Final report on '*Identifying priority areas and aligned innovations for sustainable goat production in West Africa*'

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Summary of the topic area

Goat production is a vital aspect of livestock farming in Ghana and Nigeria, contributing significantly to food security, income generation, and rural livelihoods. Goats also have significant cultural value and are particularly important to many rural communities with respect to their ability to provide a bride price. Goats are almost entirely reared for meat purposes within these regions (with hides and manure as secondary products) as there is little desire for goat dairy products due to a belief that the flavour is not desirable (only 5% of survey respondents reported frequently consuming goat dairy products). Goat production in these regions is primarily dominated by subsistence smallholder farmers with 56% of survey respondents having <10 goats, and 88% reporting that their goats provide food for their families or food with some income, only 10% considered their goats to be a business with employees, and 2% that goats provide the majority of their income. These smallholders typically rear indigenous breeds such as the West African Dwarf (WAD) goat, but there is an appetite from many to expand into more commercial production. Indigenous breeds appear to be well-adapted to local climatic conditions and require minimal input, making them suitable for extensive and semi-intensive systems, and they therefore dominate the genetic pool. However, there are several foreign meat breeds now being utilised with mixed success (many reports that they experience higher morbidity and mortality).

Despite its importance, the sustainability of goat production in both countries face several challenges. Key issues include inadequate access to quality feed, diseases (such as peste des petits ruminants) and limited veterinary services, poor breeding practices, and challenges related to housing. Climate change also poses a threat and challenge to all these areas, with particularly strong impacts on pasture availability and increasing vulnerability to droughts, and changes in disease patterns. Additionally, land-use conflicts are becoming increasingly problematic due to urbanization and deforestation which impacts grazing lands and increases societal conflicts between goat farmers and others.

To enhance sustainability, there is a need for improved breeding programs, better provision of housing, improved health management, and increased investment in feed production. Government policies that support smallholder farmers with access to credit, extension services, and market linkages are also crucial. Integrating climate-smart livestock practices, such as agroforestry and rotational grazing, can help mitigate environmental impacts. There is already substantial local knowledge about these topics with many academic institutions working in these areas, however ability to access funding within Ghana and Nigeria is highly challenging and hinders progress. Overall, while goat production in Ghana and Nigeria holds significant economic and nutritional potential, addressing sustainability challenges through innovation, policy support, and improved management practices is essential for its long-term viability.

Challenges and barriers

Initially after discussion within the project team and informed by reviewing the literature we proposed five key areas for discussion where challenges were likely to be experienced. After online workshops with Nigerian goat farmers were held it became clear that 'Selling and the supply chain' was considered to be least problematic, therefore this area was dropped (although comments related to this could still be captured under 'any other challenges'), and four key topics were taken forward for scoring and discussion. A summary of each of these is presented below.

Breeding and genetics

The most important breed farmed within Ghana and Nigeria, is the indigenous West African Dwarf (WAD) kept by 82% (125) of our survey respondents. The WAD are small and compact, and the adult bucks weigh between 20-25 kg while the adult doe between 18-22 kg. Participants expressed that these goats are highly adaptable to local climatic conditions, trypano-tolerant and resistant to many local diseases and parasites, excellent foragers, able to utilize a wide variety of vegetation and feed resources. According to local sources the fertility rate is about 80%, the kidding rate is 1.7 per annum and the average litter size of 1.2. Participants highlighted that this breed is used in America and achieves higher productivity there. They expressed that this likely suggested that their management systems, particularly nutritional factors, are limiting production, rather than it being genetic. Other common breeds are predominantly the Red Sokoto goat (33% of respondents) and Sahelian (12%) both of which are local breeds. There is some minor use of the South African Boer goat (5%), a large breed famed for meat production abilities (Figure 1).

