SILVOPASTURE FOR BUILDING CLIMATE RESILIENCE IN LIVESTOCK SYSTEMS

UK-BRAZIL-AFRICA SILVOPASTURE NETWORK ONLINE WORKSHOP

6th February 2025, 14.00-17.00 GMT

Workshop Report

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Pastoralism (UNOWAS)

This workshop was supported through the Climate-Smart Agriculture Partnership: UK-Brazil-Africa, funded by the Foreign, Commonwealth and Development Office (FCDO) and delivered by Innovate UK.

Introduction

Members of the UK-Brazil-Africa Silvopasture Network were invited to attend an online workshop to share their experiences and ideas on silvopasture as a potential intervention for building climate change resilience in the livestock sector. Silvopasture is a livestock farming approach where trees, shrubs and forages are introduced into the grazing areas. This can be done in different arrangements and densities according to a variety of desired outcomes that include but are not limited to climate change mitigation and resilience. The workshop comprised short presentations on the experience of silvopasture practice in the UK, Brazil and Africa as well as the climate change context in the African countries. In an interactive session that followed, we sought to identify innovations that could help unlock the potential for silvopasture to help address climate change impacts on livestock production in Africa. Innovations in this sense were considered to include extension and knowledge exchange, in-field technologies, tools (e.g. for financial planning, tree species selection and planting design, monitoring), development of nurseries or markets for tree co-products, supportive policies, as well as investment and incentives schemes.

The workshop also sought to provide answers to the question: what methodologies, technologies, and tools developed in Brazil and UK could be usefully transferred to support these innovations?

The workshop was attended by 32 participants with an approximately even spread (c 10 people) from each of Africa (Nigeria and Ghana), Brazil and the UK. The workshop was well received and feedback on it has been captured (Annex 1).

This workshop report provides a summary of the presentations and the interactive sessions. The workshop findings, reported herein, have been combined with background research and 1-2-1 interviews to inform the identification of key challenges and barriers, as well as collaborative opportunities, for scaling up silvopasture (sometimes referred to as SPS, or silvopastoral systems) as a climate smart agriculture practice in Ghana and Nigeria.

Presentations

Sustainable Intensification of SPS in Northern Ghana: Key outputs and lessons

Dr James Amponsah, Forestry Research Institute of Ghana (CSIR-FORIG)

The Sustainable Intensification of Mixed Farming Systems (SI-MFS) project aims to optimise production of more food on the same piece of land while reducing the environmental footprints usually left behind by conventional farming systems. Six countries are involved in this work, including Ghana. CSIR-FORIG was tasked to explore a silvopasture intervention approach in northern Ghana. There were three components to this work:

- A large-scale survey to characterize tree diversity on-farm. This was to inform the selection of tree species that are well suited to site conditions and ensure they align well to the needs of the communities. Of most interest were trees with highest potential for planting on farm and for inclusion in agroforestry systems and land restoration initiatives.
- Co-designing silvopasture with local communities. This involved assessing farmers' perceptions on SPS, engaging local communities in the management of SPS, and documenting the lessons and best practices.
- Development of a Diversity for Restoration (D4R) Tool, based on the results of the above.


CSIR-FORIG

CSIR-FORIG were the main implementer, leading on the work to document tree species diversity in farming systems of the Savanna ecological zone and to understand farmers' preferred tree species and species characteristics for diverse land use objectives.

24 species of high cultural importance were identified and their uses documented. The three species of highest cultural importance were *Vitellaria paradoxa* (shea tree), *Parkia biglobosa* (African locust bean) and

Mangifera indica (mango). The same species were ranked in terms of farmers' preference, with *Mangifera indica* coming top, followed by *Anacardium occidentale* (cashew) and *Vitellaria paradoxa*. A wide range of uses were characterized, including medicine, food, creation of hedgerows, shade, fodder, erosion control and improving crop growth.

In terms of constraints on implementing SPS, these ranged from lack of planting materials (top), to animal grazing, financial constraints, lack of land, and risk of wildfire.

The results of this work are summarized in a report[1] and were also used by Alliance to develop the Diversity for Restoration decision support tool (D4R). The tool is simple to work with: a site is selected and then the user is taken through a series of questions to arrive at a list of recommended species.

The benefits of SPS include:

- livestock providing manure, draft power and income from sale
- crop residues and forages providing livestock feed
- trees providing shade, food, fodder, timber, nitrogen fixation and carbon sequestration
- crops providing food and income
- grasses and forages providing soil stabilisation.

In northern Ghana there is a real need for SPS because of water scarcity, competition for water between livestock and humans, overgrazing, damage to crops, long drought periods leading to herd(er) migration, and wildfires.

