure 6: Share of Cattle-keeping Households That Have Planted Pastures



Source: UBOS, 2021 Census.

Data from the Uganda National Panel Survey shows that proportion of farmers with livestock but reported to have no pastures has increased mainly in southwestern and central Uganda, with the most affected subregion being Ankole followed by Kigezi, Tooro, Bunyoro, and Buganda North. This could be the main driver of livestock population reduction in Ankole.

Figure 7: Changes in Number of Cattle-keeping Households Without Pastures



Source: SPIA, UNPS.

Changes in the watering system

The main water sources for cattle are boreholes, natural water sources (rivers, springs and stream), and wells. The use of boreholes has been rising (Table 1) and this means increased competition between animals and humans for water. In addition, it also means that natural sources of water and the wells are either drying up or getting silted. Indeed, as shown in Table 1, the share of cattle-owning households that rely on or use wells and natural sources is declining, thus putting pressure on borehole use. These results suggest a change in the ecosystem of natural water systems in Uganda, which will adversely affect livestock farmers. The practice of rainwater harvesting is also rising, but slowly. An increase in the use of man-made water sources for cattle has been noted, most notably through dams. This could be attributed to government intervention in valley dams. The main source of water for livestock for most of the cattle-keeping households is a borehole (33 percent), followed by wells (17 percent), while water from dams was only 5 percent.

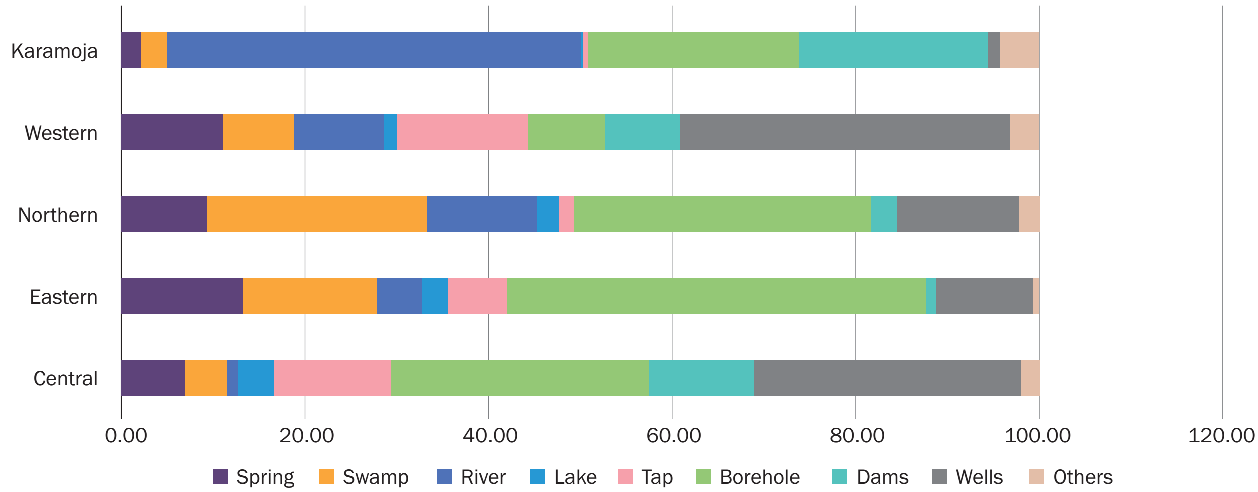
Table 1: Sources of Water for Cattle

Water source for cattle	2011	2015	2017	2020
Tap Water	2.0	4.7	4.1	3.5
Borehole	28.7	27.3	33.8	33.8
Dam	2.9	3.9	5.7	4.6
Well	20.3	21.9	21.9	20.8
Natural water sources (river, spring, stream)	30.4	33.9	23.7	23.6
Constructed Water Points	7.7	2.7	3.6	4.1
Rainwater Harvesting	4.4	4.9	5.6	5.5
Others	3.6	0.8	1.6	4.1

Source: UBOS UNPS.

In the central and western regions, wells and boreholes served as the primary sources of water. In eastern and northern Uganda, boreholes and swamps were dominant sources of water, while in Karamoja boreholes and dams were main sources of water (Figure 8). Springs were the main source of water in Elgon (36 percent and Kigezi (26 percent). Swamp use as a source of water for livestock was highest in Teso (37 percent), Lango (29 percent), and West Nile (23 percent). Rivers were the main source in Karamoja (45 percent), and West Nile (27 percent), while lakes were the least used mainly in Lango and Buganda (5 percent). Tap water was widely used in Kampala (68 percent) and Tooro (22 percent), while borehole water use was prevalent in most subregions, with the leading ones being Busoga (72 percent), Bukedi (54 percent), Lango (40 percent) and Teso (40 percent). Water from dams was mainly used in Karamoja (21 percent), Buganda North and Ankole (13 percent). Water from wells were widely used in Ankole (48 percent), Tooro (37 percent) and Buganda South (36 percent).

Figure 8: Sources of Water for Cattle by Region



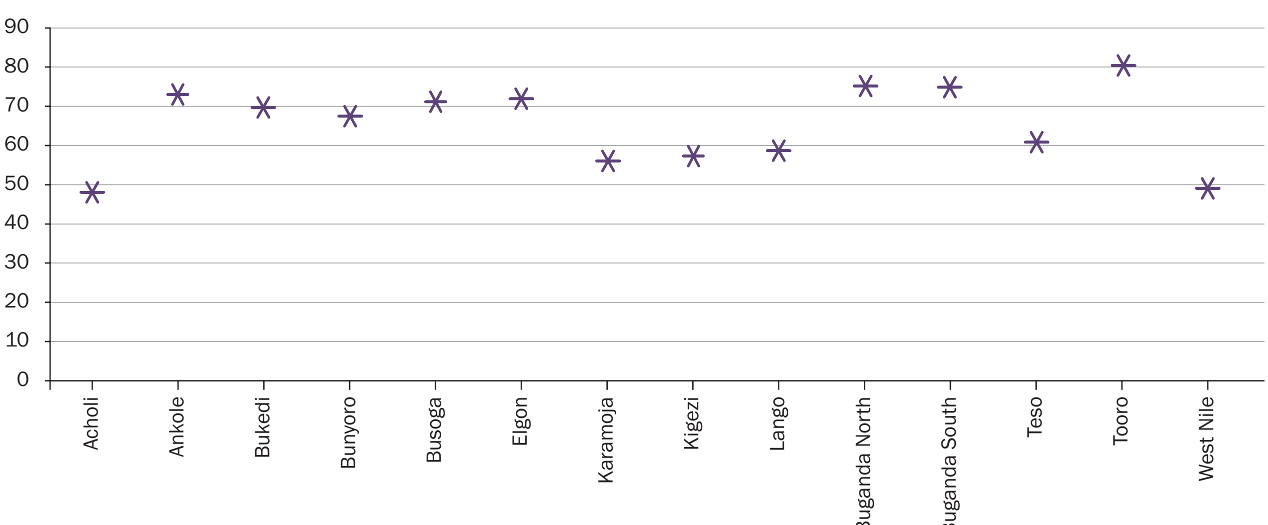
Source: UBOS, Livestock Census 2021.

The choice of water sources is correlated with herd size, access to extension, financial liquidity, and farm sizes. Farmers with a large number of animals are more likely to use boreholes, valley dams, and harvest water, while those with a large number of exotic animals are more likely to use valley dams and water ponds and less likely to use boreholes, natural water, and domestic water sources. In addition, farmers with large farms are more likely to use boreholes, natural water sources, valley dams, and less likely to use ponds, harvested water, and piped water.

Access to extension services

On average, 57 percent of the households keeping livestock accessed extension services in 2021. Such access was highest among the households keeping cattle (66 percent), goats (55 percent), pigs (58 percent), and poultry (42 percent), and lowest among households practicing apiculture (20 percent). Access to extension services in cattle was highest in central Uganda (75 percent), followed by western Uganda (71 percent), and eastern Uganda (69 percent). The Tooro subregion has highest level of access to extension services, followed by Buganda South, Buganda North, and Busoga. (Figure 16).