Random natural mating is the most common method of breeding; 44% of survey respondents report that their goats' mate within their own herd and they do not control when they breed and 28% report that their goats mix with goats from other owners with no control over breeding. A Nigerian farmer stated, "*We let the goats mate freely, but sometimes the best bucks are not the ones breeding. We need controlled breeding*." Selective breeding programs and controlled mating practices could improve genetic potential, but these require farmer training and accessibility to high-quality breeding stock. Further, this requires identification of individual goats and record-keeping which is currently limited. Controlled mating is practised by a few farms (27%), however overall, there is very little control over the time of year the goats breed with only 5% aiming to kid at a specific time of year. Of the few farms who aim to kid at a specific time of year, they all report this is done to avoid kidding during the rainy season due to associated rise in health issues. Providing adequate nutrition and care to pregnant animals is challenging when most animals are at varying stages of gestation and lactation throughout the year. Very few farms in Nigeria or Ghana practise Artificial Insemination (AI) but it is reported that there are some people providing these services.

The key challenges within this area are:

- Inbreeding due to uncontrolled mating, leading to reduced genetic diversity and lower productivity.
- Lack of record keeping and individual identification of goats contributing to inbreeding as genetic history is unknown.
- Lack of selective breeding programs to enhance productivity, which is impacted by a low understanding of heritability of traits and further links to the challenges presented by lack of record keeping which could quantify desired traits of progeny etc.
- Very limited use of artificial insemination (AI) and modern genetic improvement technologies. The ability to do this is limited by availability of expertise and training, access to required resources, and instability of power supply.

Figure 1. Purebred South African Boer goats at Yapei Livestock farms, Ghana.

Feeding and nutrition

Feed availability and quality are major constraints, particularly during the dry season. Farmers typically rely on natural pasture, crop residues, and agro-byproducts, but these resources are often insufficient. A participant from Nigeria commented, *"In the dry season, the goats have to walk long distances to find food and water. Sometimes they eat what they shouldn't and fall sick."* Innovative solutions such as integrating forage crops with food crops, silage and hay storage techniques, and locally produced concentrates were discussed as potential interventions. Farmers who successfully implemented silage techniques reported improved goat condition during the dry season, however

this was a very rare practice and is challenged by access to owned ground that allows grazing to be conserved – free range livestock and nomadic herds access most pastureland and consume it before it reaches optimum growth.

The majority of participants discussed the rising costs of feed as a significant barrier that is causing widespread consequences: "*Very high cost of feed which is tilting the system of production to some form of free range to access free forage*. *This is causing SERIOUS farmers/ goat rearers/neighbor clashes".* Some linked these rising costs to the growth of the poultry industry which requires significant feed inputs and has increased the price of supplies. Farmers often stated that the availability of feed was a primary constraint to their herd size, therefore improving the ability to provide feed in the dry season would allow expansion of goat production.

The key challenges related to feeding and nutrition can be summarised as:

- High costs of, and limited access to, supplementary feeds and limited storage facilities.
- Competition between livestock sectors (particularly poultry) and human consumption for available feed resources.
- Poor understanding of, and ability to provide balanced rations, leading to nutritional deficiencies.
- Seasonal variations exacerbated by climate change leading to periods of feed and water scarcity.
- Urbanisation reducing the availability of pastureland and forage.

Health issues

Goats are susceptible to various diseases, and most are particularly exacerbated during the rainy season, which is of key concern to farmers and health professionals. Inadequate veterinary services were frequently expressed as challenging. Whilst there are health professionals across both countries, it was felt that there were too few to meet demands, and that access to, and costs of vaccinations and other medicines is problematic. Storage of medicines is a particular challenge due to distances between veterinary supplies and farmers and unreliable power supplies (particularly important in the case of live vaccinations that must be kept within a specific temperature range to ensure efficacy).

Specific health issues that were mentioned by participants as of major challenge were:

- Peste des Petits Ruminants (PPR)
- Foot and Mouth Disease
- Parasites: both ecto (worms) and endo (lice, mites, tick)

- Scouring/diarrhoea
- Pneumonia
- Mastitis
- Rumen impaction
- Helminthosis
- Foot rot (during the rainy season)
- Bloat
- Heartwater
- Anthrax
- Orf

The rainy season was frequently mentioned as being of the biggest concern when it comes to outbreaks of virus, diseases and general ill health (with respiratory symptoms and parasitic infections flagged as particularly problematic). Often this was linked to goats being housed, with many participants stating that this perception prevents them from housing goats. There is a strong belief that housing prevents goats from finding medicinal plants and there was a desire expressed to understand more about organic treatments, and treatments using native vegetation.