In this context the project undertook extensive engagement with two local communities to establish demonstration SPS systems. A community workshop was held to introduce SPS, because the idea of combining trees and farming on the same piece of land was novel. Co-design approaches were used to identify challenges and how to address them. The local farmers came up with their preferred species and preferred design, and experimental SPS plots close to the communities were established.

[1] Barbara Vinceti1, James Amponsah2, Stella Britwum Acquah2, Reginald Tang Guuroh2, Beatrice Darko Obiri2, Tobias Fremout1, Dunja Mijatovic1 and Daniel A. Ofori2 (2024) Tree Diversity Across Northern Ghana's Cultivated Landscapes: Supporting Agroforestry with a Focus on Native Tree Species. Rome (Italy): Bioversity International. 33 p.
1 Alliance of Bioversity and CIAT
2 CSIR - Forestry Research Institute of Ghana (FORIG)

For this purpose, communal lands were granted for planting trees and forages. Help was given in planting and management, using climate-smart techniques such as half-moon shaped micro-catchments. Small animal pens were made to introduce livestock. All of this was performed with the support of socio-economic research into the livelihoods of these local communities. The work was publicized through various media. There was also a wider capacity-building component, for example the organization of a training workshop.


CSIR-FORIG

What are the key lessons from this work?

- Strong community and other stakeholder engagement are vital for any successful SPS intervention in northern Ghana. It is important to collaborate with local people, co-design the system, and support them in ongoing maintenance of the system.
- It is important to anticipate challenges common in dry forest landscape restoration and to resolve them by blending local knowledge with a scientific approach.
- Gaining a good understanding of the socio-economic and livelihood issues of the community is critical for a successful SPS intervention.
- SPS interventions should aim to address multiple needs of local communities: irrigation systems to support domestic water supply and off-season farming, fencing for crop production, trees for shading.

In discussion the question was raised about native tree seeds in the soil seedbank and whether these are an important resource, i.e. using natural regeneration, which requires management and protection from browsing. The project didn't address this question, but it was commented that in the case of *Vitellaria paradoxa,* because it is a naturally occurring tree embedded in the culture of the northern part of Ghana, people don't pay much attention to its conservation. But in fact, it is under pressure and there is ongoing research on this.

Another question was about seasonal grazing activities and how these can be taken into account. There are measures to establish larger and wider grazing corridors across the region and these will help protect established farms and SPS. There is a proposal to

increase the number of trees along these corridors and the Animal Sciences Department of the University of Development Studies is working on how to establish climate resilient forages and trees.

Silvopasture in Nigeria

Boma Iriso, Department of Animal Science, University of Port Harcourt

Nigeria has a land area of 923,769 km^2, the vast majority in the so-called northern region of the country. There are six geopolitical zones in Nigeria, with 86 states spread across them.

There are several challenges associated with SPS in Nigeria:

- Herder-farmer conflicts: the nomadic pastoralists travel large distances to reach fresh pastures; the animals sometimes eat the farmers' crops along the grazing routes and this leads to clashes. Loss of life is sometimes recorded.
- Flooding: seasonal flooding has occurred over the last five years.
- Water scarcity: this drives the southward movement of the pastoralists towards the rainforest zones of the country. Drought conditions lead to desertification.
- Rapid urbanization: in recent times real estate companies have been buying lands from local communities for development.
- Deforestation: Some of the drivers of deforestation in Nigeria include logging, urbanization, and wood harvesting. The Nigerian government has implemented policies and programs aimed at reducing deforestation, such as the National Forest Policy and the Nigerian Erosion and Watershed Management Project. Furthermore, NGOs and international partners have also provided support to combat deforestation through reforestation and afforestation initiatives, sustainable land management practices, and public awareness campaigns.
- Land Tenure: In 2012 the Senate passed a bill to establish the National Grazing Reserve Commission. But it was opposed by lawmakers and referred to the assemblies in the States, so there is yet to be seen a nationwide implementation of this strategy.

Different strategies are important for the sustainable development of silvopasture in Nigeria. Citizen science education is one of them: there is the need to bring farmers and herders, many of them not well educated, on board with the approach. This requires extension work to inform them on the need to adopt SPS and enable their sharing of local experience.

The construction of dams is also needed to supply water for the sustainability of the SPS systems where there is water scarcity. Adoption of rotational grazing methods are important to allow the regeneration of trees and forages. Carbon credits and other subsidies are needed to incentivize people to continue practising SPS, yet examples of this are yet to be seen. Finally, there is the need for electric fencing to protect new tree planting.