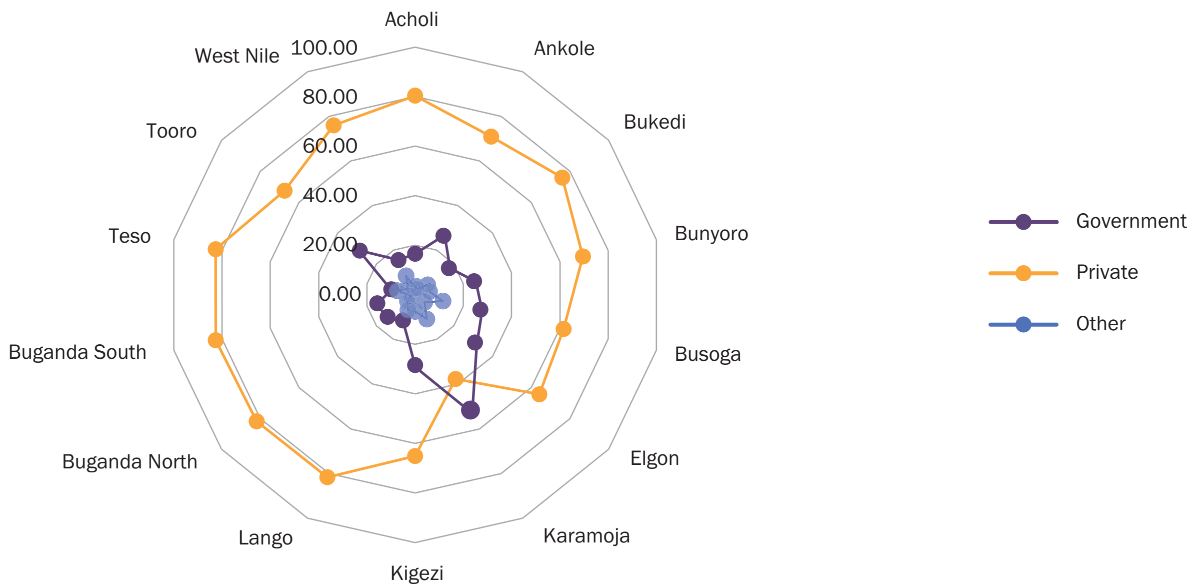
Figure 9: Access to Extension Services by Subregion



Source: UBOS.

The main source of extension services was mainly from the private sector across all livestock types and with an average of 72 percent. The use of private services was high across all the subregions except for Karamoja (37 percent), where government services were highest (Figure 10).

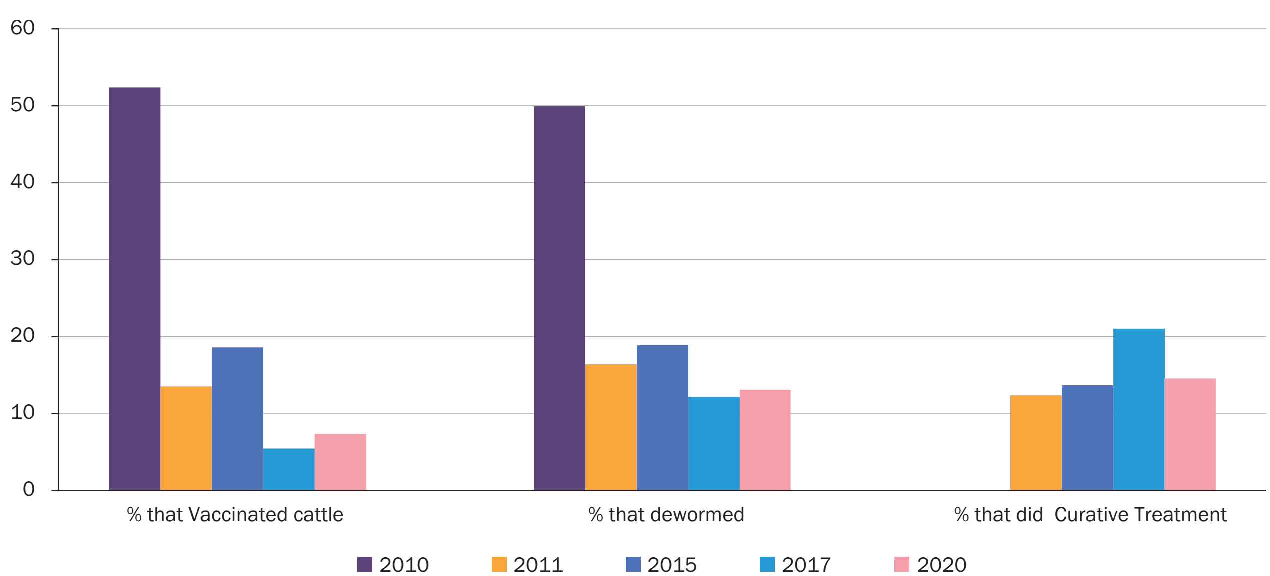
Figure 10: Access to Extension Services by Type of Service Provider



Source: UBOS Livestock Census 2021.

The livestock extension services that are demanded by the community are curative services, and preventive services like deworming and vaccination. However, access to these services has declined. Over the last 10 years access to vaccination has declined by 45 percent, deworming by 36 percent, and curative services by 2 percent.

Figure 11: Changes in Use of or Access to Cattle Health Services



Source: UBOS UNPS.

Drivers of Adoption of SLM/CSL Practices and of Livestock Productivity

This section examines the correlates or drivers of adoption of popular climate-smart livestock practices with the potential to mitigate the impacts of climate shocks on livestock productivity. They include pasture production, animal breeding or rearing of improved breeds, grazing management proxied here as livestock feeding systems, and access to veterinary services like vaccination, treatment, and deworming.

Cattle feeding systems

Our analysis suggests that the main correlates or drivers of the choice of the cattle feeding system in Uganda are gender, labour availability, household size, land availability, and herd size (Table 2). Female cattle farmers are more inclined to tethering or feeding and less likely to adopt grazing, while availability of family labour reduces the likelihood of tethering and increases the likelihood of adopting grazing. Also, farmers that own land and have a small household size are more likely to practice the paddocking (feeding) and tethering approach as opposed to grazing. Cattle farmers with large herds of cattle tend to graze rather than to feed or tether and this is also true for cattle farmers keeping indigenous and improved cattle.

Table 2: Factors Influencing the Choice of Cattle Feeding Systems

Variables	Tethering		Feeding		Grazing	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Female	0.045	0.000	0.013	0.445	-0.015	0.222
Family labor	-0.725	0.000	0.092	0.002	0.369	0.000
Acholi	-0.166	0.000	-0.525	0.000	0.642	0.000
Ankole	-0.745	0.000	-0.337	0.000	-0.320	0.000
Bukedi	0.702	0.000	-0.389	0.000	0.035	0.393
Busoga	0.787	0.000	-0.193	0.000	-0.384	0.000
Elgon	-0.384	0.000	1.328	0.000	-0.459	0.000
Karamoja	-1.844	0.000	-0.702	0.000	2.192	0.000
Kigezi	-0.538	0.000	0.074	0.259	0.523	0.000
Lango	0.723	0.000	-0.732	0.000	-0.073	0.067
Buganda north	0.374	0.000	-0.040	0.430	-0.603	0.000
Buganda south	0.019	0.662	0.053	0.319	-0.369	0.000
Teso	0.656	0.000	-0.696	0.000	0.237	0.000
Tooro	-0.258	0.000	-0.288	0.000	-0.129	0.012
West Nile	0.485	0.000	-0.637	0.000	0.328	0.000
Own land	0.171	0.001	0.079	0.221	-0.206	0.000
Partly own land	0.141	0.009	0.047	0.502	-0.006	0.900
Other land	0.077	0.196	-0.082	0.300	0.073	0.198

Variables	Tethering		Feeding		Grazing	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Private vet	0.026	0.030	0.060	0.000	0.003	0.811
Public vet	-0.014	0.451	0.121	0.000	0.046	0.014
Self vet	0.047	0.103	-0.117	0.006	-0.022	0.423
Age	0.001	0.689	-0.001	0.762	0.005	0.019
Household size	-0.009	0.000	-0.004	0.109	0.014	0.000
Number of indigenous	-0.027	0.000	-0.006	0.000	0.006	0.000
Number of exotics	-0.031	0.000	-0.008	0.000	-0.011	0.000
Constant	0.126	0.105	-1.182	0.000	-0.812	0.000

Source: NLC.

Cattle veterinary services

The factors associated with using livestock extension services are herd size, information sources, type of information, financial liquidity, and farm size (Table 3). Farmers with large herds and a significant number of exotic animals tend to vaccinate, spray, and treat their animals more frequently than those with smaller herds and fewer exotic animals. The source of livestock information being radio only influences vaccination while TV as a source of information is positively correlated with vaccination, spraying, and treating the animals. In addition, receiving livestock information from an extension officer is correlated with only vaccination and spraying but not treatment, consistent with fact that government extension officers only provide public good services like vaccinations and not treatment, which is considered a private good. Having credit is negatively associated with vaccination while input access and farm size tend to positively influence spraying.

Table 3: Drivers of Adoption of Disease Control and Management Practices

	Vaccinated	Treated parasites	Received curative treatment
Herd size and breed effects			
Log number animals owned	0.085***	0.074***	0.062***
Log number animals exotic	0.103***	0.142***	0.126***
Source of information effects			
Info source: radio	0.056***	0.033	0.018
Info source: TV	0.151***	0.086*	0.095*
Info source: extension workers	0.149***	0.102**	0.027
Info source: farmer to farmer	-0.068***	0.054**	0.008
Source of information: other (e.g, demonstration farms, newspapers)	0.033	0.061*	0.132***
Type of information received effects			
Livestock marketing information	0.153	0.245***	0.222*

	Vaccinated	Treated parasites	Received curative treatment
Livestock meat production information	-0.318**	-0.152	0.039
Livestock breeding information	0.240**	0.148	0.157
Livestock diseases information	0.107	-0.005	-0.039
Information business and entrepreneurship	0.043	-0.135	0.065
Financial liquidity effects			
Received remittances	0.072	0.028	0.064
Agricultural loan	-0.062**	0.011	0.004
Household demographics effects			
Number of male adults	0.012	0.014	0.000
Number of male children	-0.001	-0.013	-0.005
Number of female adults	0.004	0	0.022
Number of female children	-0.006	0.007	-0.018*
Number of children	0.005	0.007	0.013
Input access and farm size effects			
Distance to input trader (km)	-0.004	0.006**	0.003
Small farm sizes (comparison group–omitted group)	0.000	0.000	0.000
Medium farm sizes	0.009	0.053*	0.004
Large farm sizes	0.002	0.110***	-0.015
Constant	0.143***	0.122***	0.082**

Cattle breeds

Adaptation support is essential for Ugandan livestock farmers to prevent climatic shocks from hindering the sector's progress in adopting exotic livestock breeds. The analysis indicates that all examined shocks significantly reduce the adoption of exotic livestock, with drought and disease outbreaks showing a severity impact of approximately 4 percent. Access to improved information sources, such as television (7 percent impact) and extension agents (3 percent impact), along with information on meat production and access to credit finance, significantly contribute to the adoption of exotic cattle (Table 4). The findings demonstrate that public extension services are still crucial for enhancing better livestock husbandry practices. Despite Uganda receiving substantial remittances, our analysis reveals that these funds are not being directed towards livestock husbandry. This may indicate an awareness gap within Uganda's large diaspora community regarding investment opportunities in the livestock sector. Ranching (17 percent impact) and fencing (27 percent impact) management approaches appear to be the most effective in promoting the adoption of exotic livestock. It seems that ranching and fencing practices will drive significant transformation in the sector. Communal grazing appears to be considerably hindering progress in this area. This does not suggest that communal grazing should be abolished; rather, it should be optimized in settings where it aligns closely with cultural practices.

Table 4: Drivers to Rear Exotic and Local Livestock: Binary Probit Marginal Probabilities

	Keep Exotic Livestock	Keep Local Livestock
Source of information effects		
Information source: Radio	0.0147***	-0.0147***
Information source: TV	0.0794***	-0.0794***
Information source: Extension	0.0346***	-0.0346***
Information source: Farmer	-0.00943**	0.00943**
Information source: other (demonstration farms, newspaper)	-0.00616	0.00616
Type of information received effects		
Livestock marketing information	0.0156	-0.0156
Livestock meat production information.	0.0747**	-0.0747**
Livestock breeding information	-0.0102	0.0102
Livestock disease information.	0.0119	-0.0119
Information business and entrepreneurship	0.0601**	-0.0601**
Financial liquidity effects		
Access agricultural loan	0.0283***	-0.0283***
Receive remittances	-0.0368***	0.0368***
Feeding systems		
Feeding: zero grazing	0.0777***	-0.0777***
Feeding : tethering	-0.0163***	0.0163***
Feeding: ranching	0.166***	-0.166***
Feeding: fenced	0.270***	-0.270***
Feeding: communal grazing	-0.0331***	0.0331***
Herd size effect		
Number of large animals on the farm	0.000519***	-0.000519***
Water source effects		
Borehole	-0.0418***	0.0418***
Valley dams	-0.0122	0.0122
Public standby water system	0.00371	-0.00371
River or stream	-0.0259***	0.0259***
Pond	0.00644	-0.00644
Rain harvesting	-0.0252***	0.0252***
Piped water	0.0259*	-0.0259*

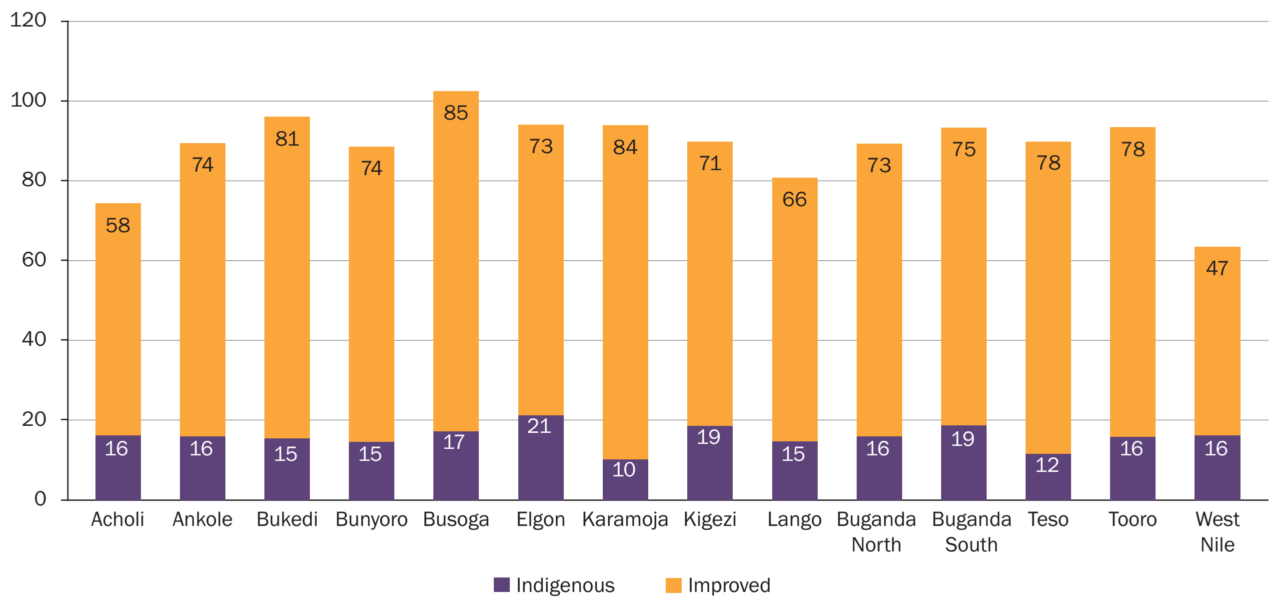
Climatic shock effects		
Shock flood	-0.0235***	0.0235***
Shock drought	-0.0394***	0.0394***
Shock hailstorms	-0.0205**	0.0205**
Shock disease outbreak	-0.0353***	0.0353***
Shock heavy rains	-0.00803	0.00803
Market access effects		
Distance to input markets	-0.00914***	0.00914***
Farm size effect (omitted small farm size)		
Medium size farms	-0.0143***	0.0143***
Large farm sizes	-0.0114**	0.0114**

Drivers of Livestock Productivity

Weekly production of milk in Uganda is estimated to be 72 million liters, which sums up to over 3.7 billion litres every year. Only 25 percent of this milk comes from indigenous cattle. Western Uganda leads in milk production, with 44 percent of the milk produced in Uganda followed by central Uganda (34 percent), eastern Uganda (13 percent), and northern Uganda (9 percent). Milk production is primarily influenced by the number of improved animal breeds, as well as the proportion of cows and milked cows in the subregion. The productivity of cows overall is highest in Ankole with 56 liters per cow per week, followed by Elgon and Buganda South with 51 liters. It is the lowest in Karamoja and Teso at 12 and 13 liters per cow per week.

