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Opportunities and challenges of a community-based bull breeding programme: a case of the regional pastoral livelihood resilience project in Uganda

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The Regional Pastoral Livelihood Resilience Project Community-Based Breeding Programme (CBBP) was designed with the objective of increasing production and productivity of local Zebu cattle by introducing Sahiwal bulls among sedentary and agro-pastoral livestock farmers. This study mapped out actors, their roles and level of influence in the CBBP as well as the opportunities and challenges encountered during its implementation using the Process Net-Map tool. The results revealed that there were differences in number and type of influential actors between sedentary and agro-pastoral livestock farmers. The bull host and subcounty veterinary officer were the most influential actors among the sedentary livestock farmers whereas it was the herdsman, bull host, and Community Animal Health Workers (CAHWs) among the agro-pastoral farmers. The CBBP was associated with benefits such as increased market value for cattle, reduced chances for cattle rustling, increased cattle productivity in terms of milk and beef production volumes and ease of access to veterinary services. In contrast, the challenges encountered were related to both governance (limited availability of veterinarians, cattle rustling, exclusion of farmers in the planning phase of the CBBP, political interference and failure of collective action) and bull management (high costs of keeping and maintaining the bulls in terms of feeding, housing, watering and veterinary care, heavy bulls injuring or breaking the small cows, sexually transmitted reproductive diseases among others). Lastly, this paper recommends adoption of a combination of well-organized and facilitated Artificial Insemination (AI) programmes alongside the improved bull service scheme as each has capacity to address the challenges of another.

KEYWORDS

actors, opportunities, challenges, community based breeding programme, pastoral areas

Introduction

Pastoral lands account for a significant portion of Uganda's territory, comprising around 44% or approximately 84,000 square kilometres of the country's total land area (Byakagaba et al., 2018). Recent statistics show that pastoralism contributes 4.3% to the national GDP (UBOS, 2020). Like in many other parts of Africa, pastoralists in Uganda live in different environments with varying ecological, social, economic and political environments. Pastoralists in Uganda inhabit diverse environmental, social, economic, and political settings, which can vary significantly in factors such as mobility patterns, livestock specialization, market integration, and management practices (Galvin, 2009).

In Uganda, the pastoral communities are mainly disaggregated into agro-pastoral and sedentary livestock farmers (Waiswa et al., 2019). Agro-pastoral livestock farmers are characterized by seasonal movement of herds combined with crop production whereas sedentary livestock farmers are permanently settled in a defined area with no seasonal movements (Dai et al., 2023). Despite these differences in mobility patterns, the pastoral groups share numerous commonalities, including a strong reliance on livestock and livestock products as a means of sustenance, a cultural identity closely tied to animal husbandry, and specialized expertise in rearing livestock in Uganda's arid rangelands. Pastoralists also share common problems which include but not limited to high poverty levels, hunger, malnutrition, and most severely the low productivity levels of their cattle in terms of low growth rate to produce beef and milk as well as the small volumes of each produced (Ouali et al., 2023).

According to Lamuno et al. (2018), indigenous cattle productivity is affected by various challenges such as poor feeding and management systems, parasites and disease infestations as well as harsh climatic conditions. Whereas a lot of interventions have been done by government and private sector such as construction of valley dams and tanks to provide water to animals in the dry spell, construction of community cattle dips and spray races to combat cattle parasites, community massive vaccination to control the prevalence of cattle diseases and rehabilitation of rangelands to ensure availability of adequate pastures throughout the year, the productivity of indigenous cattle is still low (Daum et al., 2022). A study by Greenwood, (2021) on the productivity of indigenous cattle found out that on average, it takes Zebu cattle an average of 4 years to attain salable weight as compared to the exotic and improved breeds such as Sahiwal, Borans, Freshians, among others that need only 1½ years. He also further found that even after having spent 4 years to attain salable weight, the value of indigenous cattle was still lower on market as compared to the improved breeds of 1½ years due to body size differences as improved breeds appeared bigger than the indigenous ones. Furthermore, a similar analysis by Waiswa and Günlü (2023) on dairy cattle in Southwestern Uganda revealed that on average an indigenous cow produced 3.5 L of milk daily, cross breeds produced an average of 13.6 L of milk daily whereas exotic breeds produced an average of 18.7 L of milk daily if well managed.

According to Wilson, (2018), the most viable option for improving the performance and productivity of indigenous cattle and the livelihoods of pastoralists is breed improvement. Integrating improved cattle breeds into pastoral production systems can generate multiple benefits. At the farm level, these breeds can boost both beef and milk yields, increasing the overall volume of livestock-derived foods available to pastoral households (Daum et al., 2022). This enhanced livestock productivity can in turn strengthen rural beef and dairy value chains, improving market access and income generation for smallholder pastoralists. Increased beef and milk output is particularly valuable given the constrained supply and high costs that currently limit consumption of these nutrient-dense foods within pastoral communities. Improved livestock productivity therefore represents an opportunity to address persistent challenges of malnutrition and food insecurity. Beyond their direct nutritional and income roles, cattle also serve as a critical buffer resource that pastoral families can draw upon to cope with emergencies and other shocks, such as crop failures. Facilitating access to higher-yielding cattle breeds can thus enhance the resilience of these vulnerable communities. Overall, the adoption of breed improvement strategies represents a promising pathway for simultaneously enhancing the productivity and profitability of indigenous cattle systems, as well as improving food and nutrition security outcomes for pastoral populations in Uganda.

As a result, a number of livestock improvement breeding methods are currently available for farmers to choose, ranging from natural mating using improved bulls to Artificial Insemination (AI). However, despite the overwhelming advantages of AI over natural mating as discussed by Wurzinger et al. (2021), there is low availability and use of AI services in Uganda averaging between 2% and 15% (Debir, 2016). The sub-optimal use of AI is attributed to numerous reasons including but not limited to inadequate Artificial Insemination service centres, farmer's poor perception of AI, low conception rates and limited access to high-quality genetics (Patel et al., 2017).

Karayat et al. (2016) suggests that the most viable option for breed improvement is by use of improved bulls. The challenge however arises with the cost of purchasing and maintaining them in terms of feeding and veterinary costs since majority of the agro-pastoral and sedentary livestock farmers are usually resource constrained and marginalized (Lamuno et al., 2018). According to Haile et al. (2020), to effectively enhance breed improvement using improved bulls, Community Based Breeding Programmes (CBBPs) were designed. CBBPS are designed and implemented through the cooperative efforts of farmer groups working together with technical experts and stakeholders. The

core premise of CBBPs is to harness the collective knowledge, resources, and decision-making power of smallholder livestock keepers to drive genetic improvement within their herds and flocks but without undermining their genetic integrity and resilience potential (Lamuno et al., 2018). This collaborative model allows smallholder farmers to access technical guidance, training, and other support from agricultural extension officers, researchers, and other relevant stakeholders. The integration of scientific principles and community-based participation is what distinguishes CBBPs from more traditional, top-down livestock improvement initiatives. The participatory nature of these programs also ensures that the breeding objectives and strategies reflect the specific production environments, market demands, and cultural preferences of the smallholder communities involved (Wurzinger et al., 2021).

However, studies by Haile et al. (2019) and Haile et al. (2023) on the success of CBBPs in Africa found that 87% of them do not achieve their set objectives and often collapse with the closure of implementing projects. Haile et al. (2018) recommends that; it is crucial to clearly identify the key stakeholders involved, their respective roles, and their level of influence in achieving the CBBP objectives. This insight should then inform the design of sustainability strategies by implementing partners and donors. They also further recommend that there is need to assess the opportunities and challenges associated with the CBBP help donors and implementing partners to either acknowledge their contributions or realize the failures and design possible remedies on how best to address these challenges through institutional and policy reforms. However, all the above have not been done on the CBBP in Uganda. It is upon this back ground that this paper seeks to understand the rationale of the CBBP in Uganda by mapping out actors, their roles and level of influence towards the success of the CBBP as well as identifying the opportunities and challenges associated. This will inform project implementers and donors on how best to design and handle future projects of similar nature.

In Uganda, the government, in partnership with the World Bank, implemented the Regional Pastoral Livelihood Resilience Project (RPLRP) to promote the adoption of Community-Based Breeding Programs (CBBPs) across 12 key pastoral districts in the country (Ilukor et al., 2022). This 5-year initiative (2015–2019), led by the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF), sought to enhance the genetic potential and productivity of indigenous cattle breeds in terms of both beef and milk output (MAAIF, 2019). By leveraging the RPLRP framework, the Ugandan government aimed to catalyse a participatory, community-driven approach to livestock genetic improvement within the targeted pastoral regions. This included the districts of Abim, Amuria, Amudat, Bukedea, Katakwi, Kotido, Kaabong, Kween, Kumi, Napak, Moroto, and Nakapiripirit. According MAAIF, (2019), the RPLRP procured and distributed 360 Sahiwal bulls across Teso, Sebei and Karamoja sub-regions with each district receiving 30 bulls which were given to selected bull hosts and farmer groups. The farmers under their farmer groups were trained on farmer group dynamics to strengthen their groups. They were also trained on improved animal management practices such as proper feeding, housing, and disease control so as to ensure good health of the bull as well as their entire cattle herds.

Materials and methods

Study area and research design

The Regional Pastoralist Livelihoods Resilience Project (RPLRP) was used as a case study. The RPLRP was implemented in 12 districts including: 1) Seven (7) districts in the Karamoja region, namely, Kaabong, Amudat, Moroto, Nakapiripirit, Kotido, Abim and Napak, 2) four districts in Teso region, namely, Katakwi, Bukedea, Kumi and Amuria and 3) one district in the Sebei Region, namely, Kween. However, due to financial constraints, data was only picked from eight districts, namely, Kotido, Moroto, Nakapiripirit and Nabilatuk to represent Karamoja sub region; Katakwi, Bukedea and Amuria to represent Teso sub-region as well as Kween for Sebei sub region. These districts were selected due to ease of access and political stability as compared to the other project implementation districts. These districts are particularly susceptible to the impacts of prolonged drought periods, chronic water scarcity, and land degradation driven by overgrazing and the seasonal migration of livestock in search of dwindling forage and water resources (Auma and Badr, 2022) (Figure 1).

To cater for variations in ecological, social, economic and political environments that might affect the implementation of the CBBP, the study assessed actor involvement, challenges and the opportunities of the CBBP by both sedentary and agro-pastoral livestock farmers independently. Farmers from Sebei and Teso sub regions were categorized as sedentary because they are permanently settled in one locality whereas those from Karamoja sub region were considered agro-pastoral because during periods of water and forage scarcity, pastoral households migrate with their herds to areas with more abundant grazing resources and reliable water sources (Byaruhanga et al., 2014). During the implementation of the CBBP, the bull was being kept by a bull host and the access and utilization of this bull by other cattle farmers varied across the sedentary and agro-pastoral livestock production system. As seen in Figure 2, in the agro-pastoral livestock production system, cattle keepers (community and farmer group members) would utilize the services of the bull in the rangeland as their cows graze with those of the bull host including the bull whereas in the sedentary livestock production system, cattle keepers form both the farmer group and community would bring their cows for mounting to a stationed bull probably at the bull host's home.

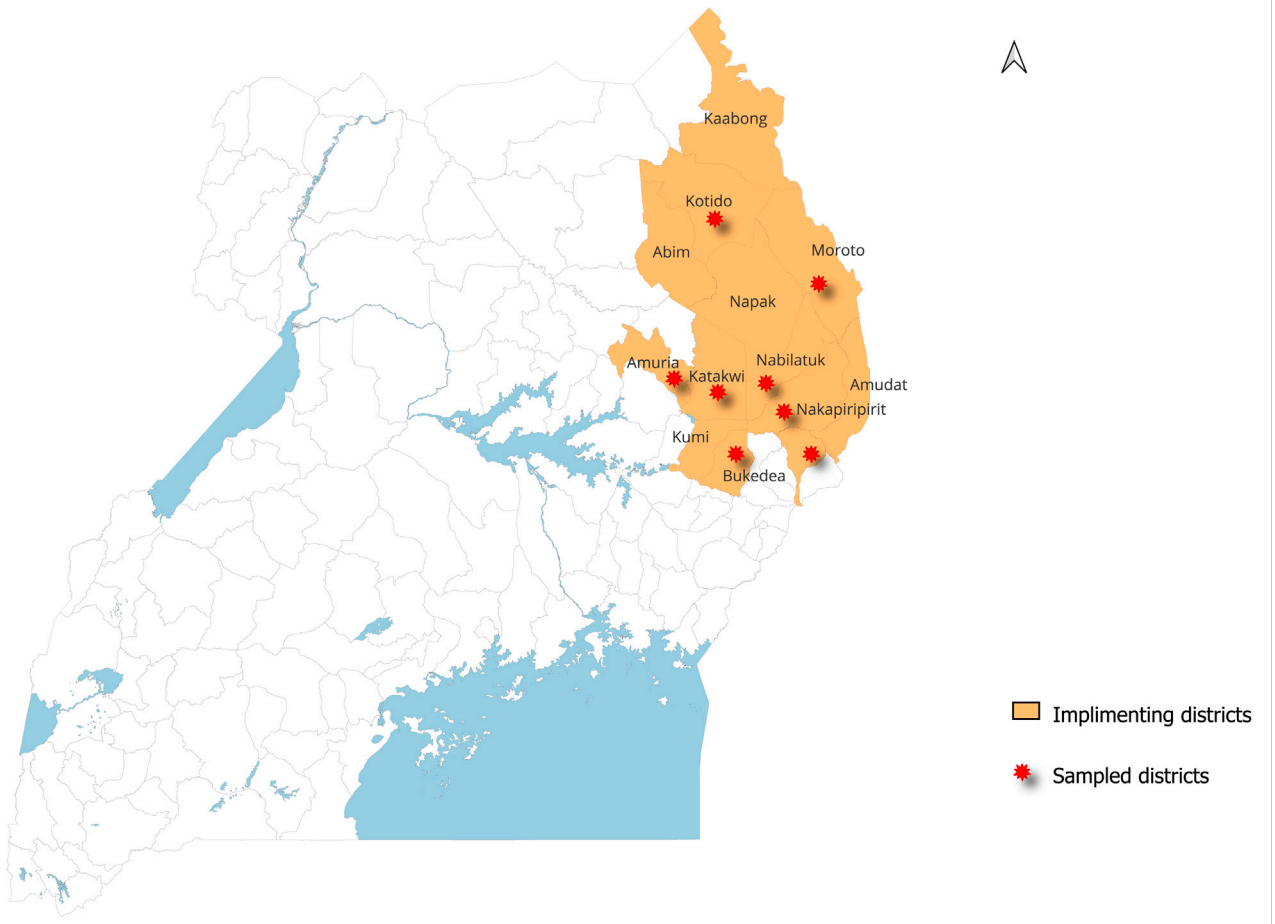


FIGURE 1
Map of Uganda showing the study area.