Relevant stakeholder organisations in Nigeria include:

- Academia
- Forestry Research Institute of Nigeria, who have been more active in the north of the country
- National Agency for Great Green Wall, a UN and Africa Union initiative implemented in trans-Sahara Africa countries, aiming to plant trees and address the issue of desertification
- International Livestock Research Institute, which has done some limited work on SPS
- National Animal Production Research Institute, which has a mandate to carry out work in this area
- Federal Ministry of Livestock Development. This was inaugurated by the Federal Government last year and a roadmap for its work is still awaited.

For the presenter, there is a strong case to make about the potential benefits of SPS in Nigeria, particularly if they integrate non-ruminants as well as ruminants. The adoption of SPS could contribute to the reduction of farmer-herder conflict. Increased awareness and adoptions of the SPS model could also improve resilience of participating farmers and contribute to the attainment of SDGs 2 and 13.

In discussion the update was made that the Federal Ministry of Livestock Development has succeeded in validating 413 grazing reserves for the country and the hope is to see them start functioning soon. SPS is an area of current research: how to adopt this climate smart approach to improve the growth and productivity of trees, forages and livestock, as well as capture carbon.

The challenge of farmer-herder conflict was emphasized, coupled with water scarcity. Resolution of this will require strong policies and political will. It is hoped that the new Federal Ministry can make a difference. One question raised was about where the pilot projects should be sited in order to encourage wider adoption. In response it was explained that each zone in the country has its own specific challenges and policies, therefore the approach needs to take these into account. The suggestion was made that it would make sense to start with states that have adopted the Grazing Reserve policies. This would better

showcase the success of the approach and this could enhance the prospect of seeing other states follow suit.

The experience of SPS in Brazil: Lessons from the experience of the Instituto Ouro Verde

Dr Alexandre de Azevedo Olival, UNEMAT (University of Mato Grosso)

Brazil is a large country and has been working with SPS for a relatively long time and its researchers have been active in global initiatives on sustainable livestock farming, such as the Global Agenda for Sustainable Livestock from its early stages. This makes it difficult to summarise the experience of SPS in Brazil. However, there are essentially two main approaches:

1. In the first, trees are grown principally to provide additional income from the system and as an effort to gain access to international markets where sustainability credentials have market value. All the ecological benefits are secondary. Crop-livestock-forest integration systems (ILPF) are low diversity and focused on the production of timber or other products. This system has been researched extensively by EMBRAPA and the ILPF network. Farms adopting ILPF tend to be very large.
2. In the second approach, trees are principally seen as ecosystem function providers. Their main purpose is to recover degraded pastures and reduce the use of chemical inputs and build long-term resilience. This approach uses different arrangements of native species depending on the local context and is being explored in the Caatinga biome. They are biodiverse systems, developed by local knowledge and experience, and adopted mostly by smallholders.

ILPF systems

Some 8.3% of Brazilian agricultural land in 2020 was managed as ILPF. The tree species are selected on the basis of their high timber production and are usually eucalyptus, a species around which there is substantial research from Brazil. The system has low diversity with 2-3 intercropped species, the different types being:

- Forest-crop (soya, rice, maize)
- Forest-livestock (beef or dairy cattle)
- Forest-crop-livestock (crops as temporary component)


IOV/UNEMAT

How was it possible to achieve such a large uptake of this system? A lot of institutions in the whole value chain have been involved: research, finance, machinery, meat trading, seed, timber, chemicals. Therefore one can conclude that, if you want to promote a high level of uptake, you need the involvement of, and promotion by, a range of stakeholders. It is easier to work with larger farms in the ILPF approach, compared to with smallholders on less well-researched SPS driven by multiple objectives.

The IOV approach

The Instituto Ouro Verde (IOV) is active in southern Amazonia, in an arc of deforestation where there is an advance of large-scale plantations. Livestock farming is the central activity here, and there is a strong presence of small farmers and a common occurrence of degraded pastures. Reduction of the rainy season is a climate change related challenge being experienced in the region.

IOV promotes biodiverse SPS systems to help meet these challenges. Two types are recognized:

- Based on scattered trees: the objective is to cover 10-30% of the pasture area with native trees (15-40 trees/ha) in multiple strata. One example is a farm with 2,413 trees of 97 different species planted over an area of 120 ha, creating 15% of average cover in paddocks, with the main objectives being improving soil fertility, forage quality and shade for cattle.
- Based on tree rows: one example has 200 trees/ha with 20 m spacing between tree lines. The main purposes are as above with the addition of fruit collection. The alleys are used for cultivation for the first 3-4 years.

In this challenging environment, how is it possible to promote a transition from conventional systems to ones based on the use of local biodiversity? Access to international networks of collaborators and international funding seems key: Brazil has

been working closely with the B&M Gates Foundation Working Trees project, which resolves farmers' concerns that the return of investment takes a long time to materialise by paying for the cost of implementation and benefits upfront to encourage adoption and duration of commitment to 20 or 30 years. Taking the lessons from ILPF, it is important to create a network of services managed by the farmers and IOV's team, to increase access to native forest seeds, provide training activities and tools for exchanging knowledge, support the commercialisation of products, provide community banking and involve new research institutions to help with technical issues. However, it also relies very much on the local communities: their local knowledge on native species including their economic uses and ecosystem service benefits. There are also innovations, like the high biodiversity nucleus SPS currently being researched to support small holders. The practical questions that need addressing include:

1. From where to obtain the seeds/seedlings (e.g. creation of seed networks)
2. How to provide for continuous learning and exchange of experiences between technicians and farmers
3. From where will come the resources needed for implementation, especially for more intensive pasture management (policy support, but also to have an autonomous strategy)
4. How to strengthen the commercialisation of the products.

Silvopasture in the UK: A short history of trees and grassland

Dr Lindsay Whistance, Organic Research Centre

The natural, pre-farmed landscape in Britain was likely similar to what we now know as wood pasture, including clusters of dense canopy and free-standing trees, with areas of open pasture and scrubland in between. As the human population turned to farming, wood pasture was a part of the farming system, with more clearly defined woodland and open pasture alongside. In the medieval period, the Domesday Book (1086) recorded 15 percent of England being covered by wood pasture and woodland combined. These early farming systems were dominated by landowners from the nobility and the church with open-field systems for tenant farmers alongside common land. Commoners were able to graze their animals and harvest natural products such as wood fuel and remnants of this system still

exist today, e.g., in the New Forest with commoners grazing cattle, sheep and ponies as well as practising 'panage' where pigs are fattened on acorns and beech mast.


Lindsay Whistance (ORC)

In 1600, the Land Enclosure Act began a process lasting 3-400 years resulting in 5000 land enclosures. This transformed the countryside, with trees becoming part of the field edges, particularly as hedgerows, which functioned as property boundaries as well as preventing animals from straying. Trees in wood pasture were often pollarded (where the tops are cut out, typically above browse height), yielding repeated crops of wood for fuel, tools, fencing and animal fodder, or kept intact for their use as a building material for domestic use and furniture as well as shipbuilding. Later on, in 17-19th centuries, parklands evolved from wood pasture, (typically old deer parks), and here the use and function of the trees took on more of an aesthetic role alongside their in-field value as shade and shelter for grazing livestock. Other types of tree planting attached to the pastoral landscape are coppices, shelterbelts, shelter woods, small-scale commercial plantings, and orchards – typically soft fruits such as apples and pears (for eating or fermenting), cherries and plums.

The use of tree fodder is an old practice and traditional fodder trees were ash, elm and holly though most trees in UK are edible and browsed. Pollarded trees yield more fodder than standard trees and, where branches are low enough, they can also be directly browsed. Tree fodder was once an important part of livestock farming to the point where some estates employed a sheriff to prevent it being stolen. Tree fodder was less valued with the introduction of fodder beet crops. The mechanisation of farms lead to the ripping out of hedgerows as well as the degradation of some existing hedgerows from loss of rural personpower and the adoption of modern fencing materials. For orchards, where the traditional practice was to graze livestock under the trees (particularly sheep and geese), there is now much more interest in dwarf trees (for ease of management and harvest),

which makes it more challenging to graze systems without resulting damage to the trees. Overall, with fewer trees in the pastoral landscape alongside in bigger herds and flocks being grazed, there is more reliance on those that exist to provide shade, shelter and browse and the resulting overcrowding can lead to the spread of animal diseases (e.g., from insect vectors also attracted to the trees), loss of vegetation and soil compaction – for which the trees are blamed. It is noteworthy, that whilst the populations of 'nuisance' flies are higher in silvopasture, they are also present on open pasture and, if silvopasture is well designed, there are also more predators present so that numbers of flies in a head count can be significantly lower.

In UK, the year 2018 was key, bringing a perfect storm of a very wet spring, followed by a hot, and dry summer and ending with two major storms (Storm Emma and 'The Beast from the East'). Farmers were feeding winter feed supplies during the summer and some had to sell their animals as the grass disappeared. During this time, the persistence of green pasture under the shade of trees was evident, from a reduction in solar radiation and from capturing moisture from evapotranspiration. In winter, ground temperatures are up to six degrees warmer under trees, allowing earlier spring grass growth and more comfort for resting animals. In the presence of trees, water infiltration is improved and an ash silvopastoral system in Northern Ireland demonstrated that the grazing season could be extended by 15 weeks. Water then remains available for longer period, buffering impacts of droughts. There is evidence for carbon sequestration in these systems too.

