Article

Experiences from the Implementation of Community-Based Goat Breeding Programs in Malawi and Uganda: A Potential Approach for Conservation and Improvement of Indigenous Small Ruminants in Smallholder Farms

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Abstract: Maintaining diversity of small ruminant genetic resources is instrumental for sustainable agricultural production. Community-based livestock breeding programs (CBBPs) have emerged as a potential approach to implement breeding programs in smallholder farms. This study assesses the viability of CBBPs as a potential approach for conservation and improvement of indigenous small ruminants, using case studies of goat CBBPs in Malawi and Uganda. Data were collected using focus group discussions, personal interviews, and direct observations. The program promotes and empowers smallholders to have access to small ruminant feed resources through protection of existing communal pasturelands, capacity building in pasture production, and conservation of crop residues and crop by-products. Implementation of the CBBP enhances the contributions through improved animal growth performance, kids' survival, and twinning rates leading to increased offtake rates and better prices. The existence of permanently established supporting organizations and other stakeholders provides sustainable institutional support instrumental for the establishment and growth of CBBPs. However, establishment of functional community-based institutions (producer cooperatives) and investments in institutional/policy reforms to safeguard fair trading, access to common resources by small ruminant keepers, and adoption of the CBBP model into national livestock development programs are some of the key milestones that can guarantee sustainability.

Keywords: farm animal genetic resources; governance; breeding programs; sustainability

1. Introduction

Small ruminants (sheep and goats) are essential for sustainable agricultural production systems, future food and nutrition security, and poverty reduction in developing countries [1]. They remain a key asset for hundreds of millions of poor rural households, often playing multiple roles as a source of food and nutrition security; fiber, hides, manure, savings, and insurance; and socio-cultural functions [1]. The adaptability, disease

resistance, ease of management, fertility, and product quality characteristics of these indigenous species and breeds help to support livelihoods even in some of the world's harshest environments [2].

Recent concerns on the loss of diversity of indigenous small ruminants have led to renewed initiatives and efforts to use, conserve, and improve small ruminant genetic resource sustainably. Maintaining diversity of small ruminants is instrumental for sustainable agricultural production as it allows farmers and researchers to select stock or develop new breeds in response to changing conditions, including climate change, new or resurgent disease threats, new knowledge of human nutritional requirements, and changing market conditions and societal needs [3]. Therefore, indigenous small ruminant breeds constitute an irreplaceable stock of adapted germ plasm and should be conserved for both present and future use [1]. Apart from the risk of extinction, conservation and improvement programs can be driven by factors such as current economic and socio-cultural value, maintenance of within breed diversity, and research and training [4]. In situ conservation is usually recommended for species and breeds that have a significant contribution to current and future food and agricultural production. This allows the breeds to (1) continue to improve in the context of changes in production conditions and offers greater opportunities for research, (2) facilitates breed evolution and adaptation to the environment and gives insight into breed characterization, (3) helps maintain indigenous knowledge for the sustainable utilization and management of breeds in rural areas, and (4) allows the breed to maintain its socio-economic and cultural roles and its contributions to environmental management [4].

Community-based livestock breeding programs (CBBPs) have emerged as a potential approach to implement breeding programs of indigenous livestock in smallholder systems [5–9]. CBBPs are participatory livestock breeding activities that involve significant interaction between researchers and farmers and prioritize farmers' objectives for maintaining livestock in the improvement programs [10,11]. A participatory livestock breeding and conservation approach that involves livestock keepers is one of the most effective and practical ways of conserving and improving small ruminant genetic resources because it increases the accuracy of the information upon which the conservation activities are based, involves minimum financial expenses, takes into account the interests of the livestock keepers, and fulfills the dual purpose of poverty reduction while stemming the erosion of domestic animal diversity [4,12]. Currently, CBBPs are tested and implemented using small ruminants of local breeds in developing countries. More specific and detailed guidelines for designing CBBPs, tailored for small ruminant systems in Africa, and performance of selected CBBPs in developing countries are given by different authors [10,13]. This paper highlights the feasibility of CBBPs as a potential approach for the conservation and improvement of indigenous small ruminants in smallholder production systems using case studies of local goat CBBPs in Malawi and Uganda.

2. Material and Methods

2.1. CBBP Pilot Implementation Design in Malawi and Uganda

In the framework of the Feed the Future Initiative led by United States Agency for International Development (USAID) in collaboration with the African Goat Improvement Network (AGIN), goat CBBPs were introduced in Malawi and Uganda. The goal of these programs was to improve the production and productivity of indigenous goats through selective breeding along with improved feeding, housing, and animal healthcare. Three CBBP pilot sites were established in Malawi and two in Uganda in 2015. The pilot sites in Malawi were established in Mzimba North, Lilongwe, and Nsanje districts (Figure 1). Each site was divided into two sub-sites, namely Zombwe-1 and Zombwe-2 in Mzimba North District, Mitundu and Mkwinda in Lilongwe District, and Ngulube and Bande in Nsanje District. A similar setup was established in Hoima and Nakapiripirit districts in Uganda (Figure 2). The sub-sites in Uganda included Buseruka and Kyabigambire in Hoima and Lolachat and Namalu in Nakapiripirit District. Table 1 provides location details for the pilot sites in the two countries.

Figure 1. Map of Malawi showing community-based livestock breeding programs (CBBP) pilot and scaling-up sites.

Figure 2. Map of Uganda showing CBBP pilot and scaling-up sites.

Table 1. Locations for the CBBP pilot sites.

Site	District	Country	Latitude	Longitude
Zombwe	Mzimba	Malawi	−11.3353	33.8588
Magoti	Nsanje	Malawi	−16.5761	35.0857
Mkwinda	Lilongwe	Malawi	−14.1670	33.7500
Buseruka	Hoima	Uganda	1.5473	31.1309
Namalu	Nakapiripirit	Uganda	1.8560	34.5816

The pilot sub-sites were further divided into sire breeding groups (SBGs). These are groups of households that can conveniently share one breeding buck/sire. A SBG constitutes 12 to 15 households with an average of 6 and 5 breeding females per household in Malawi and Uganda, respectively. The total number of goats from the participating households in each sub-site formed one breeding population categorized as a nucleus. To keep inbreeding down, the sub-sites occasionally exchanged the breeding bucks, so that bucks selected in one sub-site were used for breeding in another sub-site.

The goat breeds used in the program are the Small East African and its variants. The Small East African goat breed is hardy and highly tolerant to heat and water stress. The goats grow slowly but have a heavy-set conformation. The Malawi goat breed is closely related to the Small East African goat breed [14]. They are hardy and adapted to local harsh conditions. They are prolific and can breed all year round under good management, and twinning rates are high. The Mubende goat breed of Uganda is a sub-population of the

Small East African goat breed. Both Malawi and Mubende goats are small in size (21–35 kg mature weight) and are primarily used for meat production [14,15].

In all the sites, the goats were managed under a low-input extensive management system where they roam freely during the dry season after crop harvest and are tethered or grazed in communal grazing areas during crop growing rainy seasons. Table 2 gives details on the number of participating farmers and average goat flock sizes in each sub-site in the two countries.

Table 2. CBBP pilot sites and number of farmers involved in Malawi and Uganda.

Country	District	Sub-Site	Year of Establishment	Number of Households	Average Flock Size Per Household
Malawi	Mzimba North	Zombwe-1	2015	127	12
		Zombwe-2	2015	109	12
	Nsanje	Nguluwe	2015	177	19
		Bande	2015	112	19
	Lilongwe	Mitundu	2016	98	5
		Mkwinda	2016	224	5
	Subtotal			847	
Uganda	Hoima	Buseruka	2015	71	7
		Kyabigambire	2015	109	8
	Nakapiripirit	Lolachat	2015	32	13
		Namalu	2015	57	11
	Subtotal			269	

All animals from the participating households in the sub-sites were identified using ear tags. Each sub-site had an enumerator employed by the project and responsible for data recording. The data parameters included the following: animal (offspring), sire and dam identification numbers; offspring birth weight and type (singleton, twins, and triplets); date; and 2-month, 4-month, and 6-month live weights. Veterinary and other advisory services were provided by existing government livestock extension officers. The project initiated the drug revolving fund to ensure that drugs for common goat diseases were always available to enhance animal healthcare in the project impact areas.

Data analysis and calculation of breeding values on the farmers' predefined traits was facilitated by Lilongwe University of Agriculture and Natural Resources (LUANAR) in Malawi and the National Agricultural Research Organization (NARO) in Uganda. The breeding values were generated/calculated based on a simple mixed model accounting for fixed effects such as birth type (single, twin, triplet, etc.) and birth season. Currently, only sire selection is carried out. Buck selection is usually done twice per year, in December and June. During the buck selection event, the selected candidates are grouped into three categories (top, second-, and third-best) based on their breeding values. The farmers are then asked to select the final list, applying their preferences and other criteria (bucks from good mothers—mothering ability, color, free from visible deformities, disease resistance, etc.) from visual appraisals and observations. All the unselected bucks are castrated, slaughtered, or sold out. The selected breeding bucks are purchased by the sub-site farmer management committee; hence, the participating households do not own the breeding bucks but have the right to use the bucks. The selected breeding bucks are distributed into the SBGs. The bucks undergo prophylactic treatment every time they are transferred from one household to another to prevent disease transmission from one household to another. The bucks service the females for a period of two to three years after which the bucks are exchanged between the SBGs or sub-sites or are sold out. Excess selected breeding bucks are sold to other communities, organizations, and research institutions.