This study employed a Social Network Analysis (SNA) approach to investigate the key research questions surrounding the implementation of Community-Based Breeding Programs (CBBPs) in Uganda. Specifically, the analysis sought to: 1) identify any significant differences in actor participation between sedentary and agro-pastoral livestock production systems, 2) uncover the unique challenges affecting CBBP implementation in these contrasting production contexts, and 3) explore the potential opportunities associated with the CBBP initiative across the study area. Social Network Analysis has emerged as a valuable framework for examining governance dynamics and stakeholder interactions within agricultural development projects. Previous studies, such as Ilukor et al. (2015), have successfully leveraged SNA techniques to shed light on the complexities of veterinary service provision in Uganda. Building on these prior applications, the current research applied SNA tools to map the structural properties and relational patterns of the CBBP networks operating in both sedentary and agro-pastoral livestock systems. Beyond simply calculating conventional network metrics like degree, betweenness, and centrality, the analysis delved deeper to understand the perceived influence and decision-making power of the different actors involved. This nuanced, network-centric approach allowed the researchers to unpack the unique governance challenges and opportunities inherent to the CBBP model across these disparate production environments. The findings from this multilayered SNA investigation can offer crucial insights to guide the design and implementation of future community-based livestock improvement initiatives in Uganda and similar pastoral regions.

While mathematically-derived network metrics like degree, betweenness, and centrality can provide useful structural insights, they often fall short in capturing the nuanced, socially embedded nature of actor behaviors, decisions, and power dynamics within a given network (Freeman, 2011; Stephenson, 2016). These quantitative indicators may yield contradictory or misleading results, as they fail to account for the complex social factors that shape the agency and influence of

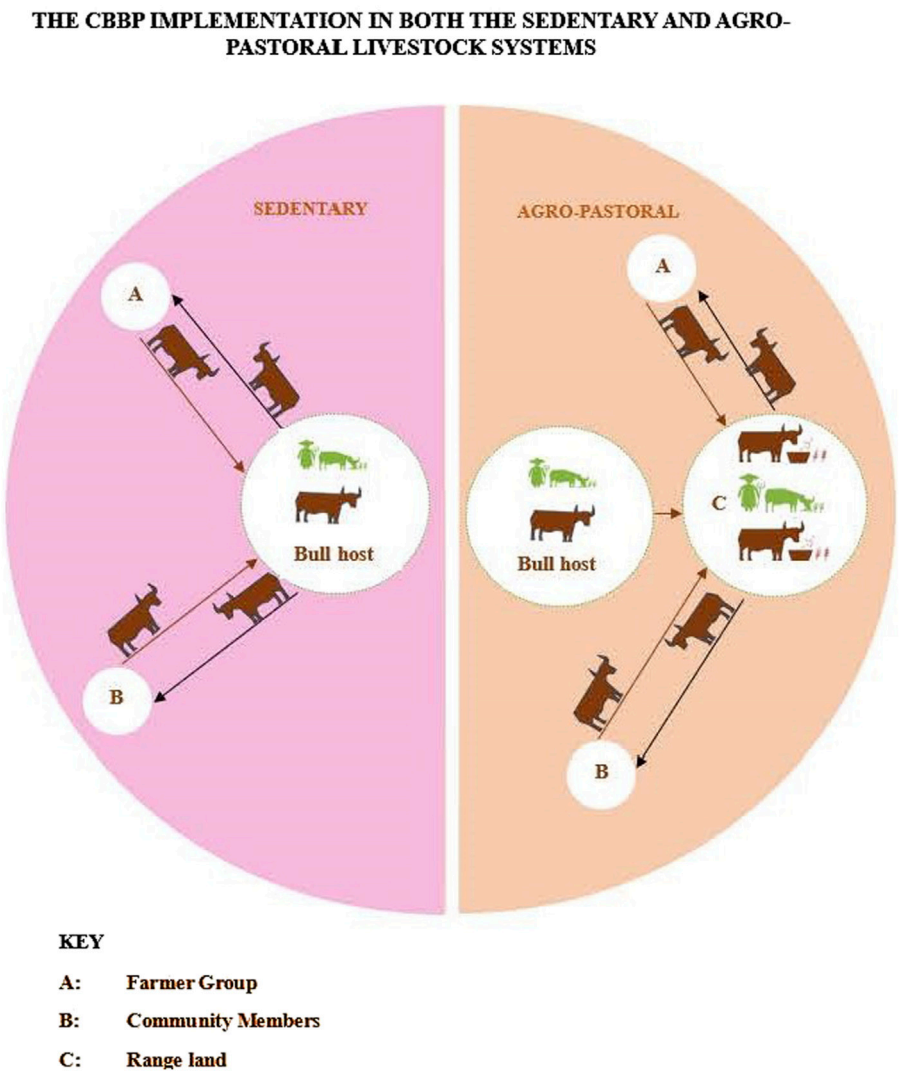


FIGURE 2
Showing CBBP implementation in the different livestock production systems.

network members (Raider and Krackhardt, 2017; Mizruchi and Marshall, 2016). For instance, in scenarios where peripheral actors exert direct influence over one another, the presumed "central" node may paradoxically be the least powerful player in the network (Mizruchi and Marshall, 2016). Consequently, the challenge of meaningfully interpreting these mathematical network measures and relating them to real-world realities often remains a significant hurdle (Raider and Krackhardt, 2017). To address these limitations, an alternative, more participatory approach to Social Network Analysis (SNA) has emerged. This methodology involves directly eliciting respondents' perceptions of actor influence and power levels, rather than relying solely on computed structural indicators (Raider and Krackhardt, 2017). Furthermore, innovative participatory SNA tools, such as "Net-Map" and "Process Net-Map," leverage interactive group-based mapping techniques to visually capture both the network structure and the underlying social-political dynamics shaping the relationships within it (Hogan et al., 2011; Schiffer and Hauck, 2010). Embracing this more grounded, qualitative approach, the current study employed the Process Net-Map tool to systematically map out the step-by-step CBBP process, identifying the key actors involved, the challenges encountered, and the opportunities that emerged. By centering the perspectives and lived experiences of the network participants, this participatory SNA methodology can generate rich, contextualized insights to guide the design and implementation of future community-based livestock development initiatives.

The Process Net-Map, a variant of the traditional Net-Map technique, offers a particularly insightful approach to Social

Network Analysis (SNA) by focusing on the consecutive steps of an implementation process rather than solely the static connections between actors (Ilukor et al., 2015). This methodological approach is especially valuable for unpacking the nuances of on-the-ground program delivery, revealing how the actual implementation may diverge from formally prescribed procedures. Developed by Birner et al. (2010) and building upon the work of Schiffer and Waale, (2008), the Process Net-Map tool circumvents the challenge of defining rigid network boundaries by following a predefined process and prompting respondents to actively identify the full cast of actors involved from start to finish (Wang et al., 2022). Crucially, the sequential, step-by-step nature of the questioning process facilitates more effective recall among participants, in contrast to the Net-Map's approach of asking respondents to holistically name all influential actors at once – a cognitive burden that can hinder comprehensive data collection (Ilukor et al., 2015).

In this study, data were collected through a combination of focus group discussions (FGDs) and key informant interviews (KIIs) to leverage the Process Net-Map tool. Sixteen (16) KIIs (2 in each district) were conducted with the officials from the veterinary department of the district, especially the district veterinary officers (DVOs) and Subcounty veterinary officers (SVOs) who were in charge of the project, before the FGDs with the bull hosts. This initial round of KIIs helped gain technical information about the CBBP that may not have been provided by the bull hosts and also ensured the selection of the most appropriate persons for the FGDs. Eight (8) FGDs (one in each district) were then conducted, comprising twelve to fifteen bull hosts, the DVO, and the SVOs. Four of the FGDs were with sedentary livestock farmers and four were with agro-pastoral livestock farmers. The FGDs involved drawing the process net-map with the aim of understanding the different actors that participated in the CBBP, their roles, and levels of influence. Furthermore, the bull hosts discussed the challenges and opportunities associated with the CBBP during the FGDs. In addition, 16 more KIIs were conducted (2 per district) with the technical people, including some bull hosts who appeared to have more information during the FGDs, as well as the DVO and SVOs, to cross-check and validate the information generated from the actor process net-mapping exercise. This multipronged data collection strategy, combining the participatory Process Net-Map with targeted expert interviews, helped to triangulate the findings and strengthen the overall analytical rigor. By centering the lived experiences and perspectives of the key stakeholders involved in the CBBP implementation process, this innovative SNA approach offers a granular, contextually grounded understanding of the governance dynamics, challenges, and opportunities inherent to community-based livestock development initiatives. The rich, nuanced data generated through the Process Net-Map methodology can inform more effective, responsive, and impactful program design and delivery moving forward (Table 1).

The process of identifying actors and their roles in the community-based breeding programme during the FGDs followed three phases as adopted from a study by Ilukor et al. (2015). In Phase 1, the researchers asked the respondents to describe the process step-by-step. Whenever a new actor was mentioned, the researcher would write the actor's name on a manila chart laid out in front of the respondents. This process provided a robust way to obtain data on established patterns of interaction between actors, as it enabled the participants to narrate what happens in the real world. Different coloured arrows were used to represent different types of links between the actors. Each step in the process was indicated by a link between actors, and the link was numbered. A legend on the map was used to describe the meaning of each number. This procedure was repeated until the last actor in the community bull breeding scheme was reached. During the discussions, more actors were added whenever the participants recalled them. This iterative approach ensured a comprehensive capture of all the relevant actors involved in the process. The step-by-step nature of this process, as opposed to asking respondents to holistically name all influential actors at once, facilitated more effective recall among the participants. This, in turn, helped to generate a rich and nuanced understanding of the various actors, their roles, and the dynamics of their interactions within the community-based breeding program.

In Phase 2, the researchers asked the respondents to define the level of influence that each actor had in the community-based bull breeding program. To visualize the influence levels, the researchers set up "influence towers" using office pins. The researchers pinned the name of each actor onto the manila chart, and then assigned a number of office pins to the actor's name, corresponding to their perceived level of influence. Actors who were considered to have no influence were not assigned any pins. The more pins an actor had, the higher their perceived level of influence in the community-based breeding program. Respondents were encouraged to adjust the number of pins assigned to each actor during the interview, and to verbally explain the reasons for the influence levels they attributed to the different actors. This visual representation of influence levels was intended to facilitate a more nuanced discussion and understanding of the relative influence of the various actors. Without such a visualization, especially when dealing with a large number of actors, it would have been more difficult for the respondents to articulate and compare the influence levels of the different stakeholders. The use of this "influence tower" approach, as adopted from Birner et al. (2010) and Schiffer and Hauck (2010) enabled the researchers to elicit rich information from the respondents about the power dynamics and stakeholder influence within the community-based bull breeding program.

In the final Phase 3, the researchers asked the respondents to identify the existing opportunities for the community-based bull breeding program (CBBP), as well as its implementation hurdles and

TABLE 1 Number and type of interviews in the two main case study production systems.

Production system	District	KIIs before FGD	FGD (net map)	KIIs after FGD
Ago-pastoral	Kotido	2	1	2
	Nakapiripirit	2	1	2
	Nabilatuk	2	1	2
	Moroto	2	1	2
Sedentary	Katakwi	2	1	2
	Amuria	2	1	2
	Bukedea	2	1	2
	Kween	2	1	2
TOTAL		**16**	**8**	**16**

The bold values represent totals of each tool (KIIs and FGDs) that were conducted.

challenges. The focus was on eliciting the main attributes that farmers appreciated as opportunities or advantages of the CBBP. The researchers also explored the known governance problems and other challenges documented in the literature, as well as any additional issues that may not have received much attention before. Each individual participant was asked to share their positive and negative experiences with the CBBP during the interview. However, the interviewers emphasized that the goal was not to simply uncover problems that had occurred in the study location, but rather to identify potential entry points for addressing challenges and improving the program. In this final phase, the researchers also paid particular attention to specific actor positions and linkages that seemed likely to pose structural problems for the effective implementation of the CBBP. This allowed them to pinpoint critical leverage points and opportunities for strengthening the program. By systematically exploring both the opportunities and the implementation challenges from the perspectives of the various stakeholders, the researchers were able to develop a holistic understanding of the CBBP and identify potential avenues for enhancing its design and delivery. After data collection, the process net maps drawn were digitalized by drawing flow charts in PowerPoint using connectors to allow presentation of the results in a way that reflects the step-by-step mapping approach used during the interviews as seen in Figures 3, 4.

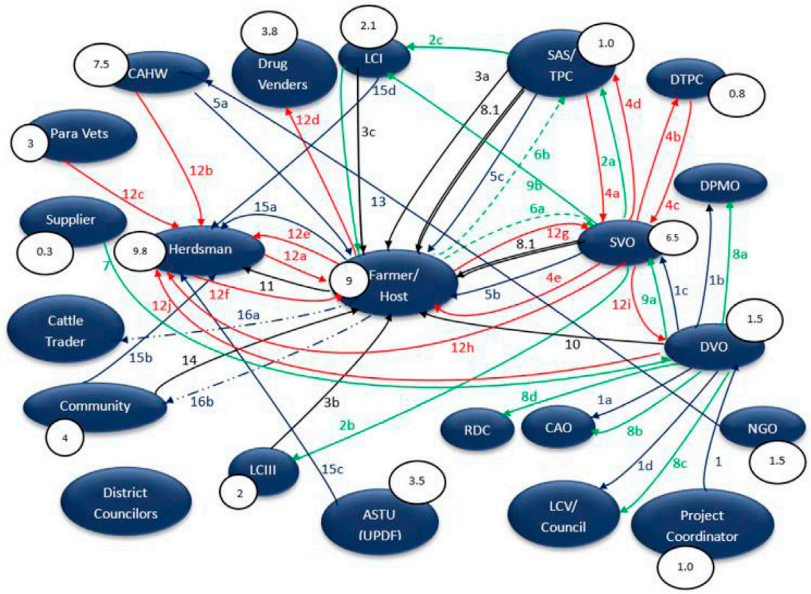
Results

Using the Net-Map tool, the researchers identified 18 main actors in the community-based bull breeding program (CBBP) within the agro-pastoral production system, namely; Bull Host farmer, Herdsman, Farmer Group, Community Members/Other Farmers, Subcounty Veterinary Officers (SVO), Para-vets, Community Based Animal Husbandry Workers, Veterinary Drug Shops, Local Council Leaders, Security Personnel, District Veterinary Officer (DVO), Agriculture Officer (Ao), District Leadership (CAO, RDC, CP/LCV), Nongovernmental organizations, Subcounty Chief (SAS), Cattle Trader, Bull Supplier and the Ministry of Agriculture, animal industry and Fisheries (MAAIF) which was the project implementing body. However, these actors vary in a way that some are present in one livestock production system and missing in another. In addition, majority of the actors crosscut in both production systems and each actor level of influence also varies across the different production systems.

Actor mapping and the CBBP process in the agro-pastoral production system

The description of the process and actor influence in the community-based bull breeding scheme (CBBP) within the agro-pastoral livestock production system was based on focus group discussions (FGDs) conducted with bull hosts. During the process influence mapping exercise, a total of 17 actors were identified as the main stakeholders in the CBBP. These 17 key actors are listed in Table 2. The digitalized representation of the actor network is presented in Figure 3, which visualizes the interconnections and relationships between the various stakeholders involved in the community-based bull breeding program.

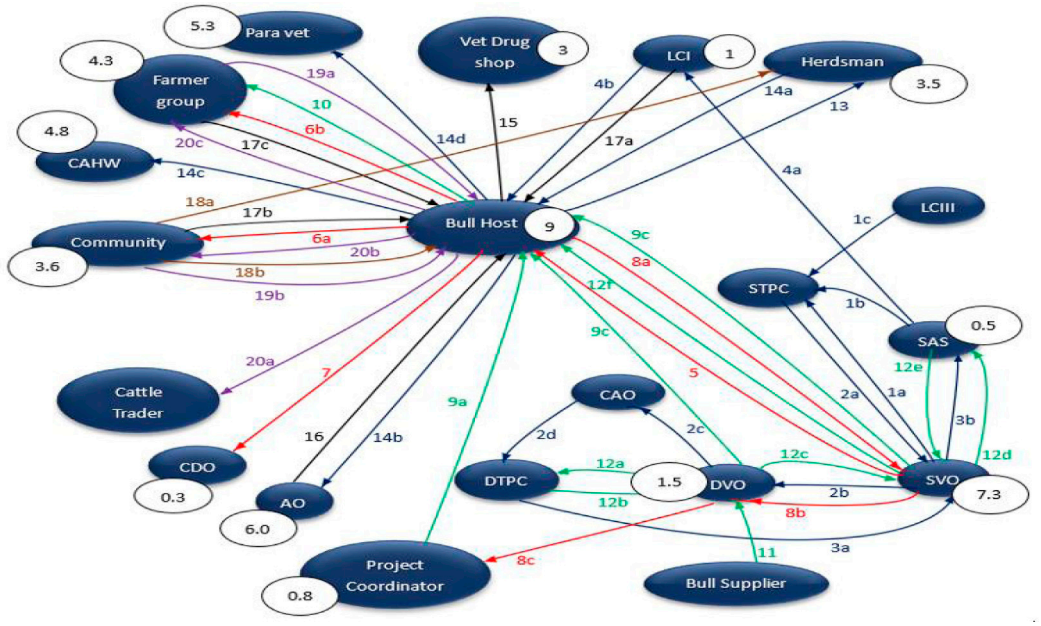
Following the digitalization of the actor network map, the researchers calculated the mean influence scores for each stakeholder. This was done by summing up the individual ranking scores attributed to each actor across the two focus group discussions. The sum was then divided by the number of districts that had reported on that particular actor. The resulting mean value for each actor's influence was rounded to the nearest whole number. This allowed the researchers to arrive at a standardized influence score for each of the 17 key stakeholders identified through the Net-Mapping exercise. In



1. DVO gets information from the project coordinator about the breeding bulls and the beneficiary requirements.
1a. DVO informs CAO about the district receiving bulls from the project
1b. DVO also informs the DPMO about the district receiving bulls from the project
1c. DVO informs SVO about the project and instructs them to work with the sub-county chiefs to select beneficiaries
1d. DVO also informs the Chairperson LCV about the district receiving the breeding bulls
2a. The SVO informs the sub-county technical committee (Sub- County chief and councilors) about the project and the requirements for beneficiaries
2b. SVO also informs the Chairperson LC III about the project and the requirements for beneficiaries
2c. The sub-county technical committee called for a meeting of LC1 chairpersons to inform them about the project and how farmers will participate
3a, 3b and 3c. The sub-county technical planning committee, Chairpersons LC III and Chairpersons LC I respectively shortlisted the beneficiaries from their sub-counties of jurisdiction.
4a. The SVO received the selected lists of beneficiaries from the sub-county technical committee
4b. The SVO submitted the list of beneficiaries from the sub-counties to the district technical committee for approval.
4c. After approval, the DTC communicated to the SVO about the selected lists of beneficiaries
4d. The SVO takes the list of approved farmers to the STC
4e. The SVO informs the selected farmers about the project and advises them to form breeding groups.
5a, b and c. The SVO, CAHW, and STC called for a meeting to train farmers on how to form groups and enlighten them more on the project.
6a, 6b. The SVO and STC again called for a meeting at sub county headquarters to train farmers on animal management practices specifically pasture growing and housing.
7. The bull supplier brought the bulls to the district and handed them over to the DVO
8a, 8b, 8c, and 8d DVO handed over the bulls to the DPMO, CAO, LCV, and RDC for commissioning.
9a. The DVO instructs the SVO to inform the selected beneficiaries to come to the district headquarters and pick their bulls
9b. The SVO informs the LCI chairpersons to inform the beneficiaries to go to the district and pick the bulls
9c. The LCI chairperson informs the beneficiaries to go to the district and pick the bulls
10. The DVO hands over the bulls to the beneficiaries
11. The bull beneficiaries' hand over the bull to the herdsman for management (feeding, watering, security, etc)
12a. Herdsman informs the farmer about the diseased bull
12b. Herdman contacts CAHW to come and treat the bull
12c. If CAHW is not available or fails to treat the bull, the herdsman calls the Para- Vet
12d. Sometimes the bull host goes to the market and buys veterinary drugs from drug vendors
12e. The farmer gives the drugs acquired from the drug vendors to the herdsman to treat the bull
12f. In scenarios where the bulls fail to recover from sickness, the herdsman informs the farmer
12g. The farmer responds by calling the SVO to come and treat the bull
12h. The SVO gets in touch with the herdsman who is the custodian of the bull to treat it
12i. In case the SVO fails to treat the bull, he refers the case to the DVO
12j. The DVO gets in touch with the herdsman who is the custodian of the bull to treat it
13. The NGOs train and equip CAHW with veterinary drugs
14. The community offers cows for mating with the bull to enhance breeding
15a. The bull host supervises the herdsman and provides security to the bull and other cattle
15b, c, and d. The Community, Anti Stock Theft Unit (ASTU) and LCI also work closely with the herdsman to ensure the safety of the bull and other cattle
16a. In scenarios of disposing off the bull, the farmer takes it to the cattle traders in cattle markets
16b. Sometimes, the farmer sells the bull to any member of the community or exchanges it to get other bulls or cows

FIGURE 3
A network of actors involved in the CBBP of the agro-pastoral production system.

addition to the mean influence scores, the researchers also calculated the range -which is the difference between the highest and lowest influence scores assigned to the actors. This range provided an indication of the variance in perceived influence levels among the different stakeholders involved in the community-based bull breeding program. By computing both the mean influence scores and the range, the researchers were able to develop a more nuanced understanding of the relative power dynamics and level of influence exercised by the various actors within the CBBP ecosystem. This quantitative analysis complemented the qualitative insights gathered through the focus group discussions (Table 2).



1a, 1b and 1c. SVO, SAS, and LCIII respectively compiled lists of farmers and submitted to STPC for vetting
2a. The STPC forwarded approved list of beneficiaries to the SVO
2b. The SVO submitted approved list of beneficiaries to the DVO
2c. The DVO submitted approved list of beneficiaries to the CAO
2d. The CAO submitted approved list of beneficiaries to the DTPC for approval at the district level
3a. The DTPC sends the approved list if beneficiaries to SVO
3b. The SVO delivers the approved list if beneficiaries to the SAS
4a. The SAS informs the LCI chairperson about the selected farmers to participate in the project
4b. The LCI chairperson informs the farmers about the selected farmers to participate in the project
5. The SVO trained farmers (bull hosts) to form farmer groups
6a. The bull host informs the community members about the project
6b. The bull host mobilizes the community members about the project
7. The bull host goes to the CDO to register the group
8a. The bull host submits the name of the registered group to the SVO
8b. The SVO compiles the list of the formed breeding groups and submits them to the DVO
8c. The DVO submits the list of the formed breeding groups to the Project Coordinator for documentation
9a, 9b and 9c. The Project Coordinator, DVO and SVO trained farmers on the project objectives, bull management and group dynamics
10. The bull host went back and trained other group members on what he had learnt from the meeting with the Project Coordinator, DVO and SVO
11. The bull supplier delivered the bull to the DVO
12a. The DVO handed over the bull to DTPC for officiation
12b. The DTPC handed back the bull to the DVO
12c. The DVO handed the bull to the SVO
12d. The SVO hands over the bull to SAS for officiation at Sub County level
12e. The SAS hands back the bull to SVO
12f. The SVO hands the bull to the bull host
13. Herdsman grazes the bull
14a. Herdsman informs the bull host of the sick bull
14b. The bull host informs AO of the sick bull
14c. The bull host informs the CAHW of the sick bull
14d. The bull host informs the Para-vet of the sick bull
15. Farmers go vet drug shop to buy drugs
16. The AO advises the bull host on general bull management practices
17a, 17b and 17c. The LCI, Community and farmer group assist the bull host in ensuring security of the and other animals
18a, 18b. Community provides grazing land for the bull and other cattle
19a, 19b. Farmer group and community members provide cows for mating with the bull
20a. The bull host will take the bull to the market to sale to cattle traders
20b, 2c. The bull host looks for any group or community member and exchanges the bull for the cows

FIGURE 4
A network of actors involved in the CBBP of the sedentary production system.

TABLE 2 Actor scores in the CBBP in the different districts in the Agro-pastoral production systems.

Actor	Kotido	Moroto	Nabilatuk	Nakapiripiriti	Total	Mean	Range
Bull Host	8	9	9	10	36	**9.0**	2.0
Herdsman	10	10	10	9	39	**9.8**	1.0
Community Members/Other cattle Farmers	0	8	4	4	16	**4.0**	8.0
Subcounty Veterinary Officers (SVO)	6	6	7	7	26	**6.5**	1.0
Para-vets	5	4	3	0	12	**3.0**	5.0
Community Animal Health Workers	9	5	8	8	30	**7.5**	4.0
Veterinary Drug Vendors	7	3	5	0	15	**3.8**	7.0
Local Council 1 Chairpersons	3	2	0	5	10	**2.5**	3.0
The army (UPDF-ASTU)	4	0	4	6	14	**3.5**	6.0
District Veterinary Officer (DVO)	0	0	6	0	6	**1.5**	6.0
District Leadership (CAO, RDC, CP/LC V	0	1	0	2	3	**0.8**	3.0
Nongovernmental organizations	—	—	2	1	3	**1.5**	2.0
Farmer group	0	1	1	3	3	**1.7**	3.0
Cattle Trader	0	0	0	0	0	**0.0**	0.0
Bull Supplier	1	0	0	0	1	**0.3**	1.0
MAAIF/Project Coordinator	2	0	1	1	4	**1.0**	2.0

Herdsman

In the agro-pastoral livestock production system, the responsibility of caring for the animals typically falls on the children from livestock-keeping households. These are tasked with the day-to-day management and tending of the livestock belonging to their families. The herdsmen were ranked as the most influential actors in the Community based Bull breeding scheme in the agro-pastoral livestock production system with a mean score of 9.8 because they are responsible for feeding, watering, and general management of the bull and other cattle. The range for the herdsman score was lowest meaning that there is greater agreement among the bull hosts in the study districts about the influence of the Herdsmen in the CBPP. Since the pastoral areas are characterized by general lack of water and pasture for animals, herds men spend much time with the cattle than the owners. In the FGDs, it was reported that at times herdsmen in the agro-pastoral communities can move over 200 km away from home to places with water and pastures and graze cattle and can stay there for almost 2 months.

During such periods, it is the herdsman with full control over the bull and other cattle and it is upon his willingness to allow the cows of the other community members to mate with the improved bull. In scenarios where the herdsman is not the one keeping the improved bull, he identifies cows on heat and take them for mating with this improved bull. The herdsman is generally responsible for overseeing the welfare and health the bull, it's off springs and the general herd at large. It was reported that incase the herdsmen fails to perform their duties, the CBBP cannot achieve success. For example, if the herdsman does not water and feed the bull very well, it cannot perform its duties well. Also, if the herdsman does not detect cows on heat and take them to mate with this improved bull, less offspring will be sired in the breeding communities and if the herdsman does not treat or report cases of sickness to the cattle owner or veterinarians, all cattle can die. However, it was reported that some herdsmen fail to detect and report sick cattle on time and cattle end up dying, fail to graze cattle on time and also connive with the rustlers to steal the bulls and their offspring.

Bull hosts

In the agro-pastoral communities, cattle are regarded as assets, a store of wealth, collateral for credit, and an essential source of pride in the community. Therefore, breeding to increase the quantity and quality of cattle is taken seriously because cattle count much on the livelihoods in these communities. The host is a member of a cattle breeding group that provides shelter to the breeding bull and is also responsible for the routine management activities. The bull host was ranked the second highest influential actor in the CBBP of the agro-pastoral livestock production system with a mean score of 9.0. They supervise the herdsman to ensure that the cattle are well fed, healthy and in good state. The range for the bull host score was low meaning that there is greater agreement among the bull hosts in the study districts about their influence in the CBPP. It was

also found that in scenarios where the bull is owned by a group, the role played by the hosts is voluntary. However, the hosts enjoy benefits such as having more access to the breeding stock, extension services, and training. Furthermore, even though majority of the bull hosts were Male, it was reported that women are closer to these animals and so they perform more duties in terms of feeding, watering, and identification of illnesses than men. In the agro-pastoral context, women have a strong vested interest in the welfare of the communal breeding bulls, as the loss of a bull would directly impact their household's primary source of income. Women closely monitor the bulls' wellbeing, as they bear the brunt of the financial consequences if a bull were to fall ill or perish. Conversely, the men's influence in the bull breeding program stems from their role in mobilizing resources for the bulls' veterinary care and treatment expenses. Additionally, men play a key decision-making part in determining whether to sell a bull or retain it for continued breeding within the community. This complementary dynamic, where women focus on the day-to-day care and men contribute to resource allocation and strategic decisions, highlights the gender-based division of responsibilities that helps sustain the community-based bull breeding program in the agropastoral system.

Community animal health workers

Within the agro-pastoral communities, the Community Animal Health Workers (CAHWs) serve as an important local resource for basic livestock healthcare. These CAHWs are typically selected from within the communities themselves, and undergo a relatively short, non-formal training program - usually around 3 months in duration. Through this abbreviated yet targeted training, the CAHWs acquire foundational knowledge and skills in animal health management. This allows them to provide essential veterinary services and advice to their fellow community members, who may have limited access to formal veterinary care and resources. The CAHWs' intimate understanding of the local context, coupled with their practical training, positions them as readily accessible and trusted providers of animal health support within the agro-pastoral production system. This community-based model helps bridge the gap between the livestock keepers and more distant, formally-trained veterinary professionals. By empowering local community members as CAHWs, the system taps into the existing social networks and knowledge of the agro-pastoral communities, thereby enhancing the overall resilience and self-reliance of the livestock management practices. The CAHWs were responsible for identifying and treating sick animals, referring severe cases of cattle illnesses to the Subcounty Veterinary officer and the District Veterinary Officer as well as performing other breeding related tasks such as castration. The CAHWs were ranked as the third influential actors in the CBBP of the agro-pastoral production system with a mean score of 7.5 because they were ever readily and freely available to attend to the sick bulls, offsprings and other cattle with immediate effect. The range for the CAHWs score was low meaning that there is greater agreement among the bull hosts in the study districts about the influence of the CAHWs in the CBPP. However, it was reported that CAHWs sometimes fail to correctly diagnose cattle thus leading to death. It was reported by one of the respondents that when his bull fell sick, the CAHW diagnosed and treated it for anaplasmosis, but it eventually died. After the death of the bull, the district veterinary officer carried out a postmortem and reported that the bull died because of East Coast fever.

Subcounty veterinary officers (SVO)

The bull hosts ranked the sub-county veterinary officers as the fourth influential actor in the CBBP of the agro-pastoral livestock production system with a mean score of 6.5. The subcounty officers were highly ranked because they were the primary information source to the beneficiaries about the project. They also mobilized cattle farmers to form breeding groups and offered training on animal management practices. It was reported that they are ever readily and freely available to attend to the sick bulls and off springs with immediate effect as compared to the DVOs. The range for the SVO score was low meaning that there is greater agreement among the bull hosts in the study districts about the influence of the SVO in CBPP. However, despite the subcounty veterinary officer being readily available, it was reported that they often lack drugs to administer to the bulls and other cattle.

Community members/other cattle farmers

The bull hosts ranked the community members as the fifth influential actors in the CBBP in the agro-pastoral livestock production system with a mean score of 4.0. However, the range for the community members score was high meaning that there is greater disagreement among the bull hosts in the study districts about the influence of the community in CBPP. Community members support the management of the breeding bull by providing free grazing land, security and offering cows for mating with the bull. Sometimes some community members also pay for the bull service and thus help the host in mobilizing resources for veterinary care of the bull. However, because of the heavy nature of the Sahiwal bulls, some community members refused to offer their small bodied indigenous cows (mainly Zebu) for mating in fear that the bull would break them. It was also reported that, many cows died at calving because the calves (which were offspring of the Sahiwal bull) would be very big rendering the small cows unable to calve them which would cause death in scenarios where the veterinary officer is not available to assist or operate the cow. This impacted the community perception and willingness to use the bull hence leading to low bull reproductive rates in terms of offspring sired in a community. In Nakaperimolu subcounty of Abim district, one of the bull hosts reported that his bull was bewitched (its

pennis erected and it remained out for a full week until it died in pain) because as it tried to mount a neighbor's cow as they were grazing, it broke the cow's legs and so the neighbour retaliated that way.

Veterinary drug vendors

Within the community-based bull breeding program (CBBP) context, the veterinary drug vendors were ranked as the sixth most influential actor, with a mean influence score of 3.5. However, the wide range in the assigned scores indicates a lack of consensus among the bull host communities regarding the true extent of the drug vendors' influence. In the agro-pastoral production system, cattle farmers primarily rely on these readily available veterinary drug vendors, often found operating in local livestock markets, to purchase medications and self administer treatments to their animals. Farmers tend to only seek out the services of formally trained veterinarians when a particular case proves unresponsive to the privately procured drugs. This practice stands in contrast to the national guidelines stipulated in the 2007 UNBS Animal Safety Code, which mandate that all veterinary pharmaceuticals should be procured exclusively from licensed veterinary drug shops. The dominance of the informal drug vendors can be attributed to the limited accessibility of legitimate veterinary pharmacies, especially in remote rural areas. Furthermore, there are concerns that some unscrupulous vendors may exploit the farmers' limited veterinary knowledge by disguising herbal concoctions as genuine vaccines or by selling human medications, such as painkillers, anti-parasitic, and antibiotics, as treatments for livestock. While these alternative remedies may provide temporary symptomatic relief, they often fail to effectively cure the underlying animal health issues, ultimately leading to negative outcomes for the cattle. This complex dynamic, where informal drug vendors assume a prominent role in the livestock healthcare landscape, despite the existence of regulatory standards, underscores the need for improved access to formal veterinary services and products within the agro-pastoral communities.

"While these drugs provide temporary relief of the symptoms, the cattle are not cured, and they eventually die" said one of the DVOs.

However, despite their demerits, veterinary drug vendors increase accessibility to veterinary inputs that are used in routine cattle management, disease and vector control among cattle keeping communities.

The army (UPDF-ASTU)

Cattle theft is prevalent in the study areas. In order to ensure safety of cattle and cattle owners in the pastoral communities, the government of Uganda established the Anti Stock Theft Unit (ASTU) in 2005. During a key informant interview, the Anti Stock Theft Unit (ASTU) Commander reported that about 42,000 cattle were reported to have been stolen from cattle keepers in Karamoja region only between July to September 2023 but only 25,783 have been recovered. Due to the role of ASTU in the agro-pastoral production system, there were minimal cases of theft of the breeding bulls provided for the CBBP. The ASTU was ranked as the seventh influential actor in the CBBP of the agro-pastoral production system with a mean score of 3.5 because they ensured security of the bulls and the community cows for mating with the bull. However, the range in the mean scores for the ASTU was high meaning that there is greater disagreement among the bull hosts in the study districts about the influence of the ASTU in the CBPP. Furthermore, it was reported that despite the existence of ASTU, cattle raids are still the order of the day and some breeding bulls together with their offspring were raided. Severe cases of raiding the breeding bulls and their offspring were reported in Moroto district where 12 out of the 27 farmers who hosted the breeding bulls reported that their bulls were raided.

Para-vets

The para-vets were ranked eighth among the most influential actors in the CBBP in the agropastoral livestock production system with a mean score of 3.0. The range for the para-vets score was low meaning that there is greater agreement among the bull hosts in the study districts about the influence of the para-vets in the CBPP. As described by Maposa et al. (2023), paravets are skilled professionals who have received specialized training in a range of livestock care and management practices. This includes competencies in artificial insemination, first aid, the administration of medicines and vaccines, as well as assisting veterinarians with surgical, medical, and gynecological procedures. Within the context of the community-based bull breeding program in the agro-pastoral production system, these para-vets play a crucial role in supporting the overall health and wellbeing of the communal breeding bulls. They are responsible for treating sick animals, providing advisory services to the cattle farmers, and being readily available to address any emergencies that may arise. The presence of these paravets, with their intermediate-level expertise and on-the-ground accessibility, helps to bridge the gap between the livestock keepers and the more formally trained veterinary professionals. This allows for timely and localized veterinary care, which is essential for maintaining the productivity and longevity of the critical breeding bulls within the community-based breeding scheme. By leveraging the para-vets' specialized skills and their deep understanding of the local context, the agro-pastoral communities are able to enhance the resilience and sustainability of their livestock management practices. This integrative approach, combining the expertise of para-vets and the broader community, contributes to the overall success and impact of the community-based bull breeding program.

"Although para-vets cannot be a substitute for veterinarians, these personnel are able to provide cheap, locally available basic healthcare service that can lead to improvements in herd health" said one of the bull hosts. However, the bull hosts reported that despite the availability and high efficiency of the Para-vets, (always have drugs and can diagonise the right disease), their services are expensive, and are never offered on credit.

Local council 1 chairpersons

The LC 1 chairpersons were identified as the ninth influential actor in the CBBP in the agro-pastoral livestock production system with a mean score of 2.5. The range for the local council one chairperson's score was low meaning that there is greater disagreement among the bull hosts in the study districts about the influence of the local council 1 chairpersons in the CBPP. It was reported that these are responsible for settling grievances that occur in the bull breeding communities and issuing letters of proof of ownership to bull hosts when selling off the bulls or their offspring. However, it was reported that some of them failed to technically handle the grievances surrounding the community bull breeding scheme which in turn not only led to distortion of breeding groups but also death of some community members. In some scenarios, the LC1 chairpersons were also accused of issuing letters to cattle thieves without verifying the ownership of the animal which in turn promoted cattle theft in the bull breeding communities.

Farmer group

According to KIIs, it was mandatory for all beneficiaries to belong to a livestock breeding group. However, the beneficiaries reported that since these groups were just formed for the cause of acquiring the bull, majority got dismantled after the intended objective was achieved. The bull hosts ranked the farmer group 10th among the influential actors in the community based bull breeding scheme in the agro-pastoral livestock production system with a mean score of 1.7. The range for the farmer group score was low meaning that there is greater agreement among the bull hosts in the study districts about the influence of the farmer group in the CBPP. Group members support the management of the CBBP by contributing financial resources for bull management, supervising the bull host, bringing in their cows to mate with the bull, security, and at times help in the feeding of the bull. However, the farmer group scored zero in Kotido district because the respondents mentioned that the groups only existed by names just as a pre requisite to get the bulls but it was never beneficial after receiving the bulls. This was evidenced by the fact that majority of the respondents could not even remember the names of their groups. In addition, in communities where the breeding groups existed, the bull hosts noted that the commitment to the group obligations was not consistent. Some groups even had members who were not willing to make any financial contribution to support the treatment, deworming, and tick control yet they wanted to utilize the services of the bull.

District veterinary officer (DVO)

The DVOs was ranked 11th among the influential actors in the CBBP in the agro-pastoral livestock production system with a mean score of 1.5. The range for the DVO score in the agro-pastoral areas was high meaning that there is greater disagreement among the bull hosts in the study districts about the influence of the DVO in the CBPP. The DVO was supposed to quarantine the bulls in one place upon delivery by the supplier to observe any cases of illnesses, physical damages, and also approve that the breed delivered is Sahiwal although it was reported that in some districts, this was not done and some bulls eventually died as soon as they were given off to the farmers. However, the DVOs were credited for providing trainings on bull management, free drugs and vaccines to the bull hosts at the time of receiving the bull. The respondents further reported that the DVOs are more involved in administrative activities and therefore make occasional visits to the farmers. It was also noted that majority are working with the NGOs as coordinators, a position which pays well and takes most of their time.