In the case of local cows, the productivity per cow per week is highest in Elgon, followed by Buganda South, Acholi, West Nile and Ankole, while the lowest productivity is registered in Karamoja and Teso (Figure 11). The productivity of the improved animals on the hand is highest in Busoga, followed by Karamoja, Bukedi, and Teso, with lower productivity registered in West Nile, Acholi and Lango (Figure 11). The proportion of milk produced that is sold is 28 percent, and the average price per litre is 842 shillings. The proportion of produced milk sold is highest in northern Uganda (52 percent), followed by eastern Uganda (28 percent), and central and western Uganda (27 percent). The price is highest in northern Uganda and Karamoja (1000 shillings per litre) and the lowest in central Uganda at 600 per litre. The West Nile leads in share of produced milk sold (60 percent) at a price of 1000 per liter.

Figure 12: Average Milk Production Per Cow Per Week by Region and Type of Animal in Liters



Source: UBOS Livestock Census 2021.

Milk productivity is driven by feeding, water source, and disease control practices as well as social and economic characteristics (Table 5). Tethering and zero grazing are seen to milk productivity per cow per week by 18 percent (4.5 liters) and 3 percent (1.3 liters) respectively, while fencing (paddocking) and ranching increase milk productivity per cow per week by 77 percent (10 liters) and 91 percent (7 liters). With the increasing tendency to graze zero and tether animals largely driven by reducing farm size, milk production is likely to be affected. Thus, policies that address feed availability in these systems will need to be promoted.

Use of valley dams and ponds tends to lead to an increase in milk productivity per cow per week by 8 percent (5 litres) and 5 percent (4 litres) respectively. Use of boreholes piped water, and natural sources of water are negatively affecting milk productivity. This could be associated with the quality of the water. In terms of disease control and management practices, vaccination increases milk productivity by 29 percent (4 litres) per week per cow, while deworming increases milk productivity by 14 percent. Increase in the number of hired labor or family labor also increases milk productivity per cow per week by 26 percent (9 liters) and 3 percent respectively (1 litre).

Table 5: Drivers of Livestock Productivity

	Milk Productivity		Meat Productivity	
	Milk liters per cow per day	Log milk liters per cow per day	Live weight per animal	Log live weight per animal
Labor effects				
Number of family shepherds	1.171***	0.029*	-0.026	0.024
Number of hired shepherds	8.919***	0.261***	4.180***	0.079
Feeding practices effects				
Zero grazing	-1.294	-0.026	-0.25	-0.009
Tethering	-4.516***	-0.179***	-0.375	0.029
Ranching	7.296*	0.914***	10.181***	0.603***
Fenced paddocking	10.428***	0.771***	-0.993	0.291*
Communal	0.678	0.077	-0.129	0.033
Water source effects				
Borehole	-0.63	-0.073	-1.054	-0.043
Valley dams	4.958***	0.084	4.792***	0.215*
River or stream	-2.028	-0.186***	0.897	0.099*
Pond	3.677*	0.047	-0.856	0.116
Rainwater Harvesting	-0.616	-0.075	0.235	-0.069
Piped water	-4.366	-0.111	-2.747	-0.165
Disease control effects				
Vaccinated	4.012***	0.289***	1.489*	0.180***
Treated parasites	0.089	0.144**	1.165	0.093*
Received curative treatment	-0.097	-0.052	-0.082	0.014
Constant	1.254	1.253***	4.808***	0.769***
N	672	672	1152	1152

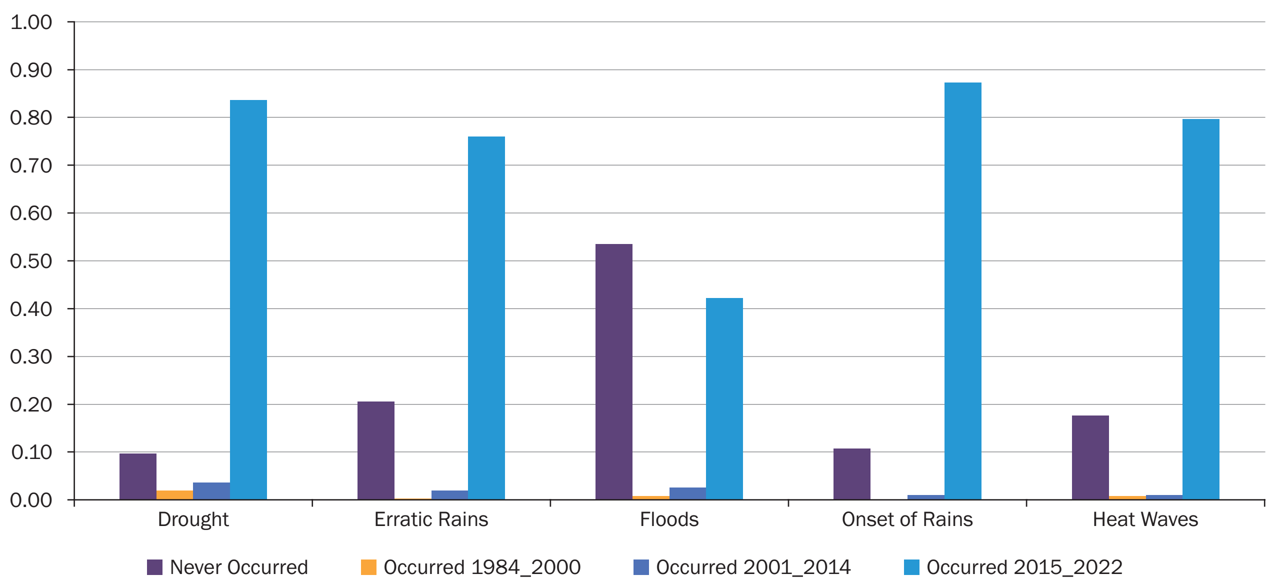
Of all the feeding systems studied, ranching had a positive significant effect on the live weight of livestock at 60 percent (10 kgs per animal). All the other systems like tethering, zero grazing, and communal grazing, although not significant, showed a negative effect on the live weight of animals. This is a very significant result, because ranching is not widespread in Uganda. With the increasing tendencies to zero graze and tether animals, Uganda's competitive advantage in beef production may be reduced. Intensification of ranching in land-abundant areas of north and northeastern Uganda will be required to boost the beef sector in Uganda. Notably, the utilization of valley dams represents the only significant water source that contributes to a 22 percent (5 kg) weight gain in animals. Vaccination is shown increases weight gain by 18 percent (1.5 kg) per animal and deworming to increase live weight per animal by 1 kg.

Climate Shocks and Livestock Productivity

Important climate shocks in agriculture include droughts, floods, and heatwaves. These events destroy crops, reduce yields, and ultimately lead to food shortages and price spikes. In addition, changes in temperature and precipitation patterns have altered the growing seasons of crops, leading to shifts in planting and harvesting times and making it harder for farmers to predict and plan for their crops. In addition, climate shocks have also affected the quality of crop yields. Higher temperatures and changes in rainfall patterns can lead to the loss of nutrients in crops, reducing their nutritional value and increasing the risk of food insecurity and malnutrition. The frequency of occurrence of these weather events (droughts, floods, delayed onset of rains, and heatwaves) increased between 2015 and 2022 (Figure 13).