2.2. Study Methodology

The study was conducted in pilot CBBP sites and in potential sites identified for scaling-up the program shown in Figures 1 and 2. Data were collected using the following tools: desk study, focus group discussion with project participants in pilot CBBP sites, interviews with selected goat keepers in potential sites identified for scaling-up the program, direct observations, and interviews with stakeholders involved in promoting goat production and improvement in the two countries.

2.2.1. Data Collection

The literature review involved a retrospective review of CBBP project documents and progress reports for CBBPs in Malawi and Uganda and published articles on small ruminant CBBPs implemented in different countries and regions. The objective was to have a general overview of the program's implementation plan, major outputs, experiences, challenges, and lessons learned.

Eighteen farmers from each pilot sub-site were randomly selected to participate in the focus group discussions (FGDs). A total of 10 FGDs were conducted in the two countries. Interviews with smallholder goat keepers were conducted in potential sites for scaling-up the program. Local veterinary officers proficient in the local language in respective sites were recruited as interviewers. Semi-structured questionnaires were used to capture data. A total of 278 goat farmers in Malawi and 197 in Uganda were interviewed. A snowball sampling method [16] was used to identify the respondents in the potential sites for scaling-up the program. This method was employed because the pre-recorded data/information of the respondents with targeted characteristics were not available [17]. The interviews were intended to assess the existence of essential factors required for the establishment of goat CBBPs in the scaling-up sites. The data collected during the interviews included the importance of local goats at the household level; the status of small ruminant feed resources; farmers' perceptions of and willingness to participate in the program; and demographic and technical parameters that may affect the sustainability of the program. The FGDs were designed to evaluate farmers' perceptions on the immediate impacts of the CBBPs in the pilot sites. Direct observations were included to obtain more information for assessment of environmental issues.

Interviews with stakeholders in the small ruminant subsector were designed to assess supporting policies and regulations for small ruminant production and the existence of potential and long-term supporting institutions including an effective livestock extension support system. Data/information were obtained from a study on scaling-up the community-based goat breeding program via multi-stakeholder collaborations in Malawi and Uganda whose detailed methodology is given by Kaumbata et al. [18].

2.2.2. Data Analysis

Quantitative data from questionnaires were analyzed using IBM SPSS version 22. Qualitative data (Table 3) from interviews and consultations with stakeholders including observations were transcribed, coded, and then interpreted based on tasks specified in the study. The interview texts and observations were analyzed using the coding process [19,20] to add key words that became the basis for the analysis. The process involved a systematic condensation of large amounts of interview texts and observations into an organized and concise summary of distinct units of specific study tasks. The codes were then added to the condensed texts and observations, categorized based on related themes describing key results of the analysis. Triangulation (comparison) of result findings from two researchers working on the same interview texts and observations were performed to validate study findings and build consensus on the results. Documents were analyzed using summative content analysis [21] bearing in mind the audience and aims of the documents to avoid using biased information.

Table 3. Quantitative and qualitative study variables.

Ser No	Quantitative Variables	Qualitative Variables
1	Average age of household head	Marital status of household head
2	Number of years in school of household head	Literacy rate of household head
3	Average family size	Ownership of grazing land and access to communal pasturelands by households
4	Land-holding size per household	Willingness to participate in the CBBP program
5	Number and type of livestock kept	Farmers' (from pilot sites) perceptions on the impact of the following CBBP activities (a) Working in farmer groups (b) Goat husbandry training (improved feeding, housing, and disease control) (c) Establishment of the drug revolving fund (d) Use of selected bucks in their goat flocks (e) Production and selling of goat breeding stock (f) Full involvement of farmers in buck selection and other breeding activities, etc.
6	Annual household income from crops, livestock, and off-farm activities	Existence of stakeholders supporting goat-based interventions
7		Roles of various stakeholders in CBBP
8		Stakeholders' perception of CBBP in terms of usefulness to all players in the small ruminant value chain and national economy
9		Existence of policies and legal frameworks guiding various activities in the small ruminant subsector