Non-governmental organizations (NGOs)

The assessment of the CBBP's influential actors placed NGOs in the 12th position, with a mean impact score of 1.5. Interestingly, the relatively low range in the assigned scores suggests a general consensus among the bull host communities regarding the limited influence of NGOs on the program's success. While the overall impact of NGOs appears to be modest, these organizations do play a role in supporting the broader agro-pastoral livestock ecosystem. For instance, NGOs like Advance Africa, which operates in the Nabilatuk and Nakapiripirit districts, provide extension services and training to the Community Animal Health Workers (CAHWs). Through these "pastoral farmer field schools" (PFFS), the CAHWs disseminate essential knowledge on disease control and deworming practices to the cattle farmers.

However, a key challenge with NGO-driven interventions is their often-short-lived nature. When these project-based initiatives come to an end, the PFFS and associated support structures tend to falter, diminishing the long-term sustainability of the knowledge transfer and community engagement efforts. Furthermore, the study found that certain districts, such as Kotido and Moroto, lack the presence of NGOs with a specific focus on livestock production. This absence of dedicated livestock-oriented NGOs likely contributes to the limited influence they wield within the CBBP in these particular locations. The mixed experiences with NGO involvement in the CBBP highlight the need for more systematic and long-term engagement strategies that can effectively embed the necessary knowledge, resources, and support structures within the agro-pastoral communities. Achieving this balance between short-term project-based interventions and sustained capacity building will be crucial for enhancing the role and impact of NGOs in the community-based livestock development initiatives.

Challenges associated with the CBBP in the agro-pastoral production system

Upon analysing the insights from the process influence mapping exercise, several key challenges emerged in the

implementation of the community-based bull breeding program (CBBP) within the agro-pastoral communities as discussed below.

Limited availability of animal service providers

One of the major challenges stated by both the bull hosts is the vulnerability of the breeding bulls and offsprings to tick-borne diseases. The respondents stated that the major tick-borne diseases include East-coast fever, Heart-water, Babesiosis, and Anaplasmosis all of which lower productivity and can lead to the death of the cattle. According to the bull hosts, the Sahiwal bulls and their offsprings are more susceptible to tick-borne diseases as compared to the local Zebu and Ankole cattle. At the beginning of the project, the farmers had the opportunity to access free veterinary drugs and vaccines provided by the project through the DVOs as well as regular advisory and monitoring from the sub county vets veterinary services. However, these services have since dwindled yet farmers are unable to consistently contribute towards the purchase of drugs and acaricides for tick control. Worse still, the agro-pastoral livestock production system faces a critical shortage of adequately trained veterinary professionals, further exacerbating the challenges faced by the community-based bull breeding program (CBBP). In many of the districts under study, the presence of qualified veterinarians was alarmingly scarce. In some cases, there was only a single university-trained veterinarian, often serving as the District Veterinary Officer (DVO). However, these DVOs were primarily occupied with administrative duties and had limited time to engage directly with the cattle farming communities. As a result, the majority of the participating farmers reported that they had never even met their respective DVOs. One bull host lamented the situation, stating, "Our problem is that we have only one Veterinary doctor in the district, and he is busy with administrative work and attending workshops. He is always out of station. At times, some of us have to just consult him on the phone of which he even rarely picks." This dire shortage of accessible and dedicated veterinary expertise within the agro-pastoral regions poses a significant challenge to the effective implementation and sustainability of the CBBP. The lack of on-the-ground support and direct engagement with the farmers undermines the program's ability to address critical animal health concerns, implement recommended breeding practices, and build the necessary technical capacity within the communities. The DVO in "question" admitted that it is true that they do not get to the villages and communities because they are occupied with other administrative workloads at the district. However, the veterinarians cited poor accommodation, lack of transport and insecurity threats as limiting factors for them to get to the communities. Worse still, some Subcounty veterinary officers are assigned to more than one subcounty due to limited staffing yet some lack own transport means to move around these sub counties and meet the farmers. Even the few with transport means said they lack proper facilitation in terms of fuel, servicing the vehicles and per diem which all limit their effectiveness.

Delay in reporting of disease cases

The agro-pastoral livestock production system grappled with significant delays in the timely reporting of cattle diseases, which severely undermined the effectiveness of the community-based bull breeding program (CBBP). This challenge stemmed from a complex interplay of socioeconomic and cultural factors. Firstly, the livestock keepers in these communities predominantly relied on traditional herbal concoctions for animal health management, rather than the recommended veterinary drugs. This preference was largely driven by poverty and limited access to formal veterinary services. By the time a farmer sought professional help, the disease had often progressed to an advanced stage, as the local remedies had failed to address the issue. Even when farmers wished to purchase the recommended pharmaceuticals, they typically had to sell a small ruminant to raise the necessary funds, further compounding the economic burden. Additionally, the long distances to the nearest markets, where both livestock and drugs could be accessed, coupled with the reliance on walking or bicycles as the primary means of transport, created significant logistical barriers. Secondly, the prevailing pastoralist culture and mindset played a significant role in delaying disease reporting. As one bull host explained, "The pastoralist culture is such that, unless the animal falls down or fails to walk, a livestock farmer will not seek the service of a veterinary service provider." This deeply ingrained belief system, which prioritized the animal's ability to ambulate over its overall health, led to the untimely demise of breeding bulls, their offspring, and the cows intended for mating. This, in turn, had a detrimental impact on the implementation and outcomes of the CBBP.

Theft of cattle

Theft of cattle is prevalent in the study areas. Thefts are mainly by cattle rustlings and criminal networks within the villages and across borders. The theft of cattle is more prevalent, and this led to some hosts selling off their breeding bulls, to reduce the risk of losses. In other communities, the local cows were raided leaving the bulls with no females to mate with and thus low reproductive rates. The Anti Stock Theft Unit (ASTU) Commander reported that about 42,000 cattle were reported to have been stolen from cattle keepers in Karamoja region only between July to September 2023 but only 25,783 have been recovered. According to a local stakeholder, all three livestock markets within the Amudat district flagrantly disregarded the established operational guidelines, enabling the perpetuation of illicit trade. This issue was further compounded by the reported collusion between cattle dealers and the district veterinary officers, who facilitated the issuance of fraudulent livestock movement permits. This collusive arrangement between the unscrupulous traders and the very authorities tasked with oversight and regulation severely

TABLE 3 Actor scores in the CBBP in the different districts in the sedentary production systems.

Actor	Katakwi	Amuria	Bukedea	Kween	Total	Mean	Range
Bull Host/Farmers	8	10	8	10	36	**9.0**	2.0
Herdsman	4	0	4	6	14	**3.5**	6.0
Farmer Group	5	5	7	0	17	**4.3**	7.0
Community Members/Other Farmers	4	1	6	4	15	**3.6**	5.0
Subcounty Veterinary Officers (SVO)	7	7	5	10	29	**7.3**	5.0
Para-vets	6	6	4	5	21	**5.3**	2.0
Community Animal Health Workers	9	4	3	3	19	**4.8**	6.0
Veterinary Drug Shops	0	—	0	9	9	**3.0**	9.0
Local Council 1 Chairpersons	2	0	2	0	4	**1.0**	4.0
District Veterinary Officer (DVO)	3	0	1	2	6	**1.5**	6.0
Agriculture Officer (AO)	7	8	9	—	24	**6.0**	2.0
District Leadership (CAO, RDC, LCV)	0	0	0	0	0	**0.0**	0.0
Community Development Officer	1	0	0	0	1	**0.3**	1.0
Subcounty Chief	0	2	0	0	2	**0.5**	2.0
Cattle Trader	—	0	0	0	0	**0.0**	0.0
Bull Supplier	0	0	0	0	0	**0.0**	0.0
MAAIF/Project Coordinator	0	3	0	0	3	**0.8**	3.0

The bold values represent the mean scores of an actor that were used to measure the actor level of influence in the success of the CBBP.

undermined the efforts of security checkpoints to effectively detect and intercept stolen cattle. The ease with which these illegal transactions could be carried out, bolstered by the complicity of the veterinary officials, created a permissive environment for cattle theft to thrive within the agro-pastoral communities.

Exclusion

The bull hosts reported that they were not consulted in regard to the breeding objective and the choice of the breeding bull that they preferred. The bull hosts reported that they were only invited for trainings so as to receive the bulls but their opinions about which bull breed is desired were not considered. This could be the reason why up to now the bulls are being referred to as the "your bulls/project bulls" implying that the farmers did not even feel the sense of ownership of these bulls since they were not involved in the selection. This is also among the reasons why most bulls are not alive currently because due to lack of the feel of ownership, the bull hosts did not pay maximum attention to these bulls in terms of health management, feeding and housing. A study by Wurzinger et al. (2021) on the effective implementation of breeding programmes in Zambia reported that; for any community breeding scheme to be successful, all relevant stakeholders especially host farmers should be included right from the initiation of breeding strategies. The problem of exclusion of stake holders in the design community breeding schemes is further discussed by Haile et al. (2020).

Opportunism

The agro-pastoral communities in the region grappled with a concerning trend of opportunistic behaviour among some bull hosts, which undermined the effectiveness and sustainability of the community-based bull breeding program (CBBP). As Neethirajan (2023) aptly described, opportunism is the practice of exploiting circumstances with little regard for principles or the consequences for others. In the context of the CBBP, this opportunistic mindset manifested in the actions of certain bull hosts who prioritized their own self-interests over the collective goals of the program. Rather than fulfilling their roles as responsible custodians of the breeding bulls, some hosts succumbed to various temptations and challenges. These included their inability to adequately manage the bulls in terms of feeding and veterinary care, concerns about the bulls being stolen, and social conflicts with fellow group members. In other cases, the hosts simply sold the bulls to address their personal or family financial needs, such as paying school fees. The most egregious example of this opportunistic behaviour was reported in Napak district, where a staggering 6 out of the 10 bull hosts in the Lopeei subcounty

sold off their assigned bulls the very next day at the Ocorimongin cattle market in the neighbouring Katakwi district. This flagrant disregard for the program's objectives and the community's long-term interests underscored the prevalence of self-serving motives over the collective welfare. Addressing this challenge will require a multifaceted approach that combines enhanced oversight, strengthened accountability mechanisms, and targeted interventions to address the underlying socioeconomic factors that may be driving this opportunistic behaviour. This could include improved financial literacy and access to alternative livelihood options, as well as the implementation of robust monitoring and evaluation systems to identify and sanction any breaches of the program's guidelines.

Actor mapping and the CBBP process in the sedentary livestock production system

The description of the process and actor influence within the Community-Based Breeding Program (CBBP) in the sedentary livestock production system was derived from focus group discussions with bull hosts. During the mapping of the CBBP process, seventeen key actors were identified, and their networked relationships are depicted in Figure 4. To analyze the relative influence of these actors, mean influence scores were calculated by summing the ranks assigned across different districts and dividing by the number of reporting districts, with the results rounded to the nearest whole number. Examining the range between the highest and lowest mean influence scores provides insights into the variability in power dynamics among the actors involved in the CBBP, as shown in Table 3.

Bull host/farmers

The bull host was regarded to as the most influential actor in the CBBP in the sedentary livestock production system with a mean score of 9.0. The range for the bull hosts' score in the sedentary livestock production system was low meaning that there is greater agreement among the bull hosts in the study districts about the influence of the Bull hosts in the CBPP. In the sedentary production system, cattle are kept among other reasons as a complementary livelihood diversification enterprise alongside crop production. Cattle more so the bulls are used to cultivate crop production fields, provide manure for fertilizing cropping fields, act as a store of wealth and are sometimes liquidated to provide income to sustain the farmers' livelihoods. Due to owning small herds of cattle mainly because of the Teso insurgency which lasted from 1987 to 1992 and rampant cattle raids by the neighbouring Karamojong communities, majority of the respondents reported to be tethering their animals. As a result, the bull host in the sedentary livestock production systems provide shelter to the breeding bull and is responsible for the routine management activities such as grazing, watering, spraying, vaccination, security, and general monitoring unlike in the agro-pastoral system where these activities are done by a herdsman. The host is involved in the daily activities regarding the management of the bull and is, therefore, able to regularly observe the bull and report any problem to the veterinary officers. In scenarios where the bull is owned by a group, the role played by the hosts is voluntary. However, the hosts enjoy benefits such as having more access to the breeding stock, extension services, and training.

Subcounty veterinary officers (SVO)

Unlike in the agro-pastoral livestock production system where the CAHWs are the most influential among the veterinary actors, in the sedentary livestock production systems, the subcounty veterinary officer is the most influential veterinary actor and the second most influential actor in the CBBP with a mean score of 7.3. The range for the SVO score in the sedentary livestock production system was low meaning that there is greater agreement among the bull hosts in the study districts about the influence of the SVO in the CBPP. The sub-county officers were highly ranked because they were the primary information source to the beneficiaries about the project. They also mobilized cattle farmers to form breeding groups and offered trainings on animal management practices. The SVO scored highly (10) in Kween district because it was reported that he was ever readily and freely available to attend to the sick bulls and offsprings with immediate effect and some tines offered free veterinary drugs unlike other veterinary service providers like the Para-vets, CAHWs and the DVOs. However, it was generally reported that SVOs often lack drugs to administer to the cattle. Secondly, many of the SVOs are concurrently serving as coordinators for the National Agricultural Advisory program. This coordinating role is a well-compensated position that demands a significant time commitment from the SVOs. As a result, the SVOs are often unable to devote sufficient time and attention to handling cases that are referred to them by the Para-vets and other private veterinary practitioners. The competing demands on the SVOs' time and resources limit their capacity to effectively address the issues brought to them by these other veterinary service providers.

Agriculture officer (AO)

The agricultural officer merged as the third influential actor in the CBBP of the sedentary livestock production system with a mean score of 6.0 higher than even the Para-vets and CAHWs. The range in the AO score in the sedentary livestock production system was low meaning that there is greater agreement among the bull hosts in the study districts about the influence of the AO in the CBPP. As a result of limited staffing of the veterinary department, most sub counties lack veterinary officers and so the agricultural officer is crippled to deliver the services of a veterinarian to the farmers. Even in the sub counties with Veterinary officers, the work load is often much and they seek assistance of the agricultural officers who are at times equally or more knowledgeable than the SVOs on veterinary issues. For example, in one of the sub counties in Bukedea district, it was reported that in case the treated cattle by

the CAHW, SVOs or Para-vets fails to recover, the case is referred to their agricultural officer since he is more knowledgeable and equipped than them as he even runs the biggest veterinary shop in the district. Furthermore, it was reported that as the agricultural officers perform their duties of supervising and monitoring farmers' gardens, they end up advising and training farmers on cattle management practices since they most times find them using the cattle for digging. Kiconco et al. (2023) in their study on agricultural extension service delivery in Uganda defined an agricultural officer as a government agricultural expert responsible for effective planning, designing and successful implementation and supervision of Agriculture extension interventions specifically in the field of crop production at subcounty level. Because their role is mainly vital in crop production, it could be the reason why this actor was not involved in the CBBP in the agro-pastoral production systems where there is limited crop production as compared to the sedentary system. Furthermore, the AO was not mentioned among the actors in the CBBP because all the bulls were given to one subcounty of Ngenge yet with a very active SVO who even merged as the most influential actor in the CBBP in the district.

Para-vets

The para-vets were ranked as the fourth influential actors in the CBBP in the sedentary livestock production system with a mean 5.3. The range in the para-vets score in the sedentary livestock production system was low meaning that there is greater agreement among the bull hosts in the study districts about their influence in the CBPP. According to the findings, Paravets are the most commonly sought-after veterinary service providers by livestock owners. This is primarily due to their widespread availability and accessibility, which stands in contrast to the more limited presence and responsiveness of Subcounty Veterinary Officers (SVOs) and District Veterinary Officers (DVOs). In cases where cattle treated by the Para-vets do not show improvement, the Para-vets typically refer the case to private veterinary practitioners, and only rarely to government veterinarians. It was also reported that many Para-vets own and operate small veterinary drug shops in the region, where they offer free consultation services to cattle farmers. However, the bull hosts noted that the Para-vets' services tend to be expensive, and they do not provide credit options to their clients.

Community animal health workers (CAHWs)

They are typically livestock keepers who have received basic training in animal health techniques, such as vaccination and deworming, from government agencies, NGOs, or farmer organizations. These trained individuals then provide a limited range of veterinary services to their local communities, for which they receive some form of payment, either in cash or in kind. CAHWs cannot be officially certified, as they do not hold certificates from government accredited training institutions. In the sedentary livestock production system, the CAHWs were ranked as the fifth most influential actor in the Community-Based Breeding Program (CBBP), with a mean influence score of 4.8. This relatively high ranking reflects the critical role CAHWs play in providing animal health services at the local level, due to the scarcity of veterinarians. The narrow range in the CAHWs' influence scores across the study districts suggests a high level of agreement among the bull hosts about the importance of CAHWs' contributions. As one respondent noted, "Thanks to CAHWs' interventions, thousands of livestock keepers benefit from curative and prophylactic treatments for their animals at a reduced cost." Furthermore, CAHWs are also recognized for their crucial role in disease surveillance, both for highly contagious livestock diseases and zoonotic diseases that can affect human populations. CAHWs report on vaccination activities and animal health situations to government veterinarians, either by phone or in person. They also play a key part in government-led vaccination campaigns.

Farmer group

The farmer group was ranked as the sixth influential actor in the CBBP in the sedentary livestock production system with a mean score of 4.3. The range in the farmer group score in the sedentary livestock production system was high meaning that there is greater disagreement among the bull hosts in the study districts about their influence in the CBPP. Group members support the management of the CBBP by contributing financial resources, collection of water and pasture for the breeding stock as well as providing cows for mating with the bull. However, the bull hosts noted that the commitment to the group obligations by group members was not consistent. Some groups had members who were not willing to make any financial contribution to support the treatment, deworming, and tick control yet they wanted to utilize the services of the bull. The farmer group score in Kween district was zero because the bull hosts reported that besides receiving the bull under groups, group members did not engage themselves in the general management of the bull including but not limited to feeding, watering, shelter and security yet majority were utilizing its services. Besides, it was reported that due to personal differences with the bull hosts, some group members went ahead to create negative publicity about the bull, for example, it was reported that some group members spread rumours that the offsprings from these bulls are impotent which discouraged community use of the bull.

Community members/other farmers

The bull hosts ranked the community among the influential actors in the CBBP in the sedentary livestock production system with a mean score of 4.5. The range in the community score in the sedentary livestock production system was low meaning that there is greater agreement among the bull hosts in the study districts about their influence in the CBPP. Community members support the management of the breeding bull by providing free grazing land, security and offering cows for mating with the bull.

Sometimes some community members also pay for the bull service and thus help the host in mobilizing resources for veterinary care of the bull. However, it was also reported that, many cows died at calving because the calves (which were offsprings of the Sahiwal bull) would be very big rendering the small cows unable to calve them which would cause death in scenarios where the veterinary officer is not available to assist or operate the cow. This impacted the community perception and willingness to use the bull hence leading to low bull reproductive rates in terms of offsprings sired in a community. In Ngenge subcounty of Kween district, it was alleged that some Community members sneaked and cut off the one of the fore legs of the bull because the cows it had mounted were dying while calving.

Herdsman

In the sedentary livestock production system, the herdsmen are not common actors since majority of the cattle farmers graze their animals by tethering. In scenarios where farmers have herdsman, they are mainly their own children who most times have dropped out of school. Unlike in the agro-pastoral livestock production system where a herdsman is the most influential actor, they are ranked among the least influential actors in the sedentary livestock production system with a mean score of 3.5. The range in the herdsmen score in the sedentary livestock production system is high meaning that there is greater disagreement among the bull hosts in the study districts about their influence in the CBPP. In the absence of the bull host, the herdsman is responsible for feeding, watering, and general management of the bull and other cattle. When cattle fall sick or gets hurt, the herds man reports the sickness to cattle owner and sometimes seeks medical treatment from service providers or buys the drugs and treats by himself. However, similarly to the case in the agro-pastoral production system, it was also reported that they sometimes fail detect and report sick cattle on time and cattle end up dying, fail to graze cattle on time and also connive with the rustlers to steal the bulls and their off springs. In Amuria district, the herdsman sored zero mainly due to small number of cattle kept (averagely between 1 and 5) which are easily managed by the bull hosts without the help of herdsmen.

Veterinary drug shops

Unlike in the agro-pastoral livestock production system where farmers mainly buy veterinary drugs from vendors in the market, in the sedentary livestock production system, farmers mainly buy drugs from drug shops. Similar to the agro-pastoral livestock production system, some farmers in the sedentary production system also treat cattle by themselves and typically seek the services of veterinarians only when an animal fails to respond. Veterinary drug shops were reported among the influential actors in the CBBP in the sedentary production system with a mean score of 3.0 because they increase accessibility to inputs that are used in routine management, disease and vector control among cattle keeping communities. The range in the veterinary drug shops score in the sedentary livestock production system was high meaning that there is greater disagreement among the bull hosts in the study districts about their influence in the CBPP. In Kween district, the farmers reported veterinary drug shops as the second most influential actor in the CBBP after bull hosts because they offer advisory services to farmers, and they seem to be more knowledgeable than veterinarians about cattle diseases. The bull hosts mention a case of Ngenge Vet center in Ngenge trading center which they praised for having quality drugs, offer advisory and extension services and ever open. However, despite their importance, veterinary drugs hops are not easily accessible by the bull hosts as they are in urban locations which are distant from the cattle keeping communities and at times some of them sell fake and expired drugs.

Challenges associated with the CBBP in the sedentary livestock production system

Political interference

One of the major problems identified by the respondents in the sedentary livestock production system was political interference especially at local government level. When asked about the selection criteria of the bull beneficiaries, the district and subcounty veterinary officers cited that however much they had a beneficiary selection criterion designed by the Ministry of Agriculture, Animal industry and Fisheries (MAAIF), the process of beneficiary selection was sabotaged by politicians most especially chairpersons of local council three and LCV. The respondents intimated that politicians sometimes meddle in the affairs of service delivery at the local government level. “Politicians plated a pro-people role and decided who would get the bulls in their respective sub counties including themselves” said one of the Subcounty Veterinary Officer.

The technical people at the district especially the DVO and SVO could not resist the wish of these politicians partly because the politicians indirectly influence their positions and promotions. Because of this, in some communities the bulls ended up in “wrong hands” and did not serve the intended purpose. For example, in one of the districts, the subcounty veterinary officer who acted a s a project focal point person in that district cannot trace 7 beneficiaries because he was just given a list of names and instructed by the Chairman LCV to give those people the bulls and from that day, he has never met those people again. Worse still, in another district, the list of beneficiaries was edited by the Chairman LCV together with some LC 111 chairpersons on the final day of giving out the bulls and the initially selected farmers by the technical teams who had even already received trainings and formed breeding groups were removed from the lists and new beneficiaries were brought on board without engaging the DVO and the other veterinary officers who had participated in the initial bull host selection. This angered the veterinarians, and they reacted by not following up on these farmers and in the end, these farmers

lacked technical support and ended up losing the bulls due to diseases and poor management.

The aggressiveness and size of the Sahiwal bulls

Bull hosts reported the aggressiveness of the bulls as being a key constraint to their management that often led to bodily harm and destruction of property. Due to their aggressiveness, it was hard to restrain these bulls for treatment, spraying them and pushing them to the grazing lands. The aggressiveness of the bulls' results from several factors that include fear, stress, inadequate feeding, and hormonal state. Bull hosts that would fail to handle the aggressiveness of the bulls ended up selling the bulls or the bulls dying of diseases. Furthermore, the bull hosts reported that the huge size of the bulls is not compatible to the small sizes of their indigenous cows especially Zebu. This limited community utilization of the bull in fear that the bulls would break their small bodied indigenous cows.

Group capture

In scenarios where the bull was given to a farmer group, the first host of the bull claimed full ownership of the bull and in many cases refused to rotate it among the other group members as they were mandated to in the project design. Every group member would be required to bring their cows to the hosts place for mating, yet some hosts were located in far distances with the other group members. This limited full utilization of the bull due to accessibility but also in cases of silent heat in cows, the local bulls would quickly mate the cows before they were moved to access the bull which hindered the project objective of cattle improvement in these communities. Worse still, even when the bull hosts sold the bulls, they were not consulting the group members and then money attained would also be used only by the host without benefiting other group members.

Limited availability of veterinary service providers

One of the major challenges stated by the bull hosts was the vulnerability of the breeding bulls and offsprings to tick-borne diseases. The respondents stated that the major tick-borne diseases include East-coast fever, Heart-water, Babesiosis, and Anaplasmosis all of which lower productivity and can lead to the death of the cattle. According to the bull hosts, the Sahiwal bulls and their offsprings are more susceptible to tick-borne diseases as compared to the local Zebu and Ankole cattle. At the beginning of the project, the farmers had the opportunity to access free veterinary drugs and vaccines provided by the project through the DVO as well as regular advisory and monitoring from the sub county vets veterinary services. However. The services have since dwindled yet farmers are unable to consistently contribute towards the purchase of drugs and acaricides for tick control. Unfortunately, the study area appears to be severely underserved when it comes to trained veterinary personnel. There are relatively few veterinarians and Para-vets who have received proper education and certification in veterinary medicine. In some districts, there was only a single university-trained veterinarian present, and in most cases, this individual was the District Veterinary Officer (DVO), who was heavily burdened with administrative responsibilities, leaving little time to directly engage with cattle farmers. In fact, many of the farmers who participated in the Process Net-Map exercises reported that they had never even met their respective DVOs. This stark disconnect between the local livestock owners and the government's veterinary representatives highlights the significant gaps in access to qualified animal health services within the study communities.

Collective action failure

Collective action, where a group of people work together towards a common goal, is a well recognized phenomenon. Yet, it is also widely acknowledged that individuals often fail to cooperate, succumbing instead to selfish behaviors that undermine the achievement of group objectives or public goods. This tension between individual and collective interests is known as the collective action problem. In the context of the Community-Based Breeding Program (CBBP), this challenge was particularly evident. When the breeding bulls were assigned to groups, the members were expected to collectively support the animal's wellbeing through contributions towards treatment, feeding, watering, and housing. However, group members faced a choice - they could either cooperate and fulfill their responsibilities, or they could opt to free-ride, relying on the efforts of others while avoiding personal costs. The bull hosts in this study reported that such free-riding behaviour was common, with limited cooperation from group members in caring for the shared bull. Despite everyone's desire to benefit from the bull's services, the burden and associated costs often fell disproportionately on the bull hosts and a few dedicated members. This lack of equitable participation, driven by financial and time constraints, ultimately compromised the bull's performance and the intended objectives of the breeding program.

Social conflicts

Social conflicts arise from disagreements amongst group members in scenarios where the bull was given to the group. The conflicts mainly resulted from unfairness in the access to the breeding livestock, the sharing of benefits, and contribution to the maintenance of the livestock. According to Lamuno et al. (2018), for effectiveness of the community bull breeding schemes, the bulls should be kept with the host for a maximum of 1 year and then rotated to another member to prevent inbreeding but also ensure equitable utilization of the bull services amongst the group members and the breeding community at large. For the bulls that were given to individuals, social conflicts rose from lack of satisfaction in the selection criteria by community members. For example, in a particular district in the sedentary production system, one of the bulls was poisoned and the host claims that it was poisoned by the neighbours who felt that they

were more competent than him in terms of cattle management and so they thought they would be the ones to receive the bull not him.

Opportunities of the community based bull breeding programme in Uganda

Despite the numerous challenges identified in this paper to be affecting the CBBP, we found several existing opportunities associated with the CBBP in Uganda and they are discussed below:

Increased market value for cattle

This paper found that the offsprings of the improved bulls (Sahiwal) arising from the CBBP have adapted to local conditions easily, have demonstrated a fast growth rate as compared to the indigenous breeds (Zebu and Ankole). It was reported that under proper management, it only takes only 18 months for an improved offspring to attain salable weight of up to 80 Kg as compared to the indigenous breeds that might fail to reach 80 Kg even after 3 years. Moreover, it was reported that even after having spent 4 years to attain salable weight, the value of indigenous cattle will still be lower as compared to the improved breeds of 1½ years due to body size differences as improved breeds at 18 months appeared bigger than the indigenous ones of 4 years. During further discussions into the subject matter with the farmers, the researcher found that at 18 months, an improved offspring (cross breed of Sahiwal and indigenous cow) costs an average of UGX 1,068,796/= (an equivalent of USD 370) while an indigenous cow costs an average of UGX 724,504/= (an equivalent of USD 196) at 3 years. The huge difference in the market value of the indigenous and cross breed cattle signals a huge opportunity for the farmers to adopt or utilize the breeding bulls to improve their herds in order to tap the monetary benefit associated. The findings of this paper are similar to those in a study by Greenwood, (2021) on the beef productivity of indigenous cattle in Eastern Uganda found out that on average, it takes indigenous cattle (Zebu and Ankole) an average of 4 years to attain salable weight as compared to the exotic and improved breeds such as Sahiwal, Freshians, Jersey, among others which on average attain salable weight within 1½ years.

Controlled chances of cattle rustling/theft

Cattle rustling has long been a central driver of conflict in the study region, particularly in the Karamoja area. The perpetrators of these livestock raids are a group of agro-pastoralists who engage in this traditional practice as a means of accumulating wealth and prestige. The Karimojong people, the largest ethnic group in the region, are divided into several subgroups such as the Matheniko, Bokora, Pian, Tepeth, and Jie, all of whom are known for their cattle herding and raiding activities. Beyond the Karimojong, other ethnic groups in the area, including the Teso, Pokot, Dodoth, and Turkana, are also deeply involved in the practice of cattle rustling. This cross-ethnic participation in livestock raids has frequently led to conflicts with neighbouring communities and the government authorities. The roots of this complex issue can be traced to a confluence of factors, such as competition for scarce resources like water and grazing land, underlying ethnic tensions, and widespread poverty. The consequences of these cattle rustling activities are far-reaching, manifesting in forced migration, internal displacement, and even child trafficking. The loss of cattle, which have traditionally provided both sustenance and social status for the people in this region, has severe economic and cultural implications. Cattle rustling disrupts the mobility of livestock herds, compelling pastoralists to relocate to areas perceived as safer. However, these new environments may not be suitable for effective livestock rearing, leading to a decline in productivity and an exacerbation of poverty. Furthermore, the displacement of pastoralist communities often results in social upheaval, as families are separated and forced to adapt to unfamiliar settings.

Efforts to address the problem of cattle rustling in the study area have been ongoing. They include the deployment of the Anti-Stock Theft Unit (ASTU) in the region, peace negotiations and disarmament programmes all aimed at ending cattle rustling in the study area and promote peace. The Karamojong people previously owned guns, which they used to protect their livestock from raiders and therefore disarmament of civilians has been a contentious issue in the region. However, despite these interventions, Cattle rustling has remained at its peak in the study area. This paper found that breeding and adoption of improved cattle through the CBBP can effectively control cattle rustling. One of the attributes of the improved cattle is that they cannot move for long distances and when forced to do so, they can eventually die thus warriors have less interest raiding improved animals. Since cattle raiding involves moving long distances, it was reported that whenever cattle raids happen, the improved cattle are either slaughtered immediately at the Kraal or left out of the raid since they cannot travel long distances and even when they are forced to move, they are slow and affect the travel plans for the cattle raiders. With the CBBP aiming at improving the performance of cattle herds in these communities, if well sustained, all the herds will be improved soon and cattle raiders will have no cattle to raid and move the long distances.

Increased cattle production and productivity

This paper found that improved cows (bull offsprings) reach productive maturity at 18 months and can mate to calve offsprings while indigenous cattle reach productive maturity at almost 3 years. The adoption of the Community-Based Breeding Program (CBBP) holds the promise of significant benefits for farmers in the study area. By improving the reproduction rates within their herds, the CBBP can foster a rapid multiplication of cattle, effectively serving as a crucial buffer resource for farmers to rely on during emergencies, such as crop failures. Moreover,

cattle in this region function as a form of "live banks," facilitating both income distribution and savings for the local communities. Notably, the crossbred offspring produced through the CBBP are expected to yield substantially higher milk output, averaging around 10 L per day, compared to the 3.5-liter average of the indigenous cattle. This increase in milk production can have far-reaching consequences. It has the potential to stimulate the development of rural milk markets and integrate smallholder farmers into improved value chains. This, in turn, can lead to improved producer incomes, which can then be used to meet households' basic needs. Furthermore, the constrained milk supply and high costs currently experienced by pastoral communities have been a significant barrier to adequate milk consumption and, consequently, have contributed to malnutrition. The increased milk production facilitated by the CBBP can thus serve as a gateway to addressing this issue, as there will be a sufficient supply of milk for both household consumption and sale. In essence, the adoption of the CBBP can catalyse a virtuous cycle, where improved cattle productivity and reproduction rates translate into enhanced household resilience, income-generating opportunities, and nutritional security for the communities in the study area. A similar study by Witto et al. (2021) in their comparative study on milk productivity between indigenous and exotic breeds of cattle in south western Uganda found that it takes indigenous cows an average of 2½ years to reach productive maturity to enable them conceive, give birth and start producing milk whereas the improved breeds only take 1½ years to reach productive maturity.

Adaptations of offsprings

Pastoral communities are found in diverse contexts across the globe, each with their unique environmental and cultural characteristics. However, a common thread among these communities is their adaptation to settings where the environmental factors, such as aridity, poor soil quality, extreme temperatures, and limited water availability, make conventional crop cultivation challenging or unviable. Operating in these more extreme and marginal landscapes, pastoral communities are particularly vulnerable to the far-reaching impacts of global climate change. The onset of global warming has ushered in a host of environmental stressors that threaten the very foundation of pastoral livelihoods. Pastoralists now face the reality of increasingly hot temperatures, prolonged droughts leading to water scarcity, and the depletion of grazing lands. Additionally, the emergence of novel tropical parasites and diseases poses a grave threat to the health and productivity of their livestock, which are the mainstay of their economy and cultural identity. These environmental changes have placed immense strain on the resilience and adaptive capacities of pastoral communities. The loss of access to critical resources, such as water and pastures, coupled with the rise of animal diseases, has disrupted the delicate balance that has sustained these communities for generations.

Pastoral groups, who have long relied on the mobility and flexibility of their livestock-rearing practices to navigate the uncertainties of their environments, now find themselves increasingly vulnerable to the cascading impacts of global climate change. Addressing the needs and supporting the adaptive strategies of these marginalized communities will be crucial in ensuring their continued cultural and economic viability in the face of a rapidly transforming climate. Being in possession of both exotic and local traits, the cross bred offsprings from the CBBP were reported to be resistant to these harsh climatic conditions, adaptive to the locally existing feeds and resistant to majority of the diseases especially tick-borne diseases thus low maintenance costs although not as compared to the local breeds. This serves as a huge opportunity to farmers in the regard that even under these harsh environments, the improved cattle from the CBBP still remain productive as compared to the local ones in terms of growth rate (beef production), milk production and reproduction.

Eased access to extension services

The role of agricultural extension services cannot be overstated when it comes to building capacity and empowering livestock farmers. These extension programs serve as a vital conduit, facilitating the transfer of critical information and technological innovations from the broader global knowledge base directly to the farming communities. By enabling this knowledge exchange, extension services empower farmers to better identify their own goals and the range of possibilities available to them. This, in turn, equips them with the necessary tools and insights to improve the productivity and profitability of their livestock operations. The Regional Pastoralist Livelihoods Resilience Project supported Veterinarians, Agricultural officers, and Community Animal Health Workers to offer free and reliable extension services to the benefiting communities in terms of trainings, bull treatment, vaccinations and supervision as well as general guidance on livestock management. The trainings given to cattle farmers under this programme included but were not limited to; Setting up recommended housing for cattle, feeding and disease management in cattle. This not only served as an opportunity for farmers to gain better knowledge and skills on cattle management practices that were even transferred in the management of other cattle apart from the bull and its offsprings but also created a strong bond between farmers and veterinary professionals which eases access and service delivery incase need be. All this eventually leads to improved animal care which in-turn transforms into better herd performance thus boosting the livestock sector in the regions.

Increased community benefits from collective action

Collective action occurs when a number of people work together to achieve some common objective. The RPLRP

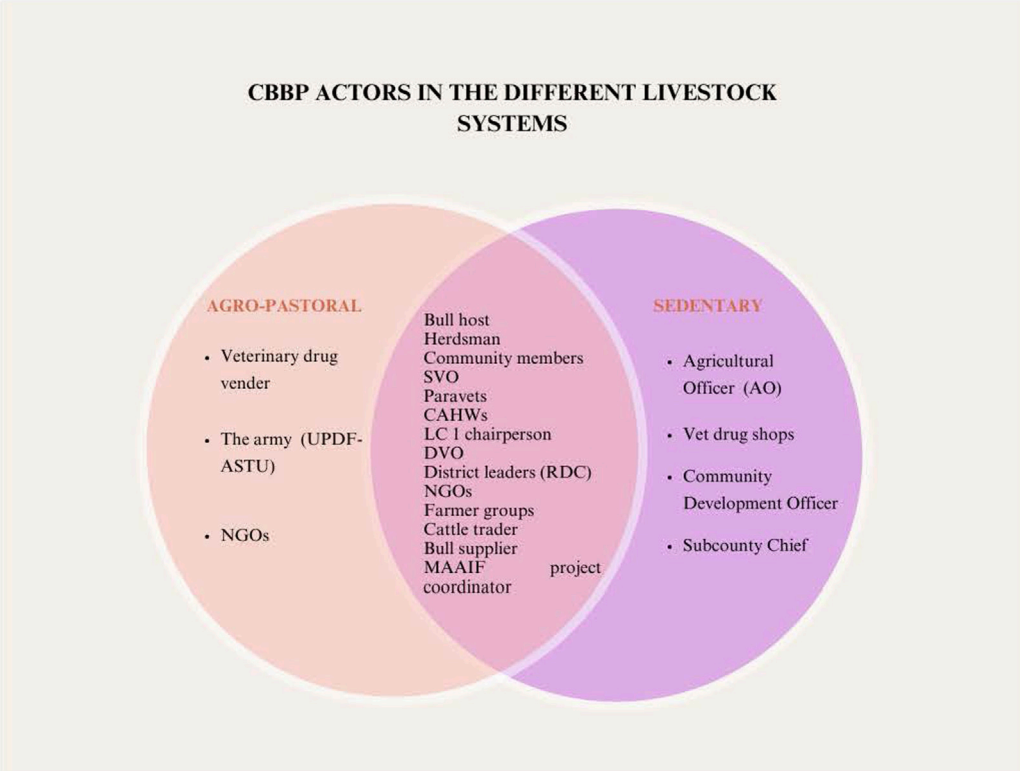


FIGURE 5
Showing actor variations in across the different production systems of the CBBP.

aided the formation of breeding groups in the project implementation areas with an aim of uniting cattle farmers to have a common focus on breed improvement. These groups were later used as a unit for dissemination of livestock management trainings and provision of free veterinary inputs such as drugs and acaricides. Some groups later acquired the Savings and Credit component with an aim of helping members attain financial freedom through savings and borrowings. All these increased individual member engagements which in turn increased socialization among community members and knowledge transfer from farmer to farmer especially on cattle management practices.

Synthesis, discussion and policy recommendations

Synthesis

The findings of this study reveal that there is substantial variation in the number and types of actors involved across the different livestock production systems. As seen in Figure 5, NGOs, Veterinary drug vendors and Security Organs (ASTU) are only involved in the CBBP of the agro-pastoral livestock production system whereas the Agricultural officer (AO), Community development officer (CDO), Subcounty chiefs and veterinary drug shops are only active in the CBBP of the sedentary livestock production system.

Furthermore, it was also found that there are variations in the actor level of influence across the sedentary and agro-pastoral livestock production systems and that the level influence of an actor in the CBBP depends on:

1. Closeness and management of the breeding bull
2. Frequency of interaction with the bull host and breeding community.
3. Bull health management (Figure 6)

The herdsman and the bull hosts are the most influential actors in the CBBP in the agro-pastoral and sedentary production system respectively because of closeness and management of the breeding bull. In the agro-pastoral production system, the herdsman is generally responsible for overseeing the welfare (feeding, watering, housing) and health the bull, it's off springs and the general herd which makes him closer to the breeding bull whereas in the sedentary livestock production

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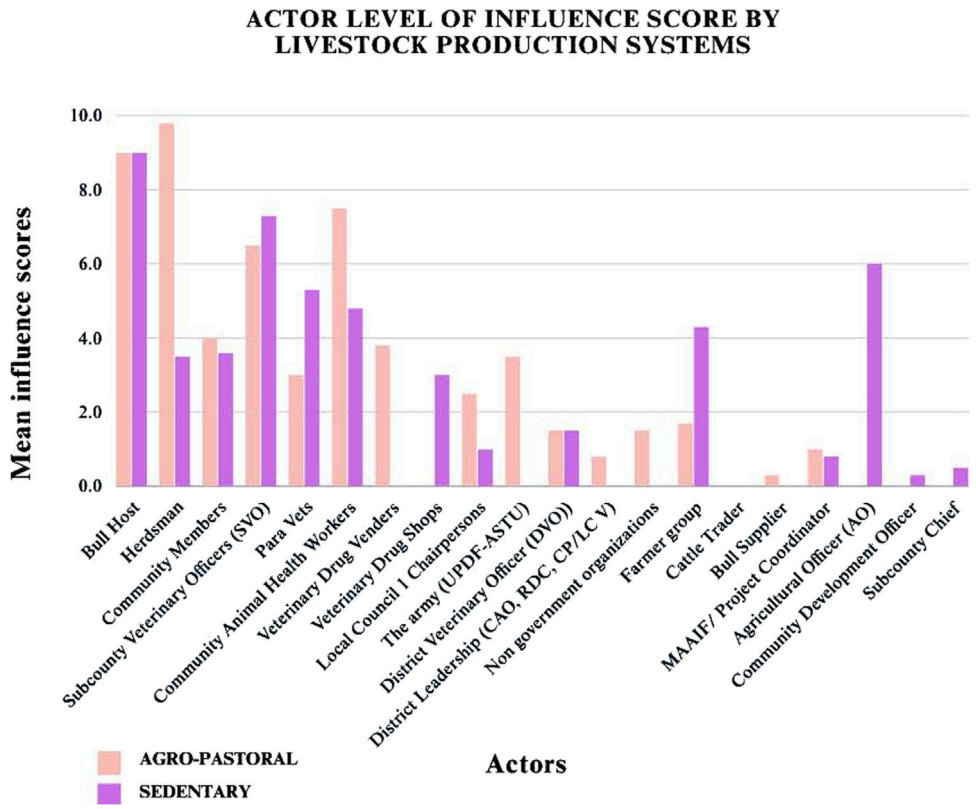

FIGURE 6
Comparison on actor influence scores by livestock production system.

system, the bull hosts take over all the above responsibilities. This is mainly because the bull hosts in the agro-pastoral livestock production system keep big herds of cattle which implicates on them a mandate of having a herdsman whereas the bull hosts in the Sedentary livestock production system keep a few cattle which might not necessitate the need of a herdsman. Because of closeness and being in charge of the management of the breeding bull in terms of feeding, watering and housing, the bull hosts merged as the most influential actor in the CBBP in the sedentary livestock system whereas the herdsman was the most influential actor for the CBBP in the agro-pastoral livestock production system. However, the bull host remains highly influential in both production systems because he takes the final discussions on the management of the bull including but not limited to; the mode of feeding, veterinary care and housing.

In addition, the Agricultural officer is among the most influential actors in the CBBP in the sedentary production system scoring even higher than the para-vets and CAHWs mainly because of their frequent interactions with the bull hosts as they visit them train them on agronomic practices and also end up discussing livestock issues which is not the case in the agro-pastoral communities who do not even have an agricultural officer as an actor in the CBBP because they do not interact with them as majority of the farmers there do not even grow crops. Furthermore, veterinary actors including the SVOs, CAHWs, Para-vets, Veterinary drug shops/vendors and DVOs have varying levels of influence in the CBBP of both production systems because bull host considers the one that regularly provides veterinary services to him/her as more influential than the others.

When it comes to the opportunities of the CBBP, we found out they are overwhelming and similar to both agro-pastoral and sedentary livestock farmers. These include; increased market value for cattle, reduced chances for cattle rustling, increased cattle productivity in terms of milk and beef production volumes and increased ease of access to veterinary services. However, there might be variations in the intensity or degree of achievement of these opportunities although it was not assessed in this paper. In addition, several problems were found to be associated with the CBBP with majority being specific to a particular livestock production system as seen in Figure 7. Delays in reporting cattle disease cases, theft of cattle, actor exclusion of farmers in the design of the CBBP and opportunism are the problems of the CBBP specifically to the agro-pastoral farmers while political interference, aggressiveness and huge size of the Sahiwal bulls, group capture, collective action

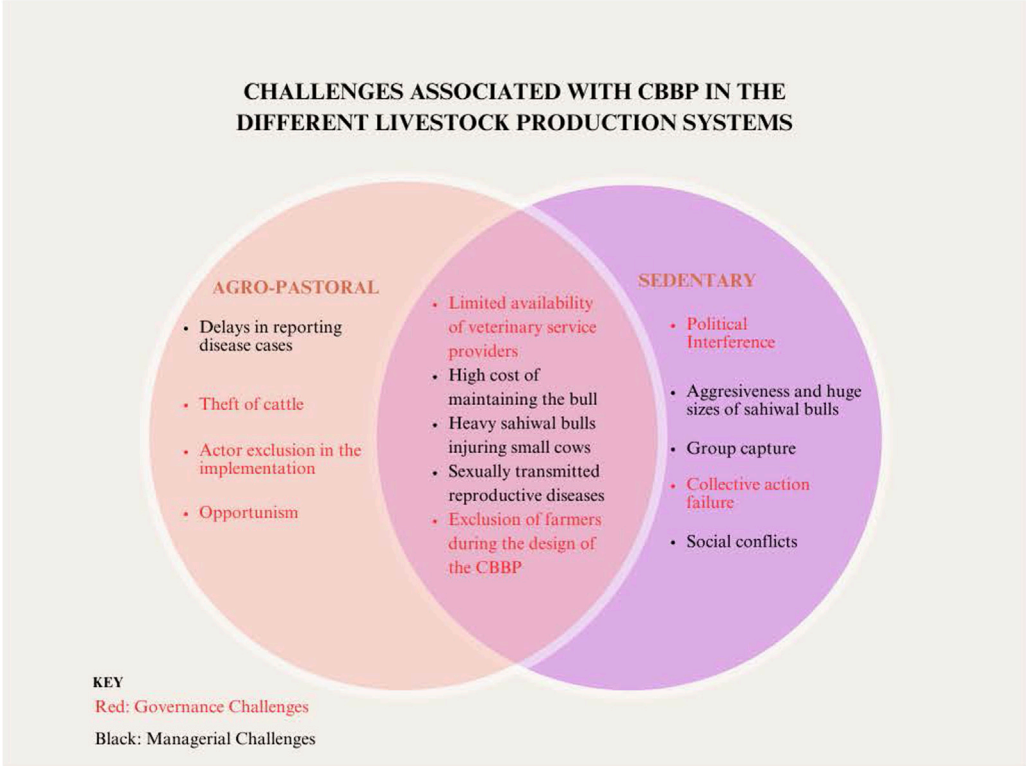

FIGURE 7
Showing CBBP problems by livestock production system.

failure and social conflicts were the problems of the CBBP specifically to the sedentary farmers. However, the challenge of limited availability of veterinary service providers was reported in both production systems. In addition, we found out that majority of the challenges faced by the CBBP are managerial rather than governance.

Discussion and recommendations to CBBP implementors

The findings presented in this study shed light on the variation in actors, their level of influence, and the opportunities and challenges associated with Community-Based Breeding Programs (CBBP) in different livestock production systems. Understanding these factors is crucial for the successful implementation and improvement of CBBPs in diverse agricultural contexts. The observed variation in actors across the agro-pastoral and sedentary livestock production systems highlights the importance of considering the specific characteristics and needs of each system. In the agro-pastoral system, NGOs, Veterinary drug vendors, and Security Organs (ASTU) play significant roles in the CBBP. These actors bring specialized expertise and resources to support the management and health of breeding bulls. On the other hand, in the sedentary system, Agricultural officers (AO), Community development officers (CDO), Subcounty chiefs, and veterinary drug shops are actively involved in the CBBP. Their engagement with bull hosts and farmers contributes to the overall success of the program.

The findings also emphasize the factors that influence the level of influence of actors in the CBBP. Closeness and management of the breeding bull, frequency of interaction with the bull host and breeding community, and bull health management were identified as key determinants. The herdsman emerged as the most influential actor in the agro-pastoral system due to their close proximity to the breeding bull and their responsibilities for its welfare and health. In contrast, the bull hosts in the sedentary system, who directly oversee the management of the bull, hold the highest level of influence. These findings implicate that there is need to put core emphasis in terms of capacity building through both technical and financial support to farmers (bull hosts) and herdsmen since the efficiency and effectiveness of their roles in the CBBP can greatly contribute to its success.

In addition, the emerging picture from this paper is that there is need to improve the local breeds in both the agro-pastoral and sedentary livestock production systems because of the opportunities associated with breed improvement which include but not limited to: Increased market value for cattle; controlled

chances of cattle rustling; increased cattle productivity in terms of milk and beef; high adaption of offspring to the environment, feeds and tolerance to disease; increased access to extension services; and increased benefits to farmers from collective action. It is important to note that the majority of challenges identified were managerial rather than governance-related. This suggests that effective program management, coordination, and stakeholder engagement are critical for overcoming barriers and ensuring the success of CBBPs. Policymakers and practitioners should focus on strengthening the managerial aspects of CBBPs, including enhancing communication channels, promoting collaboration among actors, and establishing clear guidelines for decision-making processes.

The Sahiwal breed holds great potential for the success of the community-based breeding program (CBBP) due to its remarkable ability to adapt to the harsh climatic conditions, feed availability, and resilience against tropical pests and diseases prevalent in the region. However, the use of improved bull service for breed improvement faces significant limitations and challenges. The high costs associated with the feeding, housing, watering, and veterinary care of these bulls pose a substantial burden on livestock farmers. Additionally, the large size of the bulls poses risks of injury or damage to the smaller-bodied cows during mating, while the potential for sexually transmitted reproductive diseases and the difficulties in frequently replacing the bulls to avoid inbreeding further compound the challenges. In this context, the use of artificial insemination (AI) emerges as a compelling alternative approach. AI addresses the challenges of the bull service scheme by minimizing the risk of disease transmission, reducing the costs and risks of maintaining breeding bulls, ensuring the quality of genetic material, and enabling the easy storage and transportation of frozen semen as a more accessible genetic resource compared to relying solely on live bulls.

The use of AI can be achieved by establishing AI centres at parish level (to ease access by farmers) where oestrus 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 on 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 to be under the management of the Subcounty Veterinary Officer to not only act as a backup for AI but also a demonstration and training phenomena to cattle farmers on how to manage the improved offsprings sired with the help of AI. For this to happen successfully, there is need to recruit, train and deploy AI technicians at parish level; equip them with the necessary equipment, tools and facilities; ensure timely and consistent supply of good quality semen from the desired bull breed and provide efficient transport means to enable follow ups with the cattle farmers who use the AI services. The recruited AI technicians should be trained regularly and efficiently monitored by DVOs and technical officials from MAAIF to ensure delivery of quality services to the farmers. In addition, there is need to sensitize and train cattle farmers on the benefits associated with breed improvement and involve them in the selection of the desired breed to cross breed but with technical guidance so as to increase community reception and use of the AI of the programme.

Conclusion

In conclusion, this study examined the CBBP in different livestock production systems and identified variations in actors, their level of influence, and the opportunities and challenges associated with these programs. The findings revealed that the herdsmen and the bull hosts (farmers) emerged as the most influential actors in the agro-pastoral and sedentary livestock production systems respectively. The study also revealed that the closeness and management of the breeding bull, frequency of interaction with the bull host and breeding community, and bull health management are the key factors that determine actor level of influence in the CBBP. The study emphasized the need to improve local breeds in both agro-pastoral and sedentary livestock production systems, highlighting the opportunities associated with breed improvement which are similar in both livestock production system. However, it was also found that there are numerous challenges that affect the success of the CBBP of which majority are managerial rather than governance. This study recommends adoption of a combination well-organized and facilitated Artificial Insemination (AI) programmes along-side the improved bull service scheme in a CBBP arrangement as each has capacity to address the weaknesses of the other in community breeding programmes. Overall, this study highlights the importance of tailoring CBBPs to specific livestock production systems, considering the roles of various actors, addressing managerial challenges, and exploring alternative breeding methods to improve the local breeds and enhance the overall success of CBBPs.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board (IRB) of Makerere University, Uganda. The researchers ensured that the ethical principles and guidelines for the protection of human subjects were strictly adhered to throughout the study. The participants,

who were the bull hosts, were fully informed about the purpose and procedures of the study. They were provided with clear and comprehensive information regarding their involvement, the voluntary nature of their participation, and their right to withdraw at any time without penalty. The researchers obtained written informed consent from each of the bull hosts prior to their participation in the study interviews and data collection activities.

Author contributions

The authors' respective contributions have been integral to the successful completion of this study. GS was responsible for designing the data collection tools, leading the field data collection efforts, analysing the data, and drafting the initial manuscript. JI conceptualized the overall study design, provided supervisory oversight for the data collection and tool development processes, and guided the interpretation of the results. SW complemented the team by contributing to the writing of the paper and offering valuable insights during the interpretation of the findings. The synergistic interplay of these diverse skillsets and responsibilities has been pivotal in ensuring the rigor and quality of the research presented in this paper.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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