There is an increasing awareness of the multiple benefits that trees bring to the landscape, delivering so-called 'Public Goods' such as carbon sequestration, water management, containment of air and soil pollution, biodiversity benefits, and the direct benefits to livestock. In line with this, there is currently, much interest in tending existing, repairing neglected, and introducing new silvopastoral systems of different designs in the British landscape. Those engaged in this can be loosely grouped as 'bottom-up', 'top-down' and 'independent' organisations. An example of bottom-up action is the Pont Bren initiative in North Wales, where the farmers collectively took action to increase tree cover from 1.5 to 5 percent. A top-down example is the Woodland Eggs scheme driven by the supermarket Sainsburys. The Woodland Trust represents an independent who support and engage with farmers, driving their core interest of increasing native tree cover in the UK landscape.

In the future, we can expect increasing numbers of farmers to become interested in silvopasture, and there is interest in different designs, for example alley planting, which allows hay and silage cutting in between the tree rows, or grid-type planting, which spreads the canopy better. There is interest in combining animals with biofuel crops, as well as thicker in-field planting of rows for increased shelter, particularly with modern, rotational

grazing systems. We are also seeing a resurgence of interest in tree fodder as a source of supplementary feed and minerals, as a natural parasite control and for its value in reducing gaseous emissions.

Stakeholders for scaling up silvopasture in the UK

Christian Gossell, Organic Research Centre

A range of stakeholders and sectors of activity are important in the application of silvopasture in the UK, many of which will be relevant to other countries. They can be split into three groups

Core:

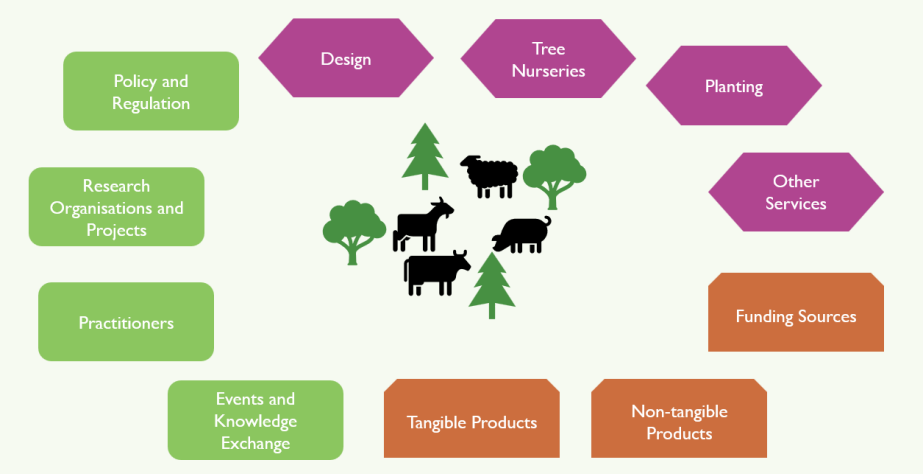
- Policy and regulation: legal requirements and regulation of activities
- Research organisations and projects: providing the research evidence to underpin successful silvopasture projects
- Practitioners: practising and demonstrating silvopasture through peer networks
- Events and knowledge exchange: raising awareness and bringing relevant stakeholders together.

Practical:

- Design: support and services for designing a successful silvopasture system
- Tree nurseries: providing a reliable and sustainable source of trees
- Planting and other services: providing the knowledge and contractual services (e.g. for fencing, tree management)

Economic:

- Funding sources: helping to support start-up capital costs
- Tangible products: livestock products, fruits, nuts, timber, woodchip, etc.
- Non-tangible products: including carbon, biodiversity, shelter and shade.



Interactive session: scaling up silvopasture in Africa

A Miro board was used to identify silvopasture knowledge, technology and implementation gaps in Africa. This was with a view to identifying collaborative opportunities to address these gaps and support the scaling up of this practice to address climate change challenges to the livestock sector. Participants were all invited to make contributions, resulting in a total of 44. These were grouped into the following 16 topics, and related comments (made in the Chat facility of the Teams meeting) were mapped to them (Annex 2).

1. Animal health
2. Animal welfare
3. Animals and Green House Gases (GHGs)
4. Awareness
5. Land tenure and conflict
6. Land value
7. Finance and economics
8. Pasture quality
9. Tree selection and traits
10. System management
11. Ecosystem services
12. Climate change impacts
13. Tree survival and protection
14. Fodder
15. Tree disease
16. Biocircularity and soils

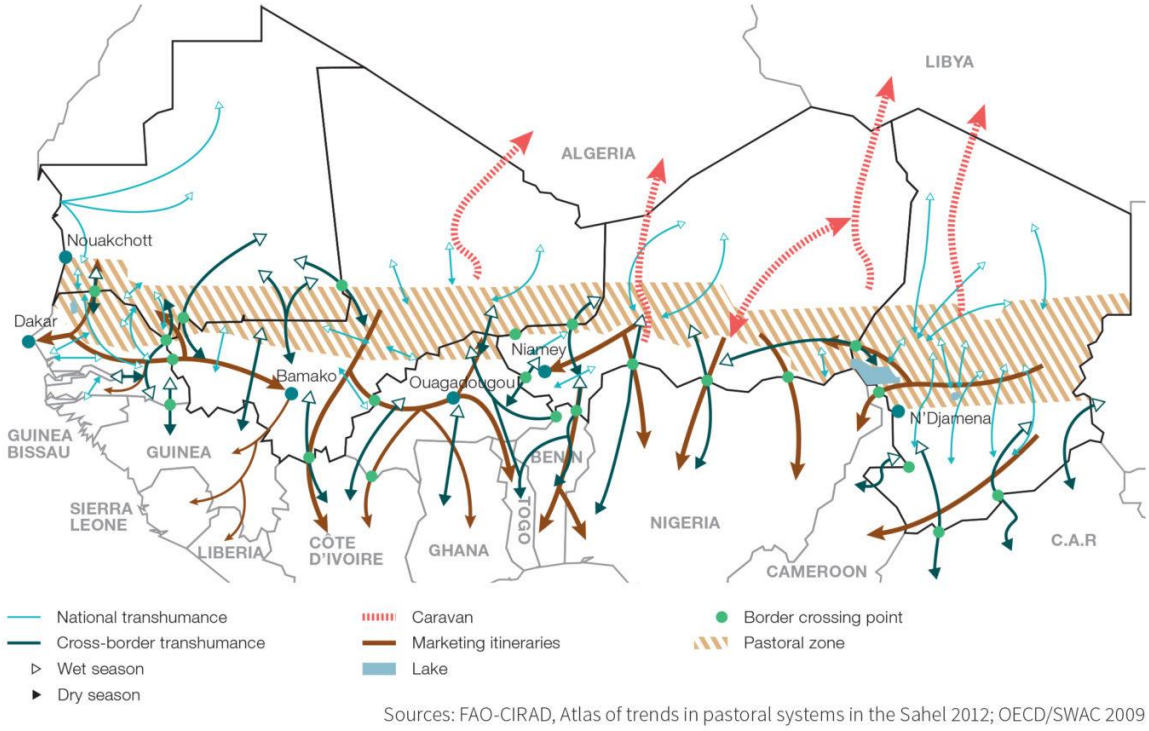
The following points came up in discussion.

- There is a difference between establishing silvopasture, on the novelty of which there can be some excitement, and the longer-term maintenance of the system, which can be harder. From the experience of northern Ghana, it is important to involve the chiefs/traditional authorities of the communities concerned. For example, committees can be established to oversee management and benefit sharing, and it is helpful if extension officers of the Ministry of Agriculture are engaged too. A lot comes down to raising more awareness.
- On planting design (as a knowledge gap), from the literature review undertaken for Brazil there is a lot of research already done, and also a lot of traditional knowledge that can help fill these knowledge gaps in some areas.

- On the question of dealing with tree mortality when establishing SPS, it is important to accept a realistic level of tree loss and this can be factored in by over-planting and later thinning, if required.
- An important knowledge gap is on land tenure security and inter-generational use of land, with regard to the maintenance of trees. It is important to work within local customs and rules, chiefs, authorities and committees to ensure that the tree stock is preserved.
- The economic perspective is also important, i.e. how to incentivize farmers to continue to nurture, protect and value the trees. It is important to build an economic model that potentially includes rewards for farmers, as years progress, with for example promise of fertilizer supply.
- Questions were asked about UK silvopasture. The objectives and characteristics of SPS in this country show a lot of regional variation, with livestock farming being strongest in the west and north. Orchards predominate in certain counties, namely Worcestershire, Herefordshire, Gloucestershire, Somerset and Kent, due to favourable soil conditions there. Trees in silvopasture are used for food production (fruit and nut), timber and non-timber tree products as well as their benefits to livestock.

There was considerable discussion on the overriding context of farmer-herder conflict. With migratory movements of herds, in any one place the owners of the animals and the trees they graze under will often be different. The governance issue is critical. Herders often have considerable firepower and wealth (compared to smallholder farmers) and arbitration processes don't work in that situation. Traditions around itinerant grazing have broken down over time. It is trying to be addressed by international organisations but without much success so far. A move to fixed grazing is one possible answer, but this remains a big challenge, requiring policy, legal and paradigm shifts. This is also an international issue as pastoralists move through several countries.

In Ghana, managed pastures have not been part of the animal husbandry culture, in the same way that it has been in East Africa. Land tenure in Ghana varies from region to region. The cattle don't belong to the people of the lands where they graze. In the south of the country there are two rainy seasons; in the north just one. There is therefore the seasonal movement of cattle southwards. There is an ECOWAS protocol that permits travel of herders with their cattle and property between countries. When the cattle are moved, they are often not well managed and stray into the cultivated areas, destroying crops and causing conflict. In this context, silvopasture can offer a solution.



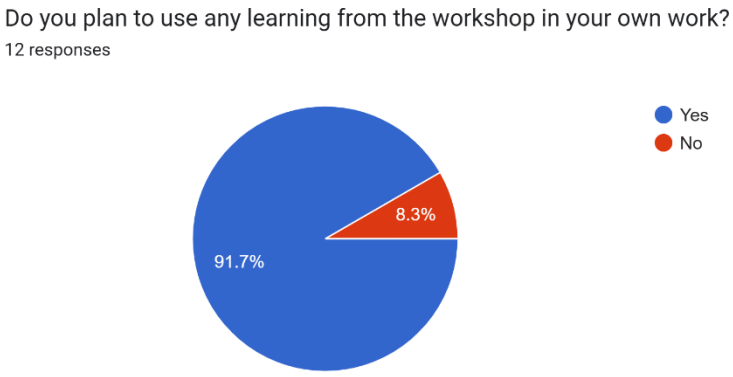
In Ghana, a committee has been set up to address the challenge of herders coming from Burkina Faso and other countries. Ranches are being created to provide feed and water for the animals, though this is not always successful, for example when the herders avoid the designated areas. More collaboration is needed between countries.

The example was given of PhD research in Nigeria looking at the socio-cultural context of farmer-herder conflicts but also other conflicts around natural resource use, for example fishing. Community-led governance solutions are needed.

Annex 1: Workshop feedback

An impact questionnaire was circulated following the workshop and 12 responses were received.

- 6 people considered it very informative, 5 sufficiently so, and 1 a little bit informative
- For 11 of the 12, the information contributed to changes in their knowledge of, or opinion about, silvopastoral systems in general
- For 11 of the 12, the information contributed to changes in their knowledge of, or opinion about, the potential for implementation of silvopastoral systems in Ghana and Nigeria
- 11 of the 12 also planned to use learning from the workshop in their own work
- All 12 identified potential topics that they would like to collaborate on
- 11 of the 12 identified potential business or innovation opportunities.



Annex 2: Knowledge, technology and implementation gaps

Miro board and chat summary

Knowledge gaps	Technical gaps	Implementation gaps

	Knowledge, technical and implementation gaps				**Chat comments**
Animal health	SPS impact on animal health including burdens of endemic disease and risk of epidemic outbreak	SPS ecto/endo parasites	Use of smart internet of things to monitor animal health and plant growth	Insect protection	I agree there seems little information on animal health impact of SPS … it may be assumed that animals will experience same burden of endemic disease & risk of epidemic/ outbreak as animals on adjacent open pasture etc systems …. but we don't know this … be valuable to monitor both behaviour & indicators of health/ disease & also when evaluating SPS wrt livestock need to consider whether health is accounted … plus any impact on micro/ immediate environment with respect to ecto- & endoparasites Just as a comment on that, I have been reviewing the literature in Brazil and they have done some really interesting research on animal thermal comfort and also on risk of parasites. Thermal comfort improves with SPS and risk of parasites does not seem to increase. Finally, as emphasised by others, it's about people & thus overall One Health outcomes - food security/ household & wellbeing PS I found information that poultry in SPS vs open/ free-range were less fearful & had lower incidence of leg/ pad disease …
Animal welfare	Animal welfare benefits from the animals' lived experience				

Animals and GHGs	Trees/shrubs w capacity to reduce GHG production from ruminants				Have you any experience/ knowledge of willow or other trees/ shrubs w capacity to reduce GHG production from ruminants? Do other participants have knowledge of trees/ shrubs that may bring these benefits in their countries/ SPS systems? We have carried out research in this direction and obtained excellent results, both by offering the fruits of native species as a nutritional supplement and by improving the quality of the forage due to partial shading. In both cases, our research has shown a reduction in methane emissions. This is a growing field of research and there is much more to know. Earlier work indicated a 50% reduction in methane from willow compared to alfalfa but more recent research considers more variables and it appears to be closer to a 30% reduction - but it also depends on metrics used. There is also some evidence that there is a reduction in nitrous oxide in sheep urine ..when using trees/shrubs with secondary metabolites which have antimethanogenic properties you can reduce CH4 production.
Awareness	Understanding and appreciation of the potential benefits of SPS	Provide to farmers ease management practices			We still have so much to learn… But that can't be a limiting factor in the advancement of systems. Much of this knowledge is being built by farmers on a daily basis. We must use our 'scientific' research framework to go deeper!
	Integration of ontologies				

Land tenure and conflict	How to resolve conflict between farmers growing crops and pastoralists using the area when agroforestry has been utilised as a source of shade and feed for their livestock	How is governance of trees planted in communal areas to ensure sustainable use? Relatedly, who is the user group? Should herders such as Fulanis be part of this rather than being excluded (in corridors etc)?	Land tenure is an issue (in all countries)		I would be interested to understand what the mechanisms were for long term governance/protection of the trees planted on communal lands. Relates to question of land tenure and who accesses the communal area - also open to free-ranging pastoralists? There is standing agreement with the communities, through their leaders (chiefs) to maintain and and use proceeds for the common good of the community. Of course a clear land tenure systems and benefit sharing arrangement are key for successful any SPS. To resolve the perennial herder-crop farmer conflict, two pilot ranches have been set up in Amankwa and Wawase in the Afram plains to resolve this challenge. We can easily get information on the grazing reserves from the Livestock Development Ministry and the Presidential Livestock Reform Committee. Just a comment for later on: land tenure seems to be an issue across Brazil, Ghana, Nigeria and also my native Colombia. Maybe one point of collaboration is to learn from each other on approaches to deal with that challenge, while recognising that some issues are very local-specific. Lots of literature about the topic of farmer herder conflict. I quickly googled and this image says it all. Herders with AK47 https://africacenter.org/publication/growing-complexity-farmer-herder-conflict-west-central-africa/
Land value	Effect of planting trees on land value (in UK can go down)	Farmers fear loss of land value in the UK when they convert a field to agroforestry			
Finance & economics	The economics of agroforestry (has not been worked out in UK)	Complex economics of agroforestry as it develops year on year, unlike a simple annual crop	Marketing channels for the system's most important products		To sell the products besides including them onto the biocircularity of nutrients in the production system The provision of specialist knowledge and financial support have been flagged as challenges in Brazil, Ghana and Nigeria. So another research gap would be to look for ways in which these challenges have been addressed in similar countries. In the case of financial resources, since 2012 we have started to organise a community bank, managed by the farmers themselves, to offer microcredit.

Pasture quality	Shade impacts on nutrition and shade tolerance of pasture species	How much shade is tolerated by pasture plants and what is the impact on nutritional content	What tree species, density and management regime to allow understorey pasture to produce enough to meet livestock needs	Tech for analysing nutritional content and PSMs both beneficial and anti-nutritional factors	
Tree selection and traits	Functional traits of trees to be integrated into SPS	Ecological functions of different species (animals, trees, pasture species?)	Knowledge of soil carbon accumulation and ecosystem services using native/exotic trees/shrubs and leguminous forages	How to manage trees and shrubs to maximise their ecological functions Introduction of fast growing leguminose trees	ILPF uses just eucalyptus which is not FOREST it is monoculture of eucalyptus. where is the biodiversity? Native trees can help better the SPS and the environmental services provided.
System management	How to manage a sustainable grazing in which the whole system would take advantage	Different ways of combining species to optimise productivity and system resilience	Grazing management must be well adapted before introducing the trees/shrubs	Provision of great pasture production	
Ecosystem services	Ecosystem services as an integral part of scalable initiatives	Use of carbon credit organisations to drive uptake of tree planting in SPS. How do they verify long-term capture?	Need for more accurate metrics on carbon stored in agroforestry systems if they are to be included in carbon credit mechanisms		The eucalyptus trees will be cut after 7 years and transformed in charcoal or cellulose which will be again in atmosphere (CO2) after 2 years…is it sustainable?
CC impact	Sustainability in areas prone to drought, bush fires etc.				

Tree survival & protection	Tree survival with limited resources for watering	Systems for water management or irrigation to improve SPS management	Infrastructure for tree growing, irrigation and protection	Watering of trees in first year/ Tree protection	Have you tried to use the natural regeneration of native trees to implement SPS in Gana? Not yet. We concentrated in introducing trees from seeds and seedlings. We work with two strategies to try to overcome the problem of species mortality (whether due to lack of water or other reasons). Firstly, we always use species adapted to the conditions of the area (which ends up limiting the type of species) and secondly, we use direct sowing and plan to plant more trees than desired (for example, we plant 100 seeds for 1 individual, depending on the species).
Fodder	Tech-mechanisation of fodder harvest, processing and storing	Tech/mechanical solutions for harvesting and processing tree fodder at scale			
Tree disease	Ability to deal with novel pests/diseases in tree species planted	Use of smart internet of things to monitor animal health and plant growth			
Bio-Circularity & soils	Conversion of livestock waste and tree biomass to biochar to improve soil fertility	Biostimulation strategies			