There was a strong consensus across both countries that local native breeds experience less health-related issues than foreign breeds. This is a limiting factor when it comes to breed improvements, with participants stating that when they have incorporated foreign breeds for productivity reasons, they frequently lose these individuals due to disease.

Housing and Shelter

Housing quality significantly affects goat health and productivity. Participants highlighted that most smallholder farmers either provide no formal housing and rely on local landscapes to provide shelter when needed, or housing that has not been specifically designed for goat health and welfare. Examples of smallholder housing provisions that have been made specifically for goats can be seen in Figure 2. Inadequate housing provisions lead to exposure to harsh weather conditions, increased disease susceptibility, and higher kid mortality rates. Farmers perceive free-range systems as beneficial, and it is a very common practice with 10% allowing their goats to range fully freely at all times and 56% allowing partial free-ranging with some confinement. Issues related to free-ranging include higher mortality rates during the rainy season due to wet conditions, increased parasite loads, poisoning, and predation.

Figure 2. Examples of smallholder goat housing observed in Ghana.

Affordable, well-ventilated, and hygienic housing is essential to improve goat welfare and productivity. However cost is a key barrier "*Construction of a well wooden floor house has been a dream for goats but the cost of materials had made it impossible*" that must be considered. Enabling farmers to adopt semi-intensive systems with basic shelters could help mitigate health issues while retaining the benefits of natural browsing. This could be particularly useful for kid rearing, as this is an area where high morbidity and mortality is seen. As young goats are particularly vulnerable to climatic conditions an ability to house them well would likely greatly improve these issues. A key problem mentioned around housing is that all ages of goats tend to be housed together and due to uncontrolled breeding, that occurs year-round there is a wide spread of age and size therefore problems relating to bullying and competitive access to feed occur. Farmers also report increases in disease prevalence when housing their goats "*When we house them intensively here, they usually come down with diseases*" which prevents many from utilising housing. Disease outbreaks are likely related to goats being kept more closely together enabling easier spread, nutritional challenges, poor biosecurity, and flooring and housing materials allowing disease to persist in the environment for considerable periods of time.

***Prioritising the four core challenges identified*:**

Stakeholders in Ghana and Nigeria were asked to 'indicate how important a challenge you think the following topics are to goat farming (on a scale of 1 – not a challenge (doesn't affect your ability to farm goats in any way) to 5 – severely challenging (has severe impacts on your ability to farm goats)'. All topics scored as of high importance however it would appear that 'Health issues' and 'Feeding and nutrition' are of slightly higher priority as challenge areas (Table 1).

Table 1. A summary of scores given by participants when asked to 'indicate how important a challenge you think the following topics are to goat farming (on a scale of 1 – not a challenge (doesn't affect your ability to farm goats in any way) to 5 – severely challenging (has severe impacts on your ability to farm goats)'.

Topic	Statistic	Ghana Study trip (n=20)	Nigeria survey (n=116)	Ghana survey (n=37)	Overall (n=173)
Breeding and genetics	Median (IQR)	4 (1.5)	3 (2.0)	4 (1.0)	4 (1.0)
	Mode	4	3	4	4
Feeding and nutrition	Median (IQR)	4 (1.5)	3 (3.0)	5 (2.0)	4 (2.0)
	Mode	5	3	5	5
Health issues	Median (IQR)	4 (2.0)	3 (3.0)	5 (1.0)	4 (2.0)
	Mode	5	3	5	5
Housing and Shelter	Median (IQR)	4.5 (2.0)	3 (2.0)	4 (1.0)	3 (2.0)
	Mode	5	3	4	4

Other Challenges

All participants were also invited to submit comments regarding any other challenge areas not covered by these topic headings. Common themes are discussed below:

- **Limited extension services and training opportunities:** Many participants brought up as lack of training opportunities and extension services related to goat production as major issues '*Extension officers in both states and local Govt are grossly inadequate and few available are not updated with new technologies'*, and in the survey only 29% of respondents stated that they were aware of local goat-related extension services. However, the desired information and training required would fall under the four key challenge areas identified.

- **Lack of local funding:** There is considerable knowledge in Ghana and Nigeria with academics working within the priority areas identified by this report, however a lack of long-term research funding hinders their ability to make progress. This was further highlighted in our innovation meetings when the issue of short-term projects being unable to lead to sustained impact was discussed. Further, local goat farmers need support with credit facilities and schemes to enable them to upscale their production and invest in animals, training, and equipment – there are some regional schemes but across both countries there are limited opportunities.

- **Access to skilled labour:** Several comments were made regarding the difficulties associated with hiring staff if needed once goat production was upscaled. There are limited training opportunities to enable upskilling of staff and many skilled workers seek jobs in other countries, leaving a shortage of regional skilled labour.
- **Limited Market Access:** Farmers often sell to middlemen, reducing profit margins. There is currently very little (virtually no) market for goats' milk or goats milk products due to widespread beliefs about the tase (frequently described as salty) meaning it is viewed as undesirable. Some farmers are interested in dairy products but don't believe they could sell the products.
- **Security Concerns:** Thefts of goats and of equipment, particularly in Nigeria, remains a significant issue. The likelihood of theft results in decreased investments in goat farming, for example participants report being unwilling to buy a high value breeding male if it is likely to be stolen and their investment lost.
- **Urbanisation:** Population pressures and associated urban creep causing loss of pasture range and severe conflicts between goat owners themselves, as well as with the wider community such as those growing fruit and vegetables.

Opportunities to improve sustainable goat production, and areas for collaboration

Three meetings were held in February 2025 to discuss potential solutions for increasing the sustainability of African Goat Systems. Each of these was aligned with the challenges identified during the activities held with stakeholders in Nigeria and Ghana. Each meeting began with a presentation of the identified challenges, and then participants were asked to contribute to discussion around identification of potential solutions framed as follows:

- existing knowledge that can be directly applied to African situations
- existing knowledge that can be modified for an African situation
- innovations / future research which might be applicable to an African situation

Focus group 1: Technology and engineering solutions for Nutrition and Housing.

The meeting was attended by 16 people (Brazil, 7; UK, 3; Europe; 2, Ghana, 3; Nigeria 1) of which 12 were public sector and 4 private sector.

Participants from Africa were keen to emphasise the challenges with implementing solutions in Africa including, gender issues, the extensive nature of goat production, cultural issues, and challenges encouraging people to accept advice. The tendency for projects to be short term and for outcomes to 'fizzle out' after the end of projects was raised as an issue. A participant highlighted a

10-year study carried out in Africa with Dutch researchers. Several successful solutions (including health, nutrition and housing) were rolled out in villages, however much of the activity was not sustained after the project and long-term impact was limited.

One private sector participant highlighted that their current systems (related to housing) have a high degree of automation as they are aimed at markets with labour shortages or expensive labour. It was discussed that a different approach could be taken were labour is more accessible and lower cost, with an ability to aim for optimisation without automation. Another participant gave examples where the best technologies for the European market were imported and installed in Africa but failed to work in the conditions on the ground e.g. temperature, humidity, and water quality. Parts or technical support to fix the technologies were not available in the region so the technologies were scrapped. Each time the technologies were redesigned and manufactured locally to provide a useable solution – this approach appears to be key to sustained technology usage. Discussions are summarised in Table 2.

Table 2. Summary of focus group meeting to discuss 'Technology and engineering solutions for Nutrition and Housing' for goats in West Africa.

Solutions/ knowledge ready for deployment in African situations	Solutions/ knowledge to be modified for African situations	Innovations and future research
Knowledge of Casava (nutritional qualities and conservation techniques) in Brazil which can be shared	Demonstration farms – useful model for visually sharing knowledge	Modular field shelters – possibly fabrics (local manufacture & materials). UK supplier may support
	Knowledge of nutritional qualities and conservation techniques for other local by products in Brazil which can be adapted to other feed stuffs available in Africa	Options for simple record keeping – Apps – locally appropriate. Would support things like weighing scale use
Partners in Brazil have a publication on nutritional feeding systems for goats which can be shared	Participatory Rural Learning approaches could be adapted for the training of goat keepers especially women	Adaptation of Brazilian agro-forestry systems to African contexts (longer term)
	Solar driers adapted for feed conservation (need local manufactured/ servicing). UK knowledge of adapting these	
Weighing scales – for goat production	Feeding blocks to provide energy, protein and minerals in the feed especially in extended dry periods – adapted to include locally relevant ingredients (Brazil)	

Note: potential innovations and knowledge considered mostly likely and most feasible to take forwards in the short to medium term are highlighted in blue.

Focus group 2: Health and diagnostics solutions sustainable goat production.

The meeting was attended by 9 people (Brazil, 1; UK, 2; USA; 1, Ghana, 2; Nigeria 3) of which 8 were public sector and 1 private sector. A participant from Nigeria highlighted research underway by their group in vaccine development for young stock diseases. While there has been vaccine development in other countries work is needed on the serotypes specific to African goat production. This current work needs upscaling with the assistance of further funding.

Other challenges related to vaccine provision are vaccine availability, and delivery to remote communities. Many vaccines require a cold chain and journey times to remote areas can be long and unpredictable. It was suggested that drones offer opportunities for vaccine delivery and have been trialled in Nigeria already. An additional innovation which could support vaccine use is expanding solar power capabilities to provide more reliable access to electricity for refrigeration, this could be incorporated with the establishment of regional hubs from which vaccines can be delivered and returned. There are also issues around awareness of the benefits of vaccination, and the required frequency of use, so there is an opportunity to improve sustainability through improved education around animal health. In some cases, there is a lack of awareness when veterinary services do exist. Regional community level schemes where women are trained in basic health care practices are reported to be successful but are limited in national spread.

On participant shared their experiences of developing a 'cow side' tool disease diagnostics and expressed several key factors important to success. They stated that it is essential to identify the key stakeholders and to involve as many as possible in a co-development process. It is necessary to ensure that the barriers, motivators, and the market are understood, with consideration given to identifying existing market players, and government policies required to make it viable etc. The importance of support services and ensuring there is sufficient access to, and awareness of these is essential. To ensure longer term impact scalability must be considered otherwise impact remains isolated. This particular project occurred over the course of 18 months to 2 years, and there was consensus among the group that this timescale, or longer, is necessary to allow sufficient development.

While knowledge of goat health and veterinary services can be limited there is knowledge of medicinal plants and an appreciation of goats' ability to self-medicate when free ranging. There is an opportunity to research these plants to provide an evidence-based approach to their use, and similar projects have been done in other African countries. These plants are familiar and free, so may have better uptake, however even if the active compounds in the plants are identified, the concentrations of these will vary greatly between plants and across the season so may not be reliable as a medicinal source. There are likely additional issues with some of the medicinal plants becoming difficult to access due to land use changes.

The links between the subject of this meeting and the other two innovation meetings was discussed. Health challenges are likely greater when nutritional status is compromised, and some breeds (especially local breeds) offer some resistance to disease. Some larger scale operations are using non-native breeds but are typically larger scale with more formal management plans in place that involve applying more stringent disease prevention e.g. vaccination and health plans. The difference between those farming commercially and the prevalent smallholder subsistence systems was highlighted. It is likely that many approaches would need to be carefully aligned to the differing needs of these different system types.

Discussions are summarised in Table 3.

Table 3. Summary of focus group meeting to discuss 'Health and diagnostics solutions sustainable goat production' for goats in West Africa.

Solutions/ knowledge ready for deployment in African situations	Solutions/ knowledge to be modified for African situations	Innovations and future research
Bikes and motorcycles are very beneficial for medicine distributions	Access to solar power systems to support refrigeration for medicine and vaccine storage – larger farms or community hubs	Effective on farm/ community level disease diagnostics
	Drone usage for vaccine delivery (research stage)	Upscaling of regionally appropriate disease treatments and vaccines
	Evidence based approach to the use of medicinal plants, some research has taken place but more needed – highly regional	
	Low cost incubators for microbial testing. Suitable for a few hours to get samples safely to labs	

Note: potential innovations and knowledge considered mostly likely and most feasible to take forwards in the short to medium term are highlighted in blue.

Focus group 3: Breeding and genetic solutions for sustainable goat production.

The meeting was attended by 9 people (UK, 1; Uganda; 1, Ghana, 2; Nigeria 3) of which 7 were public sector, 2 charitable sector.

A participant representing a charity in East Africa shared knowledge of breeding programs for dairy goats and in particular cross breeding foreign dairy breeds with native breeds. The charity follows the Farm Africa model for community breeding and improvements. As with Nigeria and Ghana there was generally low to no acceptance of goat milk in Uganda when the charity originally began operating. Uptake and acceptance in his region has been based on starting with the most desperate people (HIV/AIDS created many orphans and families struggling to survive). After about 5 years of having dairy goats there was no stigma from the village and after about 10 years the rest of the village began to accept and adopt dairy practices more widely. The milk remains a subsistence product as currently there is no wider market for it, however there is some increasing interest from families with lactose intolerant babies. Experience of the participant was that in many areas it was necessary to maintain around 50% native breed genetics in the crosses as beyond this disease resistance is a problem. However, this depended on the region with disease pressures being experienced to a greater or less degree dependent on location. Some issues with provenance of bought in genetics were experienced and they still find high-quality breeding animsl difficult to source.

In some of the stakeholder meetings there was a suggestion that artificial insemination (AI) is an underutilised tool in African goat production. A representative of a large commercial goat operation in the UK suggested that AI is difficult and unreliable even in large scale commercial operations (<34% success rate achieved in their herd). Therefore, AI is not a likely widespread feasible solution for African systems, however there is some limited use when expertise and access to equipment exists so there may be some limited usage. However, unlike cattle, bucks are more easily transported to be used for breeding (many locals transport them on a motorbike). For small scale operations farmers typically have around 5 female goats and may have one buck themselves or at least one available in the local community. The best way to achieve breed improvements would be to develop nucleus herds to breed regionally appropriate stock for farms coupled with community-based breeding programmes. These might have agreements to purchase, maintain, and share males of superior quality and pooled resources could allow purchase of higher quality animals than would be otherwise achievable.

Once more the role of extension services was highlighted to share the existing knowledge from breeding programmes that have been developed by various local universities. The difference of interests between men and women was highlighted and should be taken into consideration with successful programmes providing something for everyone e.g. cash income through selling breeding stock, and nutrition source to feed children. There are also opportunities for extension services to have a role in supporting communities in record keeping. Record keeping in the dry season is a particular challenge as goats typically roam freely and breed uncontrollably. The charity operating in Uganda said that reliable record keeping on dairy goat breeding was possible to do

retrospectively by an extension service but was particularly time consuming and likely lacked some degree of accuracy.

Genomic selection was brought up in the stakeholder meetings but currently the commercial farmer from the UK is reliant on using services from New Zealand as there are none available in Europe, therefore it was agreed that the infrastructure for this is not available in Africa.

Table 4. Summary of focus group meeting to discuss 'Breeding and genetic solutions for sustainable goat production' for goats in West Africa.

Solutions/ knowledge ready for deployment in African situations	Solutions/ knowledge to be modified for African situations	Innovations and future research
Extension services to share knowledge on current research in breeding	Nucleus herds for locally appropriate breed improvements e.g. for growth rate or disease resistance	
Provide communities or extension service with hearth girth weight tape to facilitate performance based selection. i.e. select on growth rate	Apps for smart phones to support record keeping might have a role but this might be more reliable when combined with an extension service supported breeding programme	
Community based breeding programmes		

Note: potential innovations and knowledge considered mostly likely and most feasible to take forwards in the short to medium term are highlighted in blue.

Summary of key opportunities for development

1. **Improved Extension Services:** Training programs should align with the four key challenge topics identified (Health, Nutrition, Housing and Breeding), these should be tailored to systems with consideration given to the prevalence of smallholder subsidence production, whilst also allowing opportunities for more commercial development where desired.
2. **Technology Adoption:** Use of precision livestock technology, mobile veterinary services, and online knowledge-sharing platforms could improve access to advice/ support and farmer decision-making. Accessibility must be considered, particularly with regards to internet connection, intermittent power supply, and language barriers.
3. **Market Development:** Strengthening value chains, cooperative models, and certification schemes to ensure fair pricing and improve economic viability. Whilst participants did not see this as a key challenge due to the smallholder nature of largely using meat for their own consumption or within a small community, farmers that wish to expand are likely to face this as a future barrier.

4. **Research Collaborations:** Linking African researchers with international experts to develop region-specific innovations that are appropriately tailored, particularly in the four key challenge topics identified (Health, Nutrition, Housing and Breeding).
5. **Policy Advocacy:** Promoting government and NGO interventions targeted at goat farming rather than broad livestock initiatives to improve sector-specific support.

With continued collaboration and investment, the sustainable development of goat production can significantly contribute to food security, rural livelihoods, and economic growth in Africa.

Key stakeholders and their roles in the sustainable development of goat production

- **Farmers**: Implement improved practices and participate in training to enhance productivity and animal welfare.
- **Veterinarians & Researchers**: Provide disease management solutions, breed improvement programs, and nutritional guidance.
- **Universities & Research Institutions**: Conduct studies on sustainable goat production, support data collection, and train extension officers.
- **Government & NGOs**: Support farmers through policies, subsidies, and access to credit and veterinary services.
- **Private Sector:** Develop and supply innovative feed, housing, and breeding technologies to improve goat production efficiency.

Gender and social inequality

Overall, we reached fewer women than men, despite regional information suggested that goat keeping is particularly important for women and that more women are involved with goats compared to other livestock. We had hoped that circulating an anonymous survey may help with this, however even this activity only achieved 18% of responses being from women. This may highlight the fact that fewer women are involved in decision making at household and farm level even though they are the majority goat rearers in smallholder farming systems. Women and youth are often underrepresented in goat farming initiatives *"You need to empower females because the majority of goats reared in subsistence farming are reared by females".* Women's participation in goat farming provides economic empowerment, but challenges such as land ownership, cultural restrictions, and access to financial resources persist. Addressing these disparities requires tailored interventions, including microfinance programs, gender-sensitive extension services, and cooperative models that ensure equitable access to resources.

Barriers to transformational change

Despite the identified opportunities, several systemic barriers may hinder widespread adoption of sustainable practices:

1. **Low Adoption of Innovations:** there are likely issues around adoption primarily due to financial constraints, but regional cultural and political situations must also be considered. Co-design processes should be utilised to mitigate this potential barrier.
2. **Limited Infrastructure:** Poor transport networks (and high cost of these) and lack of cold storage facilities affect market access and vaccine distribution. This barrier is particularly strong in remote regions, but less so in the urban fringes. A lack of access to veterinary diagnostic services and the subsequent high cost of these is also problematic. Access to other equipment and infrastructure to improve feeding and housing is also likely to be experienced. Focusing on local and accessible solutions will be important.
3. **Fragmented Research and Policy Implementation:** Farmers often feel that there is a disconnect between research findings and practical application due to a lack of consideration of practical constraints. It is essential to link up farmers and researchers to enable co-design processes that will allow greater uptake of findings in communities. Establishing demonstration farms and local knowledge hubs would likely help this considerably. The ability of policy changes to improve uptakes must not be underestimated and could include assistance with financing, and disease monitoring.
4. **Climate Change:** Erratic weather patterns already impact feed availability and disease prevalence, these are likely to continue to change. Understanding and predicting these pressures is paramount to the ability to mitigate them.

It is clear that addressing the four key challenge areas identified within this report can all help to improve the climate resilience of goat farming in West Africa. Healthier, more robust goats that are housed and fed in ways that increase productivity, and reduce morbidity and mortality will greatly improve the sustainability of goat production. Support is needed to fulfil these goals, and this scoping project identified a wide range of expertise across the countries involved that could assist.