Our analysis of the UHIS (2022) survey shows that 84 percent of the communities interviewed reported floods to have occurred between 2015 and 2022, while 76 percent, 42 percent, 87 percent, and 80 percent report erratic rains, floods, delayed onset of rains and very high temperatures respectively (Figure 13).

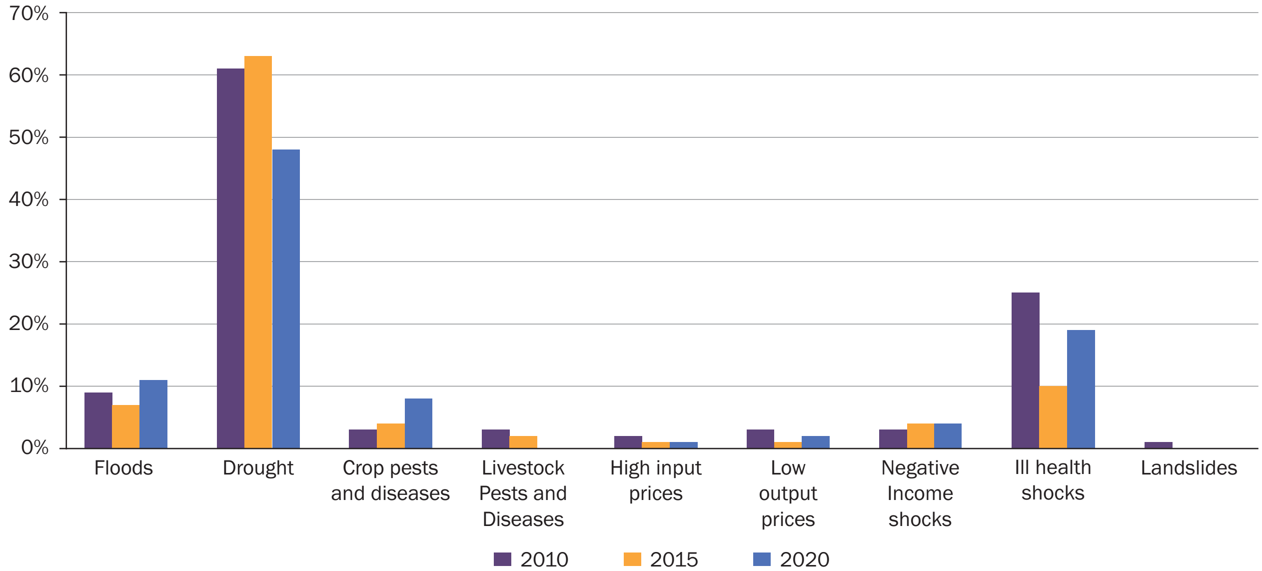
Figure 13: Occurrence of Weather Shocks



Source: UHIS Community Survey 2022.

Households, on the other hand, have reported drought, floods, and ill health as the three dominant shocks affecting their agricultural production activities. Over the last 10 years drought prevalence has dominated the overall experience of shocks, with 6 in 10 households experiencing it. Flood shocks, although still low, seem to have increased in the decade between 2010 and 2020. Fifty percent of the households attributed soil erosion to flooding. The prevalence of crop pests and diseases has also increased in the last 10 years from 3 percent in 2010 to 8 percent in 2020. Besides these climate shocks that directly impact agricultural production, households are also facing a double crisis with increased health shocks that indirectly affect agricultural production. Two in every 10 households report experiencing ill health shocks.

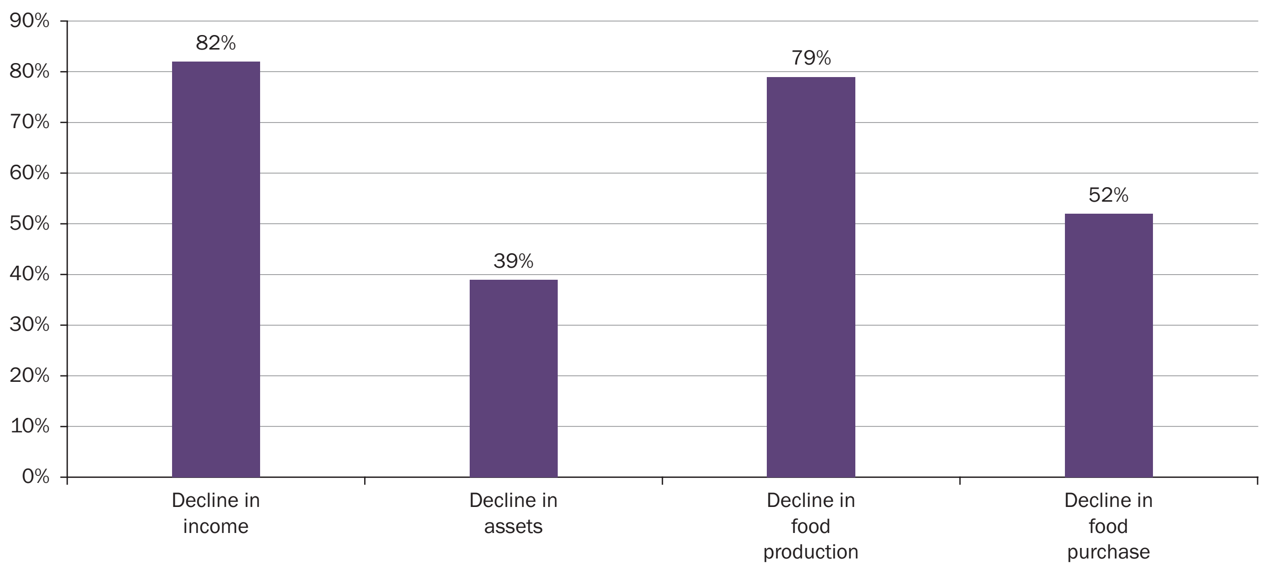
Figure 14: Household Shock Experience between 2010–2020



Source: UNPS UBOS.

Households have reported that these shocks have resulted in significant income and food vulnerability, leading to the depletion of assets as they sell possessions to mitigate their effects. As many as 82 percent of households indicated a decline in household income due to climate change-related shocks, while 79 percent reported decreased agricultural production attributed to climate change. The decline in household income has had a direct effect on food purchasing patterns, as illustrated in Figure 15. The combination of reduced food production and decreased food purchases further exacerbates the food security situation for agricultural households.

Figure 15: Effects of Shocks on Households



Source: UNPS 2020.

Effects of climate shocks on livestock productivity

The regression analysis results indicate that floods reduce the live weight of the animal by 19 percent (9 kgs per animal) and milk productivity per cow per week by 67 percent (8 liters), as shown in Table 6. Although negative, drought had no significant effect on the live weight of the animal but had a significant negative effect on milk productivity of 22 percent (3.4 liters). Animal diseases are responsible for loss of 7 litres of milk per animal per week (14 percent) and the loss of live weight of 8 kgs per animal (37 percent). Heavy rains on the other hand are correlated with an increase in live weight per animal by 8 kgs (19 percent) and a reduction in milk yield by 3.3 liters per cow per week.

Table 6: Effects of Climate Shocks on Livestock Productivity

Effect of Climate Shocks on Livestock Productivity				
	Meat Productivity: Live weight (kgs per animal)	Log Meat Productivity: Live weight (kgs per animal)	Milk Productivity (milk litres per cow)	Log Milk Productivity (milk litres per cow)
Shock flood	-8.830*	-0.186**	-8.229***	-0.672***
Shock drought	-2.512	-0.0509	-3.427***	-0.218***
Shock hail storms	0.000	0.000	0.88	0.0033
Shock diseases and p-value	-7.672**	-0.140**	-7.091***	-0.373***
Shock heavy rains	8.188*	0.186**	-3.328***	-0.186***
Constant	52.86***	3.942***	20.93***	2.555***
Estimation	Classical OLS	Classical OLS	Classical OLS	Classical OLS
Heteroscedastic stand	Yes	Yes	Yes	Yes

Impacts of climatic shocks on livestock productivity by herd size

Floods affect small livestock herders and large livestock herders with similar magnitude, reducing daily milk production per cow by 49 percent (1.7 liters per day) for small livestock herders and by 46 percent (1.8 liters per day) for large livestock herders. The biggest difference in yield is due to droughts, which seem to be more severe for small livestock herders, causing 80 percent loss in milk yield per cow, as compared to 34 percent milk yield loss in large livestock herders (Table 7). However, hailstorms are more disastrous for large herds than small herds. The findings suggest that both small livestock farmers and large livestock farmers need interventions to enhance livestock production, especially drought climate-smart practices for small herders.

On mitigation, the results show boreholes, dams, and ponds are more effective in mitigating drought for small herders, but they do not seem to be effective for large herders. This does not imply that these water sources are not beneficial for large herds; rather, it indicates inefficiency and user-related issues among large herds concerning these water sources. Actions are needed to make dams and ponds work. Access to piped water seems to be highly beneficial to both small herders and large herders in mitigating drought effects on livestock productivity.

Table 7: Impacts of Climatic Shocks on Livestock Productivity by Herd Size

	Small herd size (below average herd size)	Large herd size (above average herd size)	Small herd size (below average herd size)	Large herd size (above average herd size)
Climatic shock effects	**Dependent variable: Milk per cow per day (liters)**	**Dependent variable: Milk per cow per day (liters)**	**Dependent variable: Log Milk per cow per day**	**Dependent variable: Log Milk per cow per day**
Shock flood	-1.745***	-1.763***	-0.492***	-0.455***
Shock drought	-2.626***	0.879***	-0.810***	0.343***
Shock hailstorms	-0.736	-1.229***	-0.141	-0.233***
Shock disease outbreak	-0.482*	0.0246	-0.388***	0.0183
Shock heavy rains	0.0231	-0.127	0.0235	-0.0279
Mitigation effects				
Shock disease X vaccination	-0.138	-0.224	0.191	-0.0823
Drought X borehole	1.253***	-1.322***	0.493***	-0.363***
Drought X dam	0.85	0.137	0.258	-0.160**
Drought X pond	0.723*	-2.360***	0.412**	-0.706***
Drought X pipe water	1.857***	2.582***	0.823***	0.487***
Drought X river	0.165	-0.587***	-0.00239	-0.252***
Constant	4.268***	4.292***	1.239***	1.164***
Number of large livestock households	593	1996	593	1996
Estimator	Least squares	Least squares	Least squares	Least squares

Note: The average herd size was 5 cows in the sample. About 60% had 5 cows or less. 84% had 10 cows or less. Only 5% had more than 20 cows.

Effect of Climate-Smart Livestock Practices on Livestock Productivity Under Climate Shocks

Livestock productivity is influenced by a complex array of nutritional, health, and management determinants, and also genetics. Understanding the significance and interplay of these determinants is critical for developing effective strategies to improve livestock productivity. By addressing these determinants, farmers and policymakers can improve the productivity of livestock, enhancing food security, generating income, and improving rural livelihoods. In this section, we examine adoption dynamics in livestock feeding, health, management, genetics, and their effect on livestock productivity.

Effects of water sources and feeding system on livestock productivity under climate shocks

The use of dams or valley dams is shown to increase milk production by 35 percent (11 liters per cow per week) and beef by 49 percent (10 kgs per cow), as shown in Table 8. Other watering systems like boreholes, piped water, and rivers have no significant effect on livestock productivity. Accounting for feeding systems removes the significant effect of dams on milk production. However, beef productivity increases by 35 percent (7 kgs per animal) during the drought season because of the use of valley dams. Also, high milk productivity is reported among animals kept under ranching and fencing, while zero grazing and tethering, although not significant, have a negative effect on milk production during drought season. In the case of beef, productivity increases during the drought season are reported in ranched animals or cattle.

Table 8: Effects of Water Sources and Feeding Systems on Livestock Productivity Under Climate Shocks

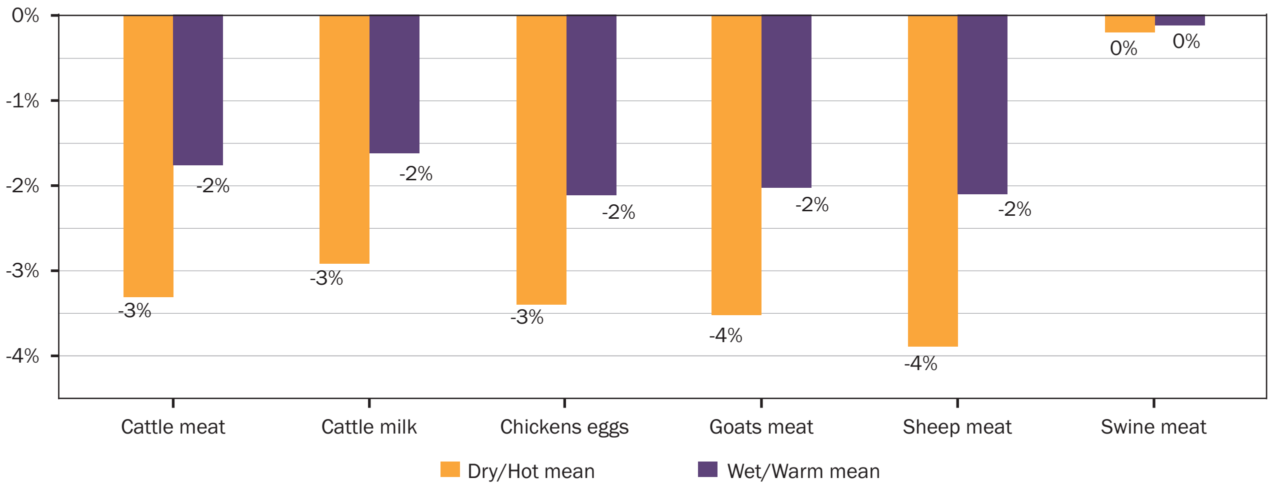
	Milk Productivity				Meat Productivity			
	Milk per cow	Log milk per cow	Milk per cow	Log milk per cow	Live Weight	Log live Weight	Live Weight	Log live Weight
	Model 1	Model 1	Model 3	Model 3	Model 1	Model 1	Model 3	Model 3
Water source interactions with drought								
Drought X borehole	-2.781	-0.142*	-1.257	-0.117	-0.881	-0.077	-1	-0.142*
Drought X valley dam	11.446***	0.348***	5.360*	-0.019	10.354***	0.487***	7.018***	0.349***
Drought X pond	5.713*	0.210*	3.988	0.053	-0.206	0.123	-0.836	0.073
Drought X piped water	1.37	0.505*	-8.232	-0.032	-1.249	0.035	-1.689	-0.157
Drought X river	-3.002	-0.232***	-3.306	-0.283***	1.669	0.146*	1.702	0.065
Feeding method interactions with drought								
Drought X zero grazing			-1.59	-0.061			0.313	0.022
Drought X tethering			-2.189	0.03			0.439	0.156
Drought X ranching			22.072***	1.695***			22.808***	0.557*
Drought x fencing			18.697***	0.980***			0.96	0.585***

	Milk Productivity				Meat Productivity			
	Milk per cow	Log milk per cow	Milk per cow	Log milk per cow	Live Weight	Log live Weight	Live Weight	Log live Weight
	Model 1	Model 1	Model 3	Model 3	Model 1	Model 1	Model 3	Model 3
Drought X communal			3.178	0.133			-2.281	-0.11
K 35% constant	5.730***	1.467***	5.051***	1.413***	4.106***	0.866***	4.048***	0.855***
Estimation	Classical OLS	Classical OLS	Classical OLS	Classical OLS	Classical OLS	Classical OLS	Classical OLS	Classical OLS
Function	Restricted Livestock production function	Restricted Livestock production function	Restricted Livestock production function	Restricted Livestock production function	Restricted Livestock production function	Restricted Livestock production function	Restricted Livestock production function	Restricted Livestock production function
Data source:	AAS 2019-2020	AAS 2019-2020	AAS 2019-2020	AAS 2019-2020	AAS 2019-2020	AAS 2019-2020	AAS 2019-2020	AAS 2019-2020

Impacts of Climate Change livestock productivity- Climate modelling

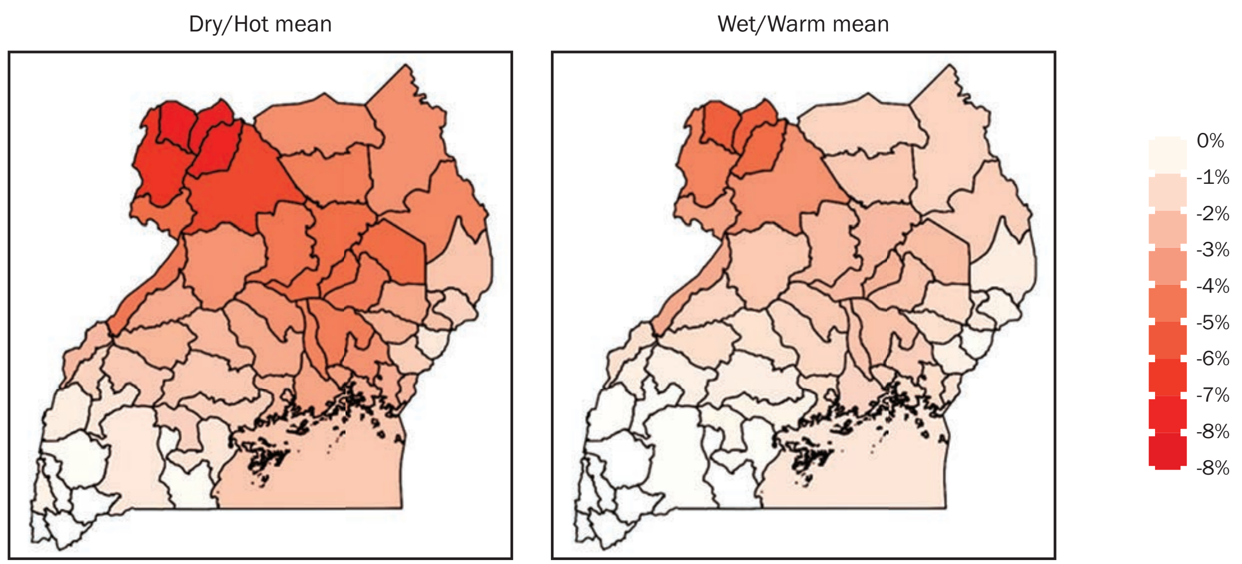
Across major livestock products, especially beef and milk, climate change impacts are expected to peak at -3 percent while impacts on swine meat, as estimated through changes in pastures, are minimal as they mostly rely on other feed sources (Figure 16). Small impacts to total livestock production by 2041-2050 are expected if no intervention is done. Both the heat and water effect are higher on the shots compared to other animals.

Figure 16: Livestock Production Shocks by Product by 2041-2050



The heat and water effect are higher on the livestock farming West Nile and Northern Uganda than any other parts of the country (Figure 17). The results further show that when impacts on cattle meat and milk are considered jointly, districts more impacted by climate change may not correspond to districts with high proportion of cattle. However, the district with the most cattle is expected to have relatively severe heat shocks.

Figure 17: Livestock Production Shocks by subregion by 2041-2050



Priority Interventions to Enhance Livestock Productivity Resilience

Climate shocks can impact livestock productivity by reducing feed and forage availability, water availability, increasing heat stress, and causing livestock diseases. Our analysis has shown that floods reduce the live weight of the animal and milk productivity per cow, while animal diseases are responsible for loss of 7 liters of milk per animal per week (14 percent) and the loss of live weight of 8 kgs per animal (37 percent). Drought on the other hand had a negative significant effect on milk productivity and negative but non-significant effects on the live weight of cattle. Heavy rains were found to have a negative effect on milk productivity and positive effect on beef productivity. Our analysis reveals that, to mitigate the impacts of climate shocks and ensure sustainable livestock productivity, there is need to invest in: (i) livestock breed improvement; (ii) livestock water infrastructure, especially dams; (iii) promoting livestock intensification systems; (iv) strengthening land rights; (v) enhancing access to veterinary services, especially vaccinations; (vi) animal feed production and (vii) supporting value addition and export of livestock products. Some of these points are now addressed in greater detail.

Animal breed improvement

Livestock or cattle breed improvement leads to increased productivity. In our analysis, we find that having improved animals in the herd increased milk productivity by 54 percent (3.5 liters per cow per week) and the live weight by 30 percent (4 kg per animal). Additionally, this leads to higher market value for cattle, reduced incidents of cattle rustling, and improved productivity in terms of milk and beef. Also, cattle breed improvement has a potential to decrease greenhouse gas (GHG) emissions in three ways: (i) higher genetic progress leads to increased production efficiency, whereby the same amount of milk can be produced with a smaller number of animals. For example, in our analysis, it requires four local cows to produce the same amount of milk as one improved cross; (ii) a lower number of heifers and bulls for beef production are raised; thus, a lower number of cattle consume feed and produce GHG emissions; and (iii) genetic improvement often leads to improved animal health, leading to lower levels of involuntary culling and increased fertility (Berry and Spangler 2023).

The government of Uganda therefore needs to invest in breed improvement and development of the cattle and livestock seed systems, not only to increase livestock productivity but also reduce GHG emissions. The government has recently increased its ambition to reduce GHG emissions from 22 percent to 24.7 percent in the new climate change plan, also known as the Nationally Determined Contribution (GOU 2022) and recognizes the need to promote highly adaptive and productive livestock breeds to reduce emissions by approximately 2.9 $MtCO_2e$ by 2030 (GOU 2018, 2022). The government has also set up a National Animal Genetic Resources Centre and Data Bank (NAGRC&DB) whose objective is to commercialize breeding activities, including procurement and distribution of semen and associated equipment. The center has been promoting artificial insemination (AI) services for over 20 years, and a number of other community breeding programs have also been promoted by other Mass Drug Administrations (MDAs), especially the bull service scheme. This could probably explain the decline in the number of households with indigenous breeds by 12 percent, and the increase in number of households keeping improved breeds by 8 percent between 2008 and 2021 (UBOS 2024).

Although progress is being observed, only 19 percent of the cattle keeping-households keep exotic/crossbreeds and only 23 percent of the cattle in Uganda are improved. The share of the cattle keeping-households keeping improved breeds is higher among dairy farmers (17 percent) compared to beef farmers (2 percent). This is associated with limited access to AI services and weakness in the approaches of breeding services. NAGRC&DB has faced challenges in commercializing breeding services, with concerns raised about the quality of semen and success rates. The use of the bull service scheme may lead to disease transfer but more importantly, bull service schemes fail because of collective action failure (Lwiza et al. 2024).

Given the importance of the livestock breed improvement, the government, through NAGRC&DB, needs to establish satellite AI centers for livestock breeding. AI minimizes the risk of spreading sexually transmitted reproductive diseases amongst breeding animals, reduces the costs and the risks of keeping bulls at the farm, and ensures the correct quality of semen. Frozen semen can be stored for years and is a more easily transported genetic material than bulls. The use of AI can be achieved by establishing AI centers at parish level (to ease access by farmers) where estrus synchronization and insemination can take place. Synchronization involves administering a series of hormones to induce a group of cows or heifers to be fertile at a chosen time period (normally 14 days), which makes it easier to determine when the cows are in heat.

After the specified period, all the synchronized cows will be in heat and can be taken back to the parish for artificial insemination, using the improved semen by technically trained personnel. In addition, an improved bull can be supplied to each subcounty under the management of the Subcounty Veterinary Officer to not only act as a backup for AI but also for training and demonstration purposes to cattle farmers on how to manage the improved offspring sired with the help of AI. To avoid burdening government, these services should be offered as a declining government subsidy exit strategy. The AI center will be considered critical infrastructure, to be established at parish level with well-qualified AI technicians under the production departments. It is consistent with Parish Development Model (PDM) pillars 1 (Production, Storage, Processing, and Marketing) and 2 (Infrastructure and Economic Services) respectively. There are 10,595 parishes across Uganda and each AI satellite center would cost $20,000. The cost of establishing these satellite AI centers would be approximately $220 million, and another $50 million would be required to make them operational and linked with NAGRC&DB and private sector companies dealing in AI services, as well as to support regulation and enforcement. As stated above, such an initiative will not only boost livestock productivity but also help in mitigating climate change.

Improve livestock water access by focusing on valley dams

Access to water is a critical aspect of livestock production, as it has been shown to lead to increased livestock weight gain (Dobes et al. 2021) and milk productivity (Carra et al. 2022). Our analysis indicates that the use of valley dams and ponds tend to lead to an increase in milk productivity per cow per week by 8 percent (5 litres) and 5 percent (4 litres) respectively while the use of boreholes, piped water, and natural sources of water are seen to negatively affect milk productivity. These differences can be linked to the quality and quantity of water (Evans et al. 2024; Piemontese et al. 2024; Westgate et al. 2022). Boreholes and piped water are mainly meant for humans, and to include animals within their remit often means that animals will not be able to have enough water. Moreover, most of the boreholes are not fenced and do not have hardened watering points to limit livestock access, leading to water contamination and affecting livestock productivity.

Natural sources, rivers and lakes are getting polluted (Nsubuga et al. 2004; Nsubuga et al., 2014) while dams and ponds are associated with significant reduction levels of phosphorus, nitrogen, turbidity, thermotolerant coliforms, E.coli, and PH. In addition, dam and pond enhancement often leads to increases in vegetation cover and biodiversity, thus leading to improved water quality (Evans et al. 2024; Westgate et al. 2022). By increasing vegetation cover and biodiversity, dams also reduce or help erosion and flooding. Managing water quality in farm dams is essential not just for animal productivity gains and biodiversity but also to mitigate climate shocks like flood and erosion control. Therefore, the government of Uganda should invest in valley dams, desilting existing valley dams both for water availability and flood control. Already, the national climate change policy recognizes the need to construct dams and dykes in flood-prone areas (GOU 2018), while Uganda's NDC policy identifies construction of water dams and valley tanks as key to improving water availability for livestock to reduce emissions (GOU 2022). Despite this, however, our analysis shows that the main dominant water sources for cattle are boreholes, natural water sources (river, spring, and stream) and wells. Moreover, the use of boreholes continues to rise, and the use of dams has remained low with an insignificant rise in the share for cattle-keeping households using it as a resource. Most cattle-keeping households primarily use boreholes (33 percent) for water, followed by natural sources (24 percent) and wells (21 percent). Dams, which significantly impact livestock productivity, are the least used source (5 percent). Cattle-keepers or communities cannot access dams, or the dams are not available in their communities because they are distant or are silted due to high sediment loading and siltation orchestrated by direct watering, high grazing intensity around the dam periphery, cutting of trees, and soil erosion (Mugerwa et al. 2014).

Therefore, desilting existing valley dams and construction of new ones in areas where there are no dams or water bodies would help in enhancing livestock water access and flood control. In addition, knowledge of livestock water needs per cow and breed in terms of quality and quantity is needed to boost livestock productivity. An animal kept under cool conditions (below 20°C) usually needs 4 to 5 liters of water for every kg of dry matter eaten. But once the temperature rises above 30°C, the amount of water needed increases to 10 to 12 litres per kg of dry food. As with the proposed AI satellite centers, dams can also be established at parish level; in fact, this was the case in northeastern Uganda and around Lake Kyoga before most of them got silted. This will cost about $1.8 billion.

Specializing and intensifying cattle production for improved efficiency and reduced greenhouse gas emissions

Cattle are the world's largest consumers of plant biomass. Digestion of this biomass by ruminants generates high methane emissions that significant impacts global warming (Faverdin et al. 2022). Therefore, livestock feeding systems are critical in both boosting productivity and minimizing methane emissions (Kiggundu et al. 2019). Our analysis shows that tethering and zero grazing decrease milk productivity per cow per week by 18 percent (4.5 liters) and 3 percent (1.3 liters), while paddocking and ranching increase it by 77 percent (10 liters) and 91 percent (7 liters). Also, of all the feeding systems, only ranching had positive significant effect on live weight, at 60 percent (10 kgs per animal). All the other systems like tethering, zero grazing, and communal grazing although not significant had negative effect on the live weight of animals. In addition, results show that meat production will require a lot more pasture and will lead to high emission intensity in systems that do not prioritize pasture production (Kiggundu et al. 2019).

Therefore, aiming for a greater specialization of cattle breeds and livestock systems toward milk and meat will increase live weight and milk production in dairy cattle because improved animal performance reduces feed use and emissions (Faverdin et al., 2022). Similarly, intensification through improved management practices (feed, reproduction, health) increases the feed efficiency of both milk and meat, leading to reduced land use and methane emissions. Intensification of ranching in land abundant areas of north and northeastern Uganda will be required to boost the beef sector in Uganda, while the intensification of dairy could happen in less land-abundant areas. Tethering and communal grazing as livestock production systems should be discouraged due to their inefficiency.

To support specialization and intensification, it is necessary to strengthen land tenure rights, facilitate the acquisition of customary and occupancy certificates, and invest in reducing the cost of land titling. This will enable land fencing, ranching, pasture production, and the development of pasture seed systems, while facilitating water investments. Furthermore, it is essential to support land-constrained farmers in transitioning from less efficient cattle systems, such as tethering, to more efficient livestock production systems like pig farming, poultry, and small ruminant production. In addition, specialization and intensification will require investments that increase feed availability. Fodder quality and inorganic feed has a significant effect on methane production, and if the feed quality is poor, the production of methane gas increases (Rojas-Downing et al. 2017; Trupa et al. 2015; Tseten et al. 2022). Therefore, Uganda should invest in the production of animal feeds and fodder to boost livestock productivity, reduce methane emissions, create shops and promote import substitutions.

Promote increased access to veterinary services, especially vaccination

Animal disease significantly reduces the productivity of livestock farming and our analysis reveals that animal diseases are responsible for loss of 7 liters of milk per animal per week (14 percent) and the loss of live weight of 8 kgs per animal (37 percent). Moreover, animal diseases have a potential to increase emissions in cattle by three times more than is the case with healthy animals (Capper 2023a). Healthy animals are more productive and sustainable as they require fewer natural resources to thrive, leading to a lower environmental impact. Our analysis shows that the only effective approach for increaseing livestock productivity and ensuring head health is through vaccination. Vaccination increases milk productivity by 29 percent (4 liters) per week per cow and increases weight gain by 18 percent (1.5 kg) per animal. Spraying and treatment did not have any significant effect on milk and weight gain in animals.

Based on these results, we recommend that the government should dedicate resources to livestock vaccination, because vaccination not only boosts productivity and prevents death but also reduces methane emission in cattle by 40 percent (Capper 2023b). Controlling livestock disease can reduce Meat Milk Yield (MMY) losses at the farm level, which improves food security, reduces GHG emissions, and enhances livestock system sustainability (Capper 2023b; Roques et al. 2023). Although the government does provide vaccination services, these services are always insufficient and carried out in firefighting mode when disease outbreaks occur, as opposed to prevention mode carried out as routine vaccination (Ilukor et al. 2015). We recommend that government should return to mandatory routine vaccination programs and promote a farmer group approach to reduce cost and increase access and reach of vaccination services, as well as formulate an all-inclusive vaccination policy. To vaccinate cattle every year may require about $50 million annually. This is a small cost compared to the losses incurred due to livestock diseases, estimated to be $1.1 billion annually (Kasaija et al. 2021).

Support private sector provision of communal holding points and feedlots to promote beef markets

Supporting sustainable expansion of livestock production in Uganda will require investments in livestock infrastructure like community feedlots (Cooprider et al. 2011; Slayi et al. 2023). These feedlots are community-managed facilities designed to optimize cattle management and improve livestock health and productivity (Cooprider et al. 2011; Manzanilla-Pech et al. 2022). Unlike the traditional extensive grazing systems, these feedlots provide controlled environments for cattle feeding and management by community members who collectively oversee cattle feeding, health care, and record-keeping (Slayi et al. 2023). The communal feedlots create economic opportunities for smallholder farmers by improving the growth and marketability of cattle. They also provide room for traceability, which is a requirement for livestock exports, thus enhancing income generation and poverty reduction efforts. Therefore, in addition to removing the barriers to market access for livestock value chains, community feedlots allow communities to adapt to climate change and contribute to mitigating greenhouse gas emissions by improving cattle management (Costa Junior et al. 2015; Harrington & Lu 2002).

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