3. Results

3.1. Demographic Characteristics of Households in the CBBP Scaling Up Sites in Malawi and Uganda

Majority (Malawi—78%, Uganda—65%) of the households were male-headed, and the average age of household head was approximately equal in the two countries (Malawi = 46.5 and Uganda = 45.6 years). The average family size was estimated at 5.6 persons per household in Malawi and 7.5 persons in Uganda, composed of approximately equal numbers of males (2.8) and females (3.0) in Malawi and 3.7 males and 3.8 females in Uganda. The literacy rate among the household heads in Malawi showed that 77% had a formal education up to primary school level, with an average of 6.3 years of formal schooling, while in Uganda, 51% had formal education up to primary school level with an average of 7.4 years of formal schooling. Majority (74%) of the households in Uganda have their own grazing land (average of 1.7 acres) while in Malawi, only 15% of the households have their own land (average of 0.7 acres) used for grazing. Nearly 100% of the households in the CBBP scaling-up sites (except in Kamuli and Masindi) indicated that they have access to communal pasturelands. During FGDs the farmers reiterated that goat nutrition is enhanced through supplementation with crop residues and crop by-products on top of feeds from natural pastures and browse. However, farmers in the drier areas (Nsanje and Nakapiripirit) usually experience feed shortages during the dry season leading to animals losing body conditions and increased mortality. Table 4 gives a summary of the average total land-holding size and flock size for major livestock species per household and depicts the relationship between total land-holding size and number of livestock kept. Where average land-holding size is small, a corresponding small herd is kept and vice versa, for all the livestock species. Of special interest is the rate of the decrease of various livestock species in response to the decreasing land-holding size. As land-holding size decreases, the corresponding magnitude of the decrease is higher in large stock (cattle) than small

stock (goats and chickens). This suggests that the farmers give up keeping large stock and opt for small stock as land-holding size diminishes.

Table 4. Average land-holding size and flock size for major livestock species in the study areas.

Study Areas	N *	Average Land-Holding Size (Hectares)	Average Flock Size—Major Species			% of Households with Access to Communal Pasturelands
			Cattle	Goats	Chickens	
Mzimba South	104	1.9 (0.7)	7.6 (3.7)	5.7 (2.9)	13.3 (6.6)	100
Salima	96	1.6 (0.6)	2.0 (1.7)	7.0 (3.1)	11.0 (4.6)	100
Neno	78	1.6 (0.5)	1.8 (1.6)	9.0 (3.5)	6.0 (2.9)	97
Total (Malawi)	278					
Kamuli	66	3.1 (1.1)	13.7 (4.7)	26.1 (9.3)	21.8 (8.0)	38
Masindi	66	1.9 (0.8)	1.0 (0.8)	7.0 (3.4)	11.7 (4.8)	21
Napak	65	3.4 (1.2)	10.8 (3.7)	11.7 (4.1)	12.0 (5.1)	100
Total (Uganda)	197					

* Number of households interviewed. Figures in parenthesis are standard deviations.

3.2. Contributions of Agricultural and Off-Farm Enterprises to Annual Household Income

Low-input subsistence farming systems are predominantly practiced in all the study areas, where livestock rearing is integrated with crop production. Indigenous cattle, goats, and chickens are the major livestock species while major crops grown vary with the agro-ecological conditions of the specific study area. For example, sorghum and green peas are the major crops in Napak, while maize, beans, and cassava are predominantly grown in Masindi and Kamuli. In Malawi, maize is the major staple across the study areas, while soybean, ground nuts, and sweet potatoes are specifically predominant in Mzimba south, Salima, and Neno, respectively.

Figure 3 shows the contribution of agricultural and off-farm activities to the annual household income. The contribution of agricultural and off-farm activities to the annual household income is diverse in the two countries. Major factors influencing the trends include proximity of the study area to towns and trading centers and varying agro-ecological conditions. For instance, Napak and Kamuli lie in the cattle corridor which stretches from southwestern to northeastern Uganda, characterized by arid and semi-arid conditions and dominated by pastoral rangelands; hence, livestock (mainly indigenous) is the chief source of income and livelihoods. The agro-ecological conditions in Masindi are favorable for crop production characterized by average small land-holding and flock sizes. Hence, crop production is the main source of income and livelihoods. The study areas in Malawi are located close to major trading centers; hence, livelihoods are mainly supported by off-farm income consisting of salaries and wages (37%), small businesses (30%), remittances (19%), and casual work (13%). Excluding income from off-farm sources, the contribution of livestock is consistently high across the study areas.

Figure 4 shows the average annual income from major livestock species (cattle, goats, and chickens) in the study areas in the two countries. Cattle represent the largest contributor to the average livestock income in some study areas (Mzimba South, Kamuli, and Napak) where mean cattle numbers per household are relatively high. However, as the grazing areas shrink (as observed earlier), farmers tend to opt for small stock resulting in reduced herd size, and the corresponding annual income from cattle also reduces. The trend is different from the annual goat income. It is consistently high across all the study areas. This observation suggests that the local goat genetic resource is instrumental in supporting livelihoods irrespective of the areas' agro-ecological characteristics, average land-holding size, and proximity to areas of increased economic activities. Selling goats in response to the needs that require money was the top reason among the reasons for selling goats in all the pilot sites in the two countries. This suggests that goats are primarily kept to finance household needs and emergencies. Consequently, majority (91% in Malawi and 97% in Uganda) of the households expressed a willingness and commitment to participate in the community-based goat improvement program. Income from other livestock species consists of revenue from sheep, pigs, and non-conventional livestock. The results of focus

group discussions in the pilot goat CBBPs in the two countries showed that goats are the major source of income amongst the livestock species kept. It was evident that the implementation of the program contributed to improvements in animal growth performance, kid survival, and twinning rates. This is probably due to improved feeding and animal healthcare. The organization of goat keepers into farmer groups has promoted access to better extension services including smallholders' capacity building and better prices for the animals. These are early program benefits that have stimulated farmers' interests and commitment to the program.

Figure 3. Household income from agricultural and off-farm activities.

Figure 4. Average annual income from major livestock species.

3.3. Existence and Availability of Support Institutions and Organizations

Permanently established institutions providing supports and NGOs involved in the implementation of goat-based interventions exist. Table 5 gives details of institutions and organizations involved in goat-based research and interventions in the pilot and scaling-up sites in the two countries.

Table 5. Institutions and organizations involved in goat-based research and interventions.

Country	Sites	Permanently Established Institutions			NGOs/Donors		Availability of Community-Based Institutions (Cooperatives)
		Livestock Extension Support System	Research Institutions	Research and Training Institutions	Mainstream	Faith-Based	
Malawi	Pilot	Department of Animal Health and Livestock Development (DAHLD)	Department of Agricultural Research Services (DARS)	LUANAR ¹ -Animal Science Department	Heifer International, TAPP ²		Under development
	Scaling-up	Department of Animal Health and Livestock Development (DAHLD)	Department of Agricultural Research Services (DARS)	LUANAR-Animal Science Department	World Vision Malawi		Not available
Uganda	Pilot	Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)	National Livestock Resources Research Institute (NaLIRRI)	Makerere University-College of Agriculture and Environmental Sciences, Kyambogo University	FAO ² , World Bank		Under development
	Scaling-up	Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)	National Livestock Resources Research Institute (NaLIRRI)	Makerere University-College of Agriculture and Environmental Sciences, Bukalasa Agriculture College	FAO, World Bank, Iowa State University-Uganda Program	Joy Goat, Caritas Hoima	Not available

¹ Lilongwe University of Agriculture and Natural Resources. ² Trustees for Agricultural Promotion Program. ² Food and Agriculture Organization.

Various institutions in both countries have been playing essential roles in the establishment of pilot and scaled CBBPs since the inception of the program. Research and training institutions have been instrumental in designing data collection tools, data processing, and generating outputs and feedback regarding selection candidates. The institutions are also responsible for the capacity building of data collection enumerators and clerks. The institutions have benefitted from the program through the capacity building of their staff members and the availability of research projects for graduate students at different levels. Ninety-two percent (92%) of the households in Malawi and 68% of the households in Uganda indicated that they access livestock extension services from a government extension support system. This suggests that livestock extension services are generally available in the study areas. Livestock extension systems provide support in animal healthcare services, farmer capacity building in general animal husbandry (feeding, housing, disease control, and breeding), agribusiness, and cooperative establishment and management. NGOs and donors mainly provide financial/material support and technical backstopping. The establishment of goat breed-stock producers' cooperatives are underway in pilot sites but are non-existent in the scaling-up sites. The scaling-up plans showed that awareness and trainings are to be extended to extension workers and policy makers and other stakeholders. The aim is to change and transform perceptions and attitudes towards indigenous livestock species and breeds and be initial activities for the process of policy dialogue. It was noted that there are currently no clear policies or legal frameworks specifically designed to promote sustainable improvement and use of indigenous small ruminants and protect them from indiscriminate crossbreeding in the two countries. Malawi has a livestock policy with only brief information on small ruminant breeding and Uganda has an animal breeding act of 2002 with general information on registration and certification of livestock breeds, regulations of animal breeders, establishment of a national animal

genetic resource center and data bank, and promotion of breed societies and associations. Availability of sustainable institutional support coupled with recognition and support of indigenous species and breeds by policy instruments and legal frameworks are important for the development and growth of the CBBPs.

4. Discussion

4.1. Feed Resources in Ruminant Production Systems

In low-input ruminant production systems, direct grazing is the main source of live-stock feed. Therefore, the availability of pastureland is one of the most important factors of production. Traditionally, family size has a direct effect on the land-holding size. As the family size increases, the land is usually apportioned to the family members who become independent to run their own families. An average of six or eight people per family as observed in this study entails that the average landholding size will inevitably diminish in the long term. Sustainable management of the small ruminant genetic resources requires that the custodians of the animals have access to grazing areas. Therefore, guaranteed access to communal pasturelands can be a solution to the problems of diminishing landholding size. Better access to communal pasturelands as observed in this study is essential for the conservation and management of the local goat genetic resources. However, the grazing areas need to be protected from encroachment such as the conversion of the communal pasturelands/rangelands into crop production fields, woodlots, and other non-agricultural developments. This is particularly important in Malawi where close to 75% of the households have no grazing land of their own and mainly rely on communal pasturelands. Secure land titles for farmers and indigenous communities as well as assured land access rights for pastoralists and an effective prohibition of encroachment on communal pasturelands and rangelands could stabilize rural livelihoods and support their custodial roles of indigenous breeds and species [20]. The rights of pastoralists and smallholder farmers as custodians of agricultural biodiversity could be recognized through legislative frameworks. In the meantime, the legislative frameworks guiding the protection of communal pasturelands do not exist in the two countries. As a provisional measure, the goat CBBP engages traditional and local leadership to strengthen existing local rules and regulations guiding the protection of communal pasturelands and rangelands. The acute feed shortages experienced during the dry season in drier CBBP areas (Nsanje and Nakapiripirit) is due to a lack of farmers' preparedness in terms of conservation and preservation of livestock feed. Farmers acknowledged that since time immemorial livestock have been relying on natural pastures and traditionally farmers do not preserve or conserve feed for livestock. Consequently, the program initiated activities to strengthen the capacity of smallholders for pasture production and conservation of crop residues and crop by-products to diversify the feed resources for the local goat genetic resources. However, regionally or nationally recognized legal frameworks and legislations are needed to secure and protect existing grazing areas for sustainable maintenance of the diversity of small ruminant genetic resources.

4.2. Contribution of Small Ruminant Genetic Resources to Rural Households' Economy

Mapiye et al. [22] noted that the best way to conserve indigenous livestock species and breeds is to continue using them commercially. Such an approach will be successful if it is economically viable and if sufficient technical support is provided [4]. This is certainly the way that most tropical local breeds will be conserved because of their adaptation to local environments and current and potential future contributions to food and agricultural production. As observed in this study, indigenous animal genetic resources (particularly ruminants) contribute meaningfully to the livelihoods of households in the study areas. The contribution is significant in marginal areas which are usually not suitable for crop production. The local goats demonstrated substantial contribution across the study areas irrespective of varying agro-ecological and demographic characteristics and areas of increased economic activities. In a household monitoring study in pilot goat CBBPs in Malawi, Kaumbata et al. [18] found that local goat enterprises in smallholder farms are

profitable and economically viable. Some sites realized a high mean net profit and return on capital because they sold more breeding bucks than their counterparts. Gutu et al. [6] found significant differences between sheep CBBP members and non-members regarding the number of animals sold, amount of mutton consumed, and income realized from sales of sheep per year. Different authors [23,24] reported high gross margins and net profits in smallholder goat production farms and attributed this to the low cost of production of the local goat enterprises. Evidence suggests that with appropriate interventions, particularly on feeding and animal healthcare, the contribution of small ruminant genetic resources to household income could be doubled. Through household modeling, Mayberry et al. [25] found that goat profitability in an extensive system was increased through improved healthcare, but the biggest improvement in productivity and profitability occurred when improved healthcare was combined with better goat nutrition. Haile et al. [7] noted that in small ruminant breeding programs, early and major productivity gains will come from improved husbandry practices and not from genetic improvement. These husbandry gains are the incentives that drive early farmers' participation and commitment. Community-based goat breeding programs are, therefore, designed to capitalize on this opportunity and potential of indigenous small ruminants by implementing selective breeding programs along with improved nutrition, housing, and animal healthcare. Preliminary evaluations of the pilot goat CBBPs in the two countries show elimination of "negative selection" (discontinuation of unfavorable practices where fast-growing animals are sold out for slaughter leaving inferior ones for breeding leading to a downward spiral in genetic quality of the breed), improved average 6-month live weight (average of 16 to 19 kg), increased percentage of kid survival (72% to 91%), improved twinning rates (8.2% to 16.7%), and improved prices (US\$34.56 to US\$48.17) per adult animal (unpublished reports). Haile et al. [7] evaluated three local sheep CBBPs in Ethiopia and found a 20% increase of household income realized from the program. Most of the participating households graduated from the government-run safety net program that meets short-term food needs through emergency relief and are now using income from sheep sales to buy food.

While these results are promising, the sustainability of the farmer breeding groups after external funding is withdrawn is not guaranteed. Mueller et al. [10] noted that similar interventions in smallholder rural farms have produced outstanding outputs, but have failed to sustain the outputs in the long-term due to a myriad of challenges faced post-external/donor support. For example, in almost all the pilot sites, farmers are already struggling to find markets that offer competitive prices for the breeding stock and some pilot sites (Nsanje, Lilongwe) are already experiencing challenges in the management of the buck and drug revolving funds. Some farmers (in all the pilot sites) disregard group bylaws and sell the buck selection candidates before the selection events. These issues, if not dealt with promptly, can be a strong recipe for group disbandment. These are clear signs that these breeding groups are not fully prepared to run and manage the breeding program independently. Therefore, as a preparatory measure to build self-sustaining small ruminant breed conservation groups, efforts are underway in both pilot and scaled goat CBBPs to build the capacity of smallholders and establish small ruminants breed-stock producer cooperatives. Cooperatives are instrumental for empowering rural farmers to actively participate in animal products value chains [26] and are a foundation for local communities to lobby for their interests and consolidate their bargaining power. Better and consistent markets that offer lucrative product prices are essential incentives that contribute to increased livestock keepers' income, thereby reinforcing the breed's survival [4,12]. It is envisaged that the cooperatives will enable smallholders to transact and sustain activities of their local breeding institutions using internally generated revenues/resources.

4.3. Roles of Supporting Institutions for Small Ruminant CBBPs

The existence of permanently established institutions and other organizations supporting small ruminant production and research guarantees the availability of sustainable institutional support. FAO [4] noted that the involvement of a range of stakeholders is

critical for the long-term success of conservation programs. Stakeholder participation is particularly vital for the creation of enabling environments for the establishment of self-sustaining small ruminant CBBPs. Literature on the conservation of Farm Animal Genetic Resources (FAnGRs) [1,4,12,27] has repeatedly mentioned the creation of an enabling environment as an important factor for the creation of sustainable FAnGRs conservation programs. This means that apart from the specialized roles institutions play in supporting small ruminant CBBPs, they also collaborate on important issues that require concerted efforts for creating the spaces (i.e., fostering the right conditions) for the programs to take off and thrive. These include but are not limited to strengthening effective extension support systems, lobbying for policy reforms, and mainstreaming cross-cutting issues. In the scaling-up effort of the goat CBBP initiative in Malawi and Uganda, special CBBP taskforces were set up to facilitate and catalyze policy change through collaborative and formal dialogue with important policy and decision makers at local, regional, and national levels [11].

Lobbying for policy support: This primarily involves creating awareness about the value of small ruminant genetic resources for contributing to sustainable food security and livelihoods. One of the main reasons for the lack of policies and legislation directly formulated and designed for the management of animal genetic resources is that policy and decision makers are usually not fully aware of the contribution of the genetic resources to food security and national economies, and the commensurate need to provide policy and budgetary support [2,27]. Therefore, undertaking such activities aimed at increasing public awareness on the roles and value of indigenous small ruminants would offer some recognition of the contribution of the genetic resources to national economies and development.

Policy dialogue also involves analyzing whether the goal of the goat CBBP model aligns with current local or national development priorities and whether existing legal frameworks support or hinder the CBBP initiative, particularly in areas of small ruminant management and value chain development. Policies such as phyto-sanitary regulations, pricing and taxation, and monopolies in processing and trading can prohibit the growth of smallholder goat/sheep enterprises. Emerging policies from other sectors like forestry, land husbandry, and irrigation regarding restrictions of access to common resources such as rangelands, communal pasturelands, watering points, crop residues, etc., can act as disincentives. The aim of such assessments is to lobby for the reformation of such policies and legal frameworks and harmonization of conflicting policies (if they exist) in the countries of focus to strengthen conservation programs such as small ruminant CBBPs.

Secondly, the assessment is meant to look at possibilities for integrating the goat CBBP model into government small ruminant development programs. The long-term vision is to achieve policy and institutional scaling-up where formal government decisions are made to adopt the goat CBBP model at regional or national levels and to ensure that the model is institutionalized through national planning mechanisms where systems and structures are adapted and resources redistributed to build institutional support and ensure sustainability. Policy frameworks, laws, regulations, and norms have to be supportive if pro-poor initiatives are to succeed [25]. The lack of appropriate policy frameworks was identified as one of the main reasons why the scaling-up of livestock interventions fail [23]. Effective and coherent pro-poor policies are crucial to capitalize on the growing opportunities offered to smallholder producers by the livestock sector. For example, the Ethiopian government has accepted CBBPs as the strategy of choice for genetic improvement of small ruminants as explicitly indicated in the Ethiopian Livestock Master Plan [28], and the government of Argentina passed a “Goat Law” in 2006 which creates space for producers, processors, traders, retailers, and regulators to meet and negotiate for mutually beneficial policies and to ensure access to communal pasturelands by farmers [23].

Effectiveness of livestock extension system: Appropriate technology and advisory services are the backbones of successful small ruminants’ conservation and improvement programs. Producers need relevant and timely information on feeding, breeding, health,

management, and the market, as well as access to inputs, for their products [23]. The extension service plays a key role in facilitating access to such information. In the pilot goat CBBPs in Malawi and Uganda, the extension has been instrumental in facilitating the implementation of the project. In addition to the provision of animal health services, extension officers have been a useful link between farmers and researchers. The extension service plays a critical role in farmer capacity building through technical and leadership trainings and facilitation of farmer to farmer learning through exchange visits, on-farm demonstrations, field days, and agricultural/animal shows. Therefore, the availability of an effective extension service is one of the prerequisites for creating sustainable CBBPs. However, improvements need to be made in the CBBP pilot and scaling-up sites on the farmer–extension officer ratio or the area one extension officer covers. According to Benor et al. [29], the recommended ratio is 1 officer to 300 or 500 households, depending on household densities in a particular area. Currently, the ratio ranges from 1 officer to 1300 or 2000 households in Malawi and 1 officer to 2500 households in Uganda [28,30].

Harmony with cross-cutting issues: Conservation and improvement programs may sometimes bring changes, which may have both positive and negative implications on society and the environment. Programs that are in harmony or have the potential to promote better management of cross-cutting issues (environmental sustainability and gender equity) are likely to receive support from governmental, private, and development sectors. In the past, ruminants have been blamed for accelerating soil erosion, desertification, and the emission of greenhouse gases. Although this is true to some extent, studies have demonstrated that with improved management in nutrition and husbandry practices, these negative effects can be drastically reduced [29,31]. In crop–livestock integration systems, small ruminants are instrumental in aiding nutrient recycling. Otherwise, less-valued crop residues are fed to animals for the production of high-value products (meat, milk, fiber) and manure. Livestock manure has the capacity to revitalize unproductive soils and boost crop production. Furthermore, the goal of small ruminant CBBPs is not to increase flock sizes but rather to improve growth performance and reproduction to increase offtake rates. Small ruminants have the potential to contribute to gender equity through the economic empowerment of women and youth. Unlike large ruminants, small ruminants are easy to manage and do not require large investments; hence, they can be owned by landless smallholders including female- and youth-headed households [23,32].

5. Conclusions

Maintaining diversity of farm-animal genetic resources is instrumental for sustainable agricultural production as it allows farmers to select stock or develop new breeds in response to changing environments, consumer tastes, market conditions, and research needs. Community-based livestock breeding programs (CBBPs) have emerged as a potential approach to implement breeding programs of indigenous livestock in smallholder farms. Goat CBBPs in Malawi and Uganda demonstrate the potential for fulfilling the dual purpose of supporting rural livelihoods while maintaining and improving the diversity of the local goat genetic resources. The program promotes and empowers smallholders to have access to small ruminant feed resources through the protection of existing communal pasturelands, capacity building in pasture production, and conservation of crop residues and crop by-products. Indigenous goats contribute significantly to the household income of smallholders in the two countries while providing socio-economic and socio-cultural services. Farmers' willingness and commitment to participate in the program and the existence of permanently established institutions and organizations supporting goat CBBPs provide opportunities and grantees sustainable institutional support instrumental for building sustainable goat CBBPs. The goat CBBPs also contribute to strengthening the management of cross-cutting issues such as environmental sustainability and gender equity.

However, to facilitate the creation of self-sustaining CBBPs, meaningful initial investments in time and other resources are required to build smallholders' capacity and to develop or strengthen their local breeding institutions. Investments in institutional/policy

reforms to safeguard fair trading, access to common resources by small ruminant keepers, and adoption of the CBBP model into national livestock development programs are some of the key milestones that can guarantee sustainability. For these to be attained, early collaborative program planning and long-term, concerted, and coordinated efforts by collaborating partners are essential. Permanently established actors, like government agencies and research and training institutions, are better placed to coordinate such efforts.

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