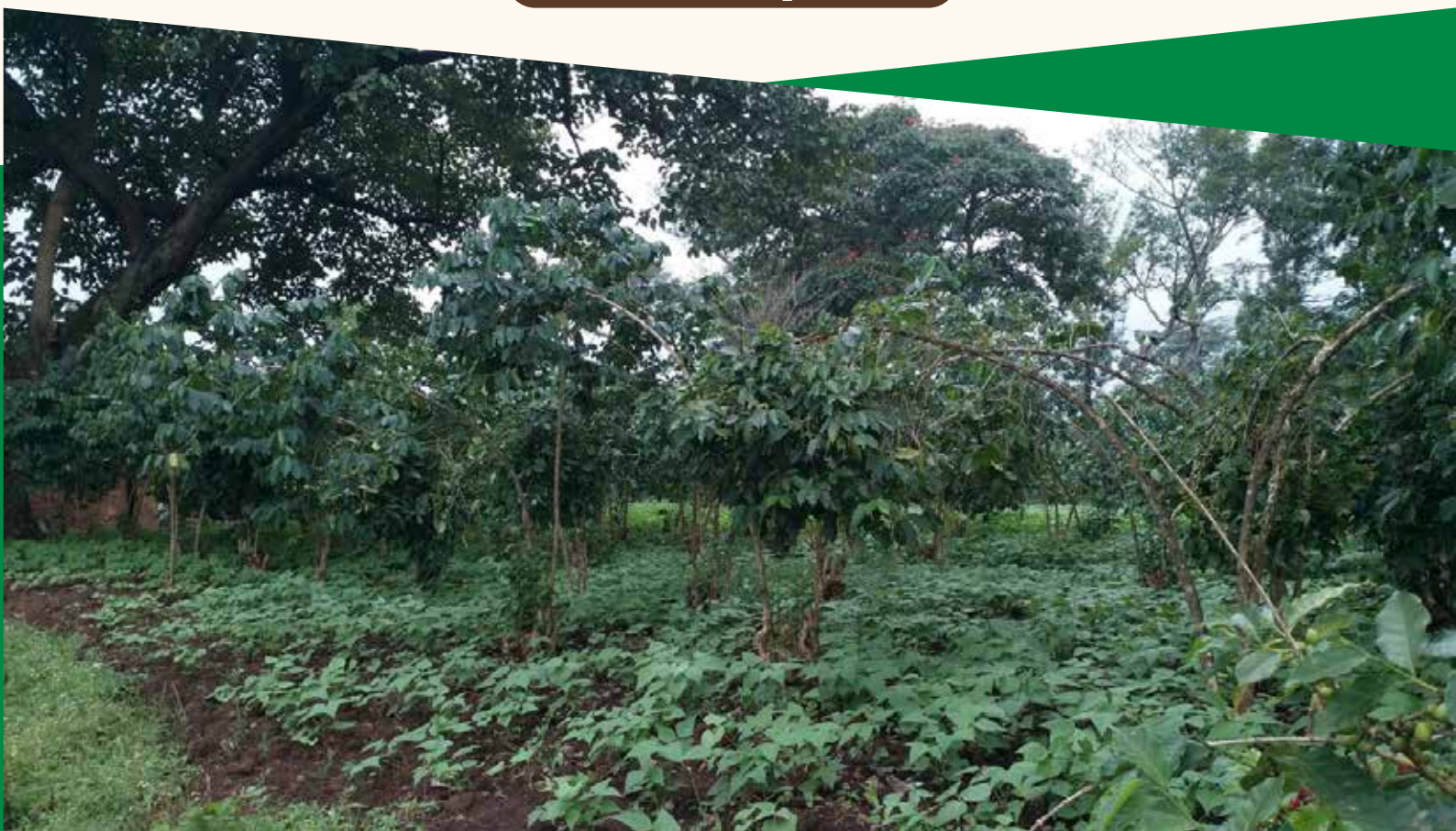# Review and Analysis of policies, strategies, attitudes, practices and institutions for strengthening coffee agroforestry in Uganda

Final Report

December 2022

Review and Analysis of policies, strategies, attitudes, practices and institutions for strengthening coffee agroforestry in Uganda

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Clement A. Okia & Joel Buyinza

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LIST OF ACRONYMS

ACIAR	-	Australian Centre for International Agricultural Research
ACPCU	-	Ankole Coffee Producers Cooperative Union
ARP	-	Agroforestry Research Program
BCTB	-	Black Coffee Twig Borer
CA	-	Conservation Agriculture
CAU	-	Café Africa Uganda
CBD	-	United Nations Convention on Biodiversity
CTA	-	Technical Centre for Agricultural and Rural Cooperation
DFO	-	District Forest Officer
DFS	-	District Forestry Services
DLG	-	District Local Government
DNRO	-	District Natural Resources Officer
DPO	-	District Production Officer
FAO	-	Food and Agriculture Organization of the United Nations
FOM	-	Farmer Ownership Model
FSSD	-	Forest Sector Support Department
GCP	-	Global Coffee Platform
GDP	-	Gross Domestic Product
ICRAF	-	International Centre for Research in Agroforestry
IITA	-	International Institute of Tropical Agriculture Institute
IUCN	-	International Union for Conservation of Nature
KADLAC	-	Kapchorwa District Landcare Chapter
MAAIF	-	Ministry of Agriculture, Animal Industry and Fisheries
MbaZARDI	-	Mbarara Zonal Agricultural Research and Development
MDAs	-	Ministries, Departments and Agencies
MWE	-	Ministry of Water and Environment
NAADS	-	National Agriculture Advisory Services
NaCORI	-	National Coffee Research Institute
NaFORRI	-	National Forestry Resources Research Institute
NARO	-	National Agricultural Research Organization
NFA	-	National Forestry Authority
OWC	-	Operation Wealth Creation
PARIs	-	Public Agricultural Research Institutes
PCDAs	-	Parish Coffee Development Assistants
P4F	-	Partnerships for Forests
R&R	-	Renovation and Rehabilitation
SDGs	-	Sustainable Development Goals
SLM	-	Sustainable Land Management
T4FS	-	Trees for Food Security

UBoS	-	Uganda Bureau of Statistics
UCDA	-	Uganda Coffee Development Authority
UCFA	-	Uganda Coffee Farmers Alliance
UCP	-	Uganda Coffee Platform
VIP4FS	-	Value Chain Innovation Platforms for Food Security
WVU	-	World Vision Uganda
YCSPs	-	Youth Coffee Service Provider businesses

ACKNOWLEDGMENT

EXECUTIVE SUMMARY

Coffee contributes more than 3% of Uganda's Gross Domestic Product (GDP) and its one of the leading foreign exchange earners, contributing 20 - 30% of the country's foreign exchange earnings. The coffee sector provides employment to over 5 million Ugandans, through coffee-related activities along the value chain. Two types of coffee, arabica and robusta, are grown in different areas of Uganda and at different altitudes. Arabica is grown between 1,300 and 2,300m above sea level around Mt. Elgon in the east and Zombo in West Nile, Mt. Rwenzori and Muhavura mountain ranges in the southwest. Robusta is mainly grown around the Lake Victoria basin at altitudes of 900 to 1,500m. The coffee sector in Uganda is under the threat from the impact of climate change, expressed as the risk of decreasing productivity and reduction of the area suitable for coffee growing. There is need to promote coffee agroforestry in the coffee growing areas of Uganda to counter the negative impact of climate change.

Café Africa Uganda under its Global Coffee Platform (GCP) Youth for Coffee Initiative in Uganda has set out to address some of these challenges through an intervention focusing on Renovation and Rehabilitation (R&R) of coffee farms. The program aims at developing, testing and promoting a universally applicable model for R&R interventions and agroforestry in smallholder mixed coffee farms in Uganda, with the support of Partnerships for Forests (P4F). This report provides an analysis of the policies, strategies, attitudes, practices and institutions that are of relevance in strengthening agroforestry in Uganda, and in particular in relation to tree growing and agroforestry systems that relate to coffee farms. The analysis was conducted through desk review of national policies, laws and regulations in agriculture, environment, forestry relating to coffee agroforestry. This was followed by stakeholder consultations in the different project sites (Luwero, Gomba, Sheema and Sironko districts) to ascertain the practical application of forestry and agroforestry in coffee, and the attitudes and opinions of farmers and other stakeholders in terms of its contribution to yield, quality and income.

Generally, there appears to be no shortage of policies and laws for agroforestry to thrive in Uganda. Agroforestry and the related concepts are generally provided for in the upstream, midstream and downstream instruments, occasionally indicated as a federating sub-sector between and with synergies for sustainable land management (SLM) and sustainable development. Overall, there exists an enabling policy environment for vibrant agroforestry in Uganda. However, a challenge exists with large–scale downstream implementation through frontline scaling-up, which may imply an adjustment in both institutions and the policy and legal framework. Given this situation, there are a number of policy and legislative frameworks that influence the implementation of agroforestry initiatives in Uganda spreading across the forestry and agriculture sectors documented in this report. The report highlights provisions that explicitly support agroforestry, those that support general forestry but not explicit on agroforestry and the existing policy obstacles. The relevant national and international frameworks, key actors and projects/ programs on coffee agroforestry in Uganda are also documented. Following a field research component, the report further documents farmers' opinions, pressures and challenges related to coffee agroforestry, the good practices and opportunities for advancing agroforestry in local policies as well as key messages for promoting integration of trees on farm.

Some of the key coffee sector state and nonstate actors highlighted in this report include; Uganda Coffee Development Authority (UCDA), National Coffee Research Institute (NaCORI), National Forestry Resources Research Institute (NaFORRI), Uganda Coffee Farmers Alliance (UCFA), Ankole Coffee Producers Cooperative Union (ACPCU) and The Coffee Gardens. Majority of these are implementing a number of projects and programs that promote coffee agroforestry among smallholder farmers in their areas of operation.

Smallholder farmers have to contend with the ever-increasing demand for forest and tree products, and associated land fragmentation. There are also a number of institutional challenges that exist along with difficult choices farmers have to make on the appropriate spatial and temporal coffee-agroforestry combinations. This has been worsened by the conflicting extension information to farmers from different knowledge sources and the limited knowledge and skills of farmers on integrating agroforestry in their coffee farming landscape. Farmers usually scatter trees in their coffee gardens with no regard to spacing, species selection and combinations in coffee systems. This conforms with recent studies, which have demonstrated that farmers have not adopted tree canopy pruning as a deliberate on-farm practice, but only remove branches of trees when there is need for fuelwood, timber or poles. Besides, there are no agroforestry designs and pruning regimes for agroforestry tree species. At institutional level, the multi-sectoral nature of agroforestry demands multi-sectoral collaboration in agroforestry extension, research and development rather than working in silos. The transitory nature of farmer-based research and development projects in agroforestry also presents sustainability issues as the short-term nature of most projects (usually lasting 2-5 years) is a key setback, yet benefits/ impacts from most agroforestry interventions take long to be realized. The packaging of research outputs has also been done in ways difficult for the farmers to understand or comprehend. These challenges have been persistent amidst absence of a Uganda National Agroforestry Strategy whose development is on-going and in its final stages.

The opinion of the stakeholders is that such challenges and pressures could be minimized by reviewing the current agricultural extension approaches to emphasize hands-on training, use existing community social networks and policy interventions should aim at integrating farmer-to-farmer extension approaches. There are also calls for institutionalizing agroforestry research and development projects within government structures and the expeditious completion of the draft national agroforestry strategy that is currently under review. At household and farm levels, creating incentives will spur the growing of trees on farms. These include providing quality tree seedlings and other planting materials, extension support and practical training on undertaking good agronomic practices, provision of fertilizers, low-cost coffee processing services and development of agroforestry-based value chains to meet domestic and regional market demands. Youth empowerment is also key and use of a cluster approach, where farmer groups jointly apply for a government intervention/ support. There is also need for a shift from traditional to more systematic agroforestry options for smallholder farmers.

The motivation to ensure agroforestry reaches out to the masses is that majority of Ugandans depend on forest products such as firewood, poles, timber, fruits and other uses. The rate at which these resources are being lost is alarming, while agroforestry continues to provide opportunities for households to enjoy the multiple benefits from trees, including food security and income generation. It has

been demonstrated that shade trees, when well-managed, contribute to better coffee yields. Integration of trees in coffee farms improves the quality of beans which fetches higher market values and can support the specialty coffee market. Lobbying for inclusion of existing agroforestry trees on farm in the carbon accounting as a contribution to Nationally Determined Contribution (NDCs) will encourage more tree planting on farm. Trees planted with coffee can offer the service of carbon sequestration for which carbon credits may be obtained. The multi-purpose nature of indigenous tree species, which have well developed root systems for effective soil and water conservation. Sequencing integration of bananas and trees could ensure household food security. Additionally, formulating regulations requiring planting of trees in fragile ecosystems such as Mt. Elgon and Rwenzori will also encourage farmers in these areas to plant and retain trees in these landscapes. Use of ICT to interest the youth should be emphasized while enhancing efficiency in providing advice to farmers on tree growing and agroforestry tree species selection. A few initiatives already exist, such as the 'Shade Tree Advice' and 'Agroforestree Database' applications developed by IITA and ICRAF respectively.

Finally, drawing from available literature on studies conducted in Uganda, Ethiopia and Costa Rica, as well as field and stakeholder consultations, we highlight 3 practical recommendations relating to (1) priority coffee agroforestry tree species for Uganda and their management, (2) development of temporal and spatial coffee agroforestry models, including demonstration of successive integration of bananas and trees in coffee and (3) integration of both trees and nitrogen fixing shrubs in coffee gardens for soil fertility enhancement and erosion control. However, the suggested recommendations and agroforestry tree species require further localized on-farm investigations prior to widescale promotion among coffee agroforestry farmers in Uganda.

CHAPTER 1

INTRODUCTION

1.1 Background

Agroforestry is a farming system involving deliberate use of trees with agricultural crops and/or animals on the same land management unit. It is recognized as one of the most functional components of farming systems that can enhance sustainable provision of global food demands[1] and a major source of household fuel wood energy needs. For example, according to the 2016 National Charcoal Survey report for Uganda[2], 20 percent of Uganda's charcoal production is estimated to come from farmlands, contributing approximately USD 11.2 million to the national economy. With deforestation trends ever-increasing, especially in protected areas, growing trees on farms reduces pressure on those areas. Additionally, Uganda has committed to the Bonn Challenge, where the Government intends to restore close to 2.5 million hectares of degraded land by 2030. The 2016 Forest Landscape Restoration Opportunity Assessment Report for Uganda[3] identified agroforestry, woodlots and farmer-managed natural regeneration as the cheapest and most feasible option for attaining this commitment. Coffee in Uganda is mostly grown in mixed stands where it is intercropped with food crops and shade trees that results in sustainable coffee production.

Coffee (both *robusta* and *arabica*) is the most important cash crop for Uganda, playing a vital part in the country's economy and livelihoods of its people. Coffee has sustained livelihoods for generations in different farming systems in Uganda[4]. It contributes more than 3% of the Gross Domestic Product (GDP) and its one of the leading foreign exchange earners for Uganda, contributing 20 - 30% of the foreign exchange earnings and supporting the livelihood of about 1.3 million smallholder households and provides employment to over 5 million Ugandans, through coffee-related activities along the value chain[5].

1 Pinho, R. C., Miller, R. P., & Alfaia, S. S. (2012). Agroforestry and the Improvement of Soil Fertility: A View from Amazonia. Applied and Environmental Soil Science, 2012. doi: 10.1155/2012/616383

2 MEMD (2016) https://pfccparliament.go.ug/wp-content/uploads/2019/04/NationalCharcoalSurvey_FINAL.pdf

3 Forest Landscape Restoration Opportunity Assessment Report for Uganda (2016), Ministry of Water and Environment – Uganda; IUCN. x + 42pp. https://portals.iucn.org/library/sites/library/files/documents/2016-076.pdf .

4 Bolwig, S. and You, L. 2007).'Quality or volume? An economic evaluation of coffee development strategies for Uganda', Development in Practice,17:3, 433 — 438. DOI: 10.1080/09614520701337285 URL: http://dx.doi.org/10.1080/09614520701337285

5 Uganda Coffee Development Authority (UCDA) (2000). Annual Report. Kampala: UCDA.

Smallholder farmers cultivate most of the coffee in Uganda, usually on farms of roughly 0.5 to 2.5 hectares[6]. Two types of coffee, arabica and robusta, are grown in different areas and at different altitudes. Arabica is grown at between 1,300 and 2,300 m above sea level around Mt. Elgon in the east and Zombo in West Nile, Mt. Rwenzori and Muhavura mountain ranges in the southwest. Robusta is mainly grown around the Lake Victoria basin at altitudes of 900 to 1,500 m and lower altitudes adjacent to the robusta growing areas. The coffee sector in Uganda is under the threat from the impact of climate change, expressed as the risk of decreasing productivity and reduction in the area suitable for coffee growing.

Climate variability and change includes increasing temperatures that will reduce the suitability of certain areas for coffee, disrupt coffee bean development, and may increase the incidences of pests and diseases. Studies (e.g., by USAID, 2013) have confirmed that coffee (both arabica and robusta) is one of the crops in Uganda that is the most vulnerable to climate change. The projected rising temperatures and increasingly-erratic rainfall patterns will lead to reduced productivity and a greater likelihood of pests and diseases. Interviews with coffee value chain actors and field observations reveal that climate hazards are already negatively affecting coffee growing in Uganda. This calls for measures towards adaptation and mitigation of climate change hazards on the coffee sub-sector including promoting coffee agroforestry in the coffee growing areas of Uganda[7].

1.2 Coffee Agroforestry

Coffee is mostly grown in mixed stands where it is intercropped with food crops such as bananas, beans, cassava and sweet potatoes, supplemented by small-scale animal husbandry to ensure households' food security[8,9]. Coffee is also grown among shade trees that result in sustainable coffee production[10]. Shade trees protect sensitive coffee bushes from harsh winds and excessive light, protect the soil against erosion, and regulate temperature and humidity. The shade trees may also have multiple uses (e.g., timber, fruit, fuel wood, and medicines). Most importantly, there is growing evidence that shade positively affects coffee quality[11]. Shade trees also have other effects such as improving nutrient cycling by absorbing nutrients through the roots at lower depths in the soil and depositing leaf litter on the surface, thus acting as nutrient "pumps". Additionally, research findings indicate that the area suitable for coffee production with unshaded plantations may decline by 60% under projected climate change by 2050[12].

6 Okecho SHO, Gold CS, Abele S, Nankinga CM, Wetala PM, Van Asten P, Nambuye A and Ragama P (2004) Agronomic, pests and economic factors influencing sustainability of banana-coffee systems of western Uganda and potential for improvement. Uganda Journal of Agricultural Sciences, 9: 415-427.

7 USAID 2013. Uganda vulnerability assessment report. African and Latin American Resilience to Climate Change Project. Tetra Tech ARD: Washington, D.C.

8Gwali, S and Kiyingi, I (2012). Productivity and profitability of robusta coffee agroforestry systems in central Uganda. Uganda Journal of Agricultural Sciences, 13 (1) 85-93.

9 http://www.ugandacoffee.org/index.php?Itemid=49&id=36&option=com_content&task=view

10 Jennifer Williams (2008). Shade trees can protect coffee crops. http://www.bio-medicine.org/biology-news-1/Shade-trees-can-protect-coffee-crops-5151-1/

11 Gwali, S and Kiyingi, I (2012). Productivity and profitability of robusta coffee agroforestry systems in central Uganda. Uganda Journal of Agricultural Sciences, 13 (1) 85-93.

12 What climate change means for the future of coffee, cashews, and avocados (nationalgeographic.com)

On the other hand, agroforestry systems can mitigate the effects of climate change and maintain 75% of the area suitable for coffee production[13]. This should act as a huge opportunity for promoting coffee agroforestry.

The coffee sector in Uganda faces other challenges that include growing land shortages, pests and diseases, aging coffee trees and the lack of quality planting materials, among others. These hamper productivity and force farmers to pursue intensification strategies that integrate coffee with multi-purpose trees and other agricultural crops[14]. Although trees are increasingly used on coffee farms, farmers' management of these trees is still largely uninformed by modern agroforestry knowledge[15]. Farmers' net profit margins are low: they mostly sell red cherries or hulled beans that have undergone minimal processing, and they usually fail to market by-products such as the husks from hulled coffee. Instead, husks usually function as litter in poultry houses, as mulch and manure, and as a domestic fuel[16].

Despite the immense benefits of trees in coffee farming systems, there still exists a challenge in integrating the concept into the policy landscape in Uganda. While the Food and Agriculture Organization of the United Nations (FAO) noted in 2013 that agroforestry belongs to 'all sectors', in practice, it rarely has its own policy space. Therefore, there is need to improve the policy environment for sustainable coffee production in Uganda.

Café Africa Uganda under its Global Coffee Platform (GCP) Youth for Coffee Initiative in Uganda has set out to address some of these challenges through an intervention focusing on Renovation and Rehabilitation (R&R) of coffee farms. The program aims at developing, testing and promoting a universally applicable model for R&R interventions and agroforestry (with support from PAF) in smallholder mixed coffee farms in Uganda. It's hoped that such a model will be integrated in the public and private coffee extension programmes in the coffee growing areas of Uganda.

1.3 Youth for Coffee in Uganda Initiative context and objectives

Café Africa Uganda (CAU) is implementing the Global Coffee Platform (GCP) Youth for Coffee Initiative in Uganda in the districts of Gomba, Luweero, Bushenyi and the Elgon region for both robusta and arabica farming communities. Youth for Coffee in Uganda Initiative is an intervention focusing on coffee Renovation and Rehabilitation (R&R) and climate-proofing coffee farms. The program aims at testing and sharing a universally applicable delivery model for R&R and agroforestry practices in smallholder mixed coffee farms. This will be done through training and equipping 150 Youth Coffee Service Provider businesses (YCSPs).

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13 Gomes, L. C., Bianchi, F. J. J. A., Cardoso, I. M., Fernandes, R. B. A., Fernandes Filho, E. I., & Schulte, R. P. O. (2020). Agroforestry systems can mitigate the impacts of climate change on coffee production: a spatially explicit assessment in Brazil. Agriculture, Ecosystems & Environment, 294, 106858.

14 Arnold, M and Dewees, P. (1998). Rethinking approaches to tree management by farmers. Overseas Development Institute, London, UK

15 Buyinza, J., Nuberg, I. K., Muthuri, C. W., & Denton, M. D. (2021). Farmers' Knowledge and Perceptions of Management and the Impact of Trees on-Farm in the Mt. Elgon Region of Uganda. Small-scale Forestry. doi: 10.1007/s11842-021-09488-3

16 UNDP (2012). The market and nature of coffee value chains in Uganda. Development of inclusive markets in agriculture and trade (DIMAT) project report. UNDP, Kampala.

The youth will be trained in coffee climate-smart coffee production and coffee R&R, and shall subsequently operate as private youth coffee service providers for farmers at a fee. The YCSPs will also be assisted to set up shade and agroforestry tree nurseries for distribution of suitable tree seedlings to participating farmers, with a view of increasing shade and multipurpose tree cover in coffee growing areas.

The agroforestry component of the project is one building block to climate proof coffee farms through bringing ambient plot temperatures down, increase soil organic matter, and diversify farm products and income. Additionally, the increased wood and root organic matter from trees and healthy coffee trees will stores additional carbon, thereby contributing to the government's sequestering targets. This could also be monetized through carbon credits. Ultimately the project intends to measure and share the findings of these interventions, nationally and internationally. The project hopes to catalyze similar investments country-wide and globally, in which the private sector, public sector and communities can achieve shared value from sustainable forests and sustainable (coffee) land use. The project will achieve this by creating convening spaces for stakeholders in Uganda to explore agroforestry and forest landscape governance as possible climate-smart investment pathways in the coffee sector.

1.4 Study Objectives

The overall objective of the study was to analyze the policy space in which forests, agroforestry and coffee operate in Uganda, and recommend practices, partners and pathways to achieve sustainable coffee production.

The specific objectives were:
1. To undertake an in-depth analysis of existing national policies, laws and institutional arrangements to identify the provisions that support agroforestry and forest protection in Uganda, and any gaps that should be addressed to enhance agroforestry practices in coffee growing areas;

2. Identify pressures, challenges likely to be faced by farmers towards implementing agroforestry and forest protection practices in the coffee growing areas and their impact on farmer prosperity;

3. Identify the good practices and opportunities to further advancement and integration of agroforestry and forest protection practices in local policies;

4. Suggest key messages to convince farmers, extension workers and coffee sector at large to include trees on farms;

5. Provide recommendations highlighting the practical ideas on what incentives can encourage farmers to plant or retain trees on their farms and what can be done to stimulate coffee agroforestry in Uganda.

1.5 Scope of work and deliverables

Successful implementation and sustainability of the Youth for Coffee initiative would require clear understanding of the policy environment related to agroforestry and forest protection in Uganda. This would involve a review and analysis of the policies, strategies, attitudes, practices and institutions that are of relevance in strengthening agroforestry in Uganda, and in particular in relation to tree growing and agroforestry systems that relate to coffee farms. The policy analysis was supported by a field research component, involving interactions with key stakeholders and field observations on coffee farms. The entire exercise adopted a bottom-up approach and engaged specific institutions and stakeholders not limited to farmers and 'Agroforestry working committee members' so as to generate practical, evidence-based policy recommendations.

The following deliverables were expected from this specific task;
1. A brief inception report detailing the consultants' understanding of the task and the methodology to be employed to complete the task, including an outline of the report.

2. A comprehensive draft report that contains a detailed analysis of the policy, and institutional environment, including opportunities and obstacles to further advance and integrate agroforestry and forest protection practices in local policies, messages to extension workers, suppliers and farmers, including ways and means of packaging the ideas in convincing materials.

1.6 Key concepts
Renovation: Refers to addition of planting material in the field, either in the form of replanting coffee trees or inserting coffee trees/shade trees

Rehabilitation: Refers to increasing tree productivity by pruning or stumping the tree. These concepts have been applied in the Americas on coffee and cocoa systems at both market system and farmer levels[17].

Agroforestry: The concept of Agroforestry is based on development of an interface between agriculture and forestry. Therefore, agroforestry is the intentional integration of trees into crop and animal farming systems to create environmental, economic, and social benefits. Simply stated, agroforestry is "agriculture with trees". Generally, for an agricultural management practice to be called agroforestry, it must also be intentional, intensive, integrated, and interactive.

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17 Wiegel, J.; Del Río, M.; Gutiérrez, J.F.; Claros, L.; Sánchez, D.; Gómez, L.; González, C.; Reyes, B (2020). Coffee and Cacao Market Systems in the Americas: Opportunities for Supporting Renovation and Rehabilitation. *International Center for Tropical Agriculture (CIAT)*. Cali, Colombia. https://hdl.handle.net/10568/108108, 154 p

Coffee agroforestry: A term used to describe the shade-grown coffee. It's the growing of coffee with the deliberate integration of trees and shrubs in coffee farms to create environmental, economic, and social benefits. Coffee agroforestry is the growing of coffee with the consideration for forested landscapes surrounding or scattered throughout coffee fields. However, there is increasing understanding that agroforestry in the coffee landscape can provide many more benefits than shade, including provision of food, firewood, poles, fodder and timber, for domestic use and income. Coffee agroforestry is a recently coined term to broaden the world's view of shade-grown coffee. It has several strategies, such as conservation approach, reforestation, afforestation, and forest management practices. The tree-coffee mix is therefore an important approach for diversifying incomes and improving farmers' wellbeing, as well as providing opportunities for employment. It can also be regarded as an approach for climate-proofing coffee farms and extending coffee growing to areas that would not otherwise support coffee without trees.

CHAPTER 2

METHODOLOGY

2.1 Introduction

The main tasks for the assignment were broken down into four steps as shown in Figure 1. The key steps included

    a.   Production of the Inception Report;

    b.   Information gathering,

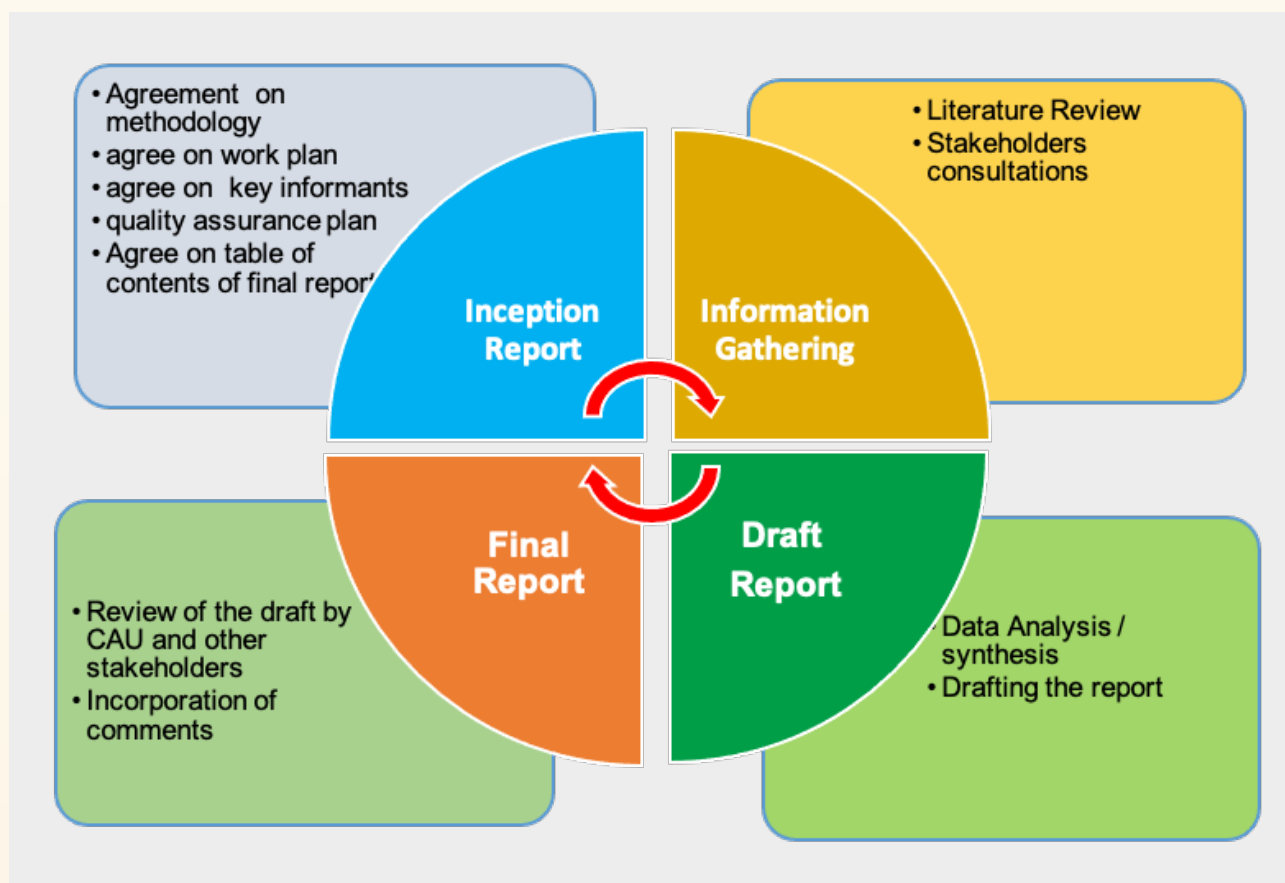   c.   Drafting of the report, and (iv) Production of final report.

Figure 1: A schematic presentation of the tasks involved in assignment

2.2 Inception Report

An inception report was produced and it formed the basis of a road map for the review process. The following issues of the report were discussed and agreed upon with CAU prior to the commencement of the work.

- Approach and methodology to be used;
- The key stakeholders to be consulted;
- The work plan and schedule of activities
- The outline for the Final Report
- The quality assurance plan

2.3 Information gathering

The methodology used for this task has two components;
1. A desk review of relevant documents relating to agroforestry
2. Stakeholder consultations in the Youth for Coffee initiative project areas
3. Consultations with other key stakeholders in the coffee, forestry and agroforestry, Agriculture and Environment sectors including; Uganda Coffee Development Authority (UCDA), National Coffee Research Institute (NaCORI), National Forestry Authority (NFA), VI Agroforestry, Café Africa Uganda (CAU), National Forestry Resources Research Institute (NaFORRI) and Forest Sector Support Department (FSSD), among others (*see list of stakeholders consulted in Annex 1*)

The key guiding questions addressed during the research were:
1. What are the current policy and legal provisions that support agroforestry and forest protection?
2. What policy and legal gaps need to be addressed and how best could that be done?
3. What considerations are important for promoting coffee agroforestry and forest protection in Uganda?

2.3.1 Structured desk review

The desk review included an analysis of existing policies and strategies, ongoing major interventions and players. The field research looked into the practical application of forestry and agroforestry in coffee, and the attitudes and opinions of farmers in terms of the contribution of coffee agroforestry to coffee yield and quality, as well as household income.

A structured desk review approach was applied with clearly predetermined search strings via scientific databases of ISI Web of Sciences (papers), Google Scholar (books, reports) and unpublished reports, covering the following aspects:

- Café Africa Uganda's work on coffee in Uganda and the Youth for Coffee in Uganda project documents
- National policies, laws, regulations in agriculture, environment, forestry, etc. relating to cof-

fee growing, coffee R&R and coffee agroforestry (shaded coffee or coffee agroforestry)

- Efforts towards integration of coffee agroforestry (shaded coffee) into Uganda's public and private coffee extension systems.
- Potential incentives for promoting shaded coffee or coffee agroforestry in Uganda

2.3.2 Stakeholder consultations

The field research component involved interviews with key stakeholders (national and field-based) and selected farm visits to assess the practical application of agroforestry in coffee, and the attitudes and opinions of farmers in terms of its contribution to yield, quality and income. The field research was also an opportunity for the consultants to familiarize with the project activities and interact with the agroforestry working committee members to generate practical, evidence-based policy recommendations. Key informant interviews (at national level and in each project site) and Focus Group Discussions were conducted (Figure 2). Interview guides were used for this purpose to capture the required information (*see Annex 2 and 3*).

Figure 2: A Focus Group Discussion in Luwero district

2.4 Data analysis and synthesis

The data collected through desk review and stakeholder consultations was analyzed and categorized in key thematic areas including (a) national policies and projects on agroforestry and forest protection; (b) agroforestry practices in coffee growing areas and their impact on farmer prosperity; (c) opportunities and obstacles for further advancement and integration of agroforestry practices into local policies; (d) contribution of trees and agroforestry systems to climate proofing coffee farms, and (e) available incentives that can stimulate coffee agroforestry in the project areas or other parts of Uganda.

CHAPTER 3

FINDINGS AND DISCUSSION

3.1 Analysis of policies, laws and institutional arrangement for delivering agroforestry

In the following sections, gaps in the policy and laws are analyzed; identifying those provisions that explicitly require achievement of agroforestry (Section 3.1.1); those which support but do not explicitly require agroforestry (Section 3.1.2), international and national frameworks relevant to agroforestry implementation (3.1.3), and those that may stand as obstacles (Section 3.1.4). also considered are the key actors in the promotion of coffee agroforestry (3.1.5) and the projects and programs on coffee agroforestry.

3.1.1 Provisions that explicitly support agroforestry

a) Policies

Uganda Forestry Policy (2001)
The policy provides for planting of trees through the development of commercial forest plantations (Policy Statement 3) trees on-farm/agroforestry (Policy Statement 6) and the supply of tree seed and planting materials (Policy Statement 11), the latter two policy provisions being relevant to the integration of trees in coffee farming systems. It is clearly stated in this policy that the promotion of tree growing on farming systems aims to boost land productivity, increase farm incomes, alleviate pressures on natural forests and improve food security.

The multi-purpose opportunities of trees on-farm are highlighted, including provision of firewood, poles, non-wood products, fruit trees and even timber. The approach to farm forestry is in form of woodlots, agroforestry, silvi-pasture, management of natural trees on farm or small-scale commercialization, given the generally low household landholding across the coffee growing areas (Nationally, approximately 80 percent of the Agricultural Households hold less than three hectares of land)[18]. There is also a provision of extension and advisory services to farmers, communities, organizations and management of forests and for the development of farm forestry. The provision for the supply of adequate of high-quality tree seeds and planting stock is Government's intent to meet the needs of small-scale farmers (including agroforestry trees) and large-scale commercial tree growers, while being mindful about the quality of the resultant forest and tree products to be derived.

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18 Uganda Bureau of Statistics (UBOS), 2020. Uganda Annual Agricultural Survey 2018. Kampala, Uganda; UBOS.

b) Laws

National Forestry and Tree Planting Act, 2003

Section 26 of the Act provides that the Minister responsible for forestry (with Forestry Sector Support Department being the technical wing), the National Forestry Authority or a local government may provide technical services to local communities, organizations, cultural or traditional institutions and other persons involved in community forests and private forests and forestry activities in general, and that a fee may be charge for such services. The Act specifically mentions the areas where assistance may be offered to include the promotion of seed production, agro-forestry and tree growing, including the growing of fruit species, among other services. This provision enables an institutional framework for extension and advisory service delivery, including promoting good on-farm forest and agroforestry practices.

Section 27 (1) provides for the security of tree tenure, emphasizing that Government or local government has no ownership of trees or forest produce situated on private land. This provision serves as an incentive to promote agroforestry on private land.

Section 48 provides for the establishment and functions of the District Forest Office, with the staff appointed by the District Council, as may be determined by Government. Among the functions of the District Forestry Officer include promoting forestry awareness in the district, promoting the planting of trees and to assist in the development and provision of advisory services relating to private forests. This includes providing extension services relating to agroforestry. This provision is an emphasis to the role of local governments through the Forestry Department to assist farmers to grow trees for any purpose. Through awareness creation, the coffee farmers may be informed about the importance of forests and agroforestry in particular.

The Forestry Policy as well as the National Forestry and Tree Planting Act as described above provide the legal backing and opportunities for integrating trees on-farm (agroforestry), and hence into the coffee farming systems. However, the support for growing trees and coffee are separated through the different institutional arrangements: the trees being the mandate of the Ministry of Water and Environment (MWE) and forestry related agencies (especially NFA), while coffee is the mandate of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), and the associated agencies. At local government levels, trees are responsibility of the District Forestry Office within the Natural Resources Department, and coffee is under Agriculture within the Production Department. This separation has promoted working in silos both the national and district levels. Promotion of coffee agroforestry calls for establishment of linkages a cross these agencies and departments.

3.1.2 Provisions that support forestry but they are not explicit about agroforestry

a) Policies

National Climate Change Policy, 2015

The Climate Change Policy affirms that Uganda depends largely on rain-fed agriculture, which makes rural livelihoods and food security highly vulnerable to the consequences of climate change and variability. Climate change in Uganda is expected to severely influence the variability of rainfall and to cause increases in temperature and the potential for evapotranspiration. Increases in aridity and drought will in turn influence agricultural production and food security. To address these challenges, the policy prioritizes the promotion of climate change adaptation strategies that enhance resilient, productive and sustainable agricultural systems. Some of the specific strategies suggested include promoting and encouraging conservation agriculture and ecologically compatible cropping systems to increase resilience to the impacts climate change. In addition, the policy supports community-based adaptation strategies through stretched extension services and improved systems for conveying timely climate information to rural populations to enhance the resilience of agricultural systems to the impacts of climate change.

Under these policy provisions, agroforestry fits well as a cropping system that increases resilience through providing shade and hence creating ambient local climates for the growth of coffee. Agroforestry can be promoted as a strategy for climate-proofing coffee farming systems in Uganda.

Decentralization Policy

The decentralization policy was officially launched in 1992 and preserved in the Constitution of the Republic of Uganda (1995)[19] and the Local Governments Act, 1997[20]. The policy provides for an appropriate measure that enables Local Government units to plan, initiate and execute policies in respect of matters affecting people within their jurisdiction. The decentralization policy aims at improving service delivery, accessibility to services and reduction of poverty within the population. The Local Governments Act, 1997 (the Second Schedule) clearly defines the functions that are devolved to Local Governments, including crop, animal and fisheries husbandry extension services, forests and wetlands and assisting the Government to preserve the environment through protection of forests, wetlands, lake shores, streams and prevention of environmental degradation, amongst others.

The decentralization of extension and advisory service delivery provides the opportunity to integrate agroforestry practices as part of the knowledge and information package to farmers as the target beneficiaries of such services. However, the current gap in the policy is in respect of how extension service is defined in the Second Schedule of the Local Governments Act, which apparently focuses on agriculture (crop, animal and fisheries husbandry) and is not explicit about forestry extension. Agroforestry majorly leans towards forestry practices, and it is a mistake to assume that it is covered under "crop". The knowledge gap observed in the field about the integration of trees on-farm, e.g.,

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19 Republic of Uganda, 1995. The Constitution of the Republic of Uganda, 1995.

20 Republic of Uganda, 1997. Local Governments Act, 1997.

identifying the right tree species to provide shade in a coffee system, spacing of the trees and shade management attests to this. In addition, the promotion of coffee growing (both robusta and arabica) by the agencies engaged under the Production Department focused on the provision of coffee seedlings, and no provision for shade trees seedlings. It was reported that farmers do not get the right guidance from extension workers and advisory service providers in general have limited knowledge and experience on integrating trees in coffee systems.

The decentralization policy provides for established mechanism in the extension services and advisory service delivery at community level, through employment of personnel with the qualifications in agroforestry, collaboration with the District Forest Office to train the frontline service providers in agroforestry practices, and developing a training manual on agroforestry. In practice, this has not been realized. The Forestry Office is one of the least facilitated sectors in the District Local Government structure in terms of staffing, transport, and funds. There is generally a scarcity of locally adapted training manual/guide for agroforestry in Uganda.

The National Agricultural Policy, 2013

The National Agricultural Policy aims at increasing household incomes, food and nutrition security and employment. MAAIF is responsible for managing and coordinating agricultural interventions. It does so through the Ministry's autonomous and semi-autonomous agencies, local governments, farmers and farmers' organizations, other ministries, departments and agencies (MDAs), the private agribusiness and agro-processing sector, civil society, academia, development partners and academia.

The National Agricultural Policy specifically states that "agricultural development strategies in Uganda will be developed and pursued according to the agricultural production zones through a commodity-based approach, and commodities that are best suited for each zone will receive public sector support for the purposes of food security and for commercialization". The concept of "production zones" appears to have received little attention and business and usual has continued to be applied. If adopted, such a concept would have benefited the coffee production by aligning extension services suitable for the coffee zone and adoption of coffee agroforestry.

The Policy focuses on enhancing food security at household and national levels, through expanded production and promotion of agricultural enterprises that enable households to improve incomes to support food purchases (Objective 1). Increasing incomes of farming households is further pursued through increasing volumes of outputs and improving quality of commodities in the specialties of crops, livestock and fisheries (Objective 2), and providing the needed technologies and extension and advisory services to improve farm productivity (Objective 3). Access to these services is to be enhanced by increased agricultural training and skills development and facilitating farmer organization into groups or cooperatives for effective extension and advisory service delivery.

The Policy also seeks to use and manage agricultural resources in a sustainable manner, through promotion and application of appropriate technologies and practices, such as Sustainable Land Management (SLM) and Conservation Agriculture (CA), to conserve the resources among all categories of

farmers (Objective 5). The Policy also requires mainstreaming appropriate measures to mitigate the impact of climate change and extreme weather events on agriculture in areas of high risk, in collaboration with MAAIF and other relevant ministries and agencies.

Human resource development in terms of skills improvement is highlighted as necessary for effective provision delivery of extension and advisory service delivery to farmers. Building the capacity of farmers and farmer organizations is equally important to facilitate sustainable knowledge and skills retention among the farmers and facilitate farmer-to-farmer learning and more effective engagement in agribusiness. It's assumed that facilitated farmers working together in groups are able to realize significant increases in their productivity and incomes.

This policy provides for collaboration with relevant MDAs, and hence it would be expected that MAAIF with its associated Departments and Agencies should collaborate with MWE, NFA and the decentralized District Forestry Services to provide technical guidance on matters related to agro-forestry in general and coffee agroforestry in the coffee growing areas of Uganda. Consultations with the key stakeholders revealed that the different MDAs have continued to operate in isolation. Agroforestry extension continues to be relegated to civil society organizations who reply on short-term project funding.

National Coffee Policy (2013)

The goal of the National Coffee Policy is to guide and regulate activities of various stakeholders in the coffee industry so as to improve production, processing, marketing and roasting of coffee.

The Policy outlines the mission of the coffee industry as, "to increase coffee production, value addition and domestic coffee consumption". Based on this mission, the policy provides for increasing coffee production and productivity at farm level through majorly, adoption of good agronomic practices (proper spacing, pruning, mulching, etc.) at farm level, growing coffee in new areas and expansion in traditional coffee growing districts, use of high yielding, disease resistant and drought tolerant varieties and management of diseases and pests, among others (Policy Objective 1).

The Policy also provides for coffee specific extension service within the unified/centralized delivery systems, training of service providers in coffee specific extension knowledge, building the capacity and supporting farmer-led extension systems, and incorporating coffee extension training in the curriculum of agricultural tertiary institutions (Policy Objective 3). The participation of farmers is to be strengthened through mobilization and sensitization of farmers to form farmer organizations, which serve as important institutional arrangements for effective engagement in all stages of coffee vale chain (Objective 4). The Policy attempts to address environmental concerns. However, this is limited to the general rhetoric of "promoting the environmental and biodiversity conservation practices", which does not clearly provide guidance on how it can be implemented under the coffee production systems.

According to National Coffee Policy, farmers and farmers' organizations will among others, promote the adoption of sustainable coffee production systems. This provides opportunity for promotion of

coffee agroforestry. Academia will among others participate in coffee research in accordance with the NARS Act and develop/integrate coffee extension training in the curriculum for agricultural tertiary institutions. This offers an opportunity to engage tertiary training institutions during curricula development and review processes to integrate coffee agroforestry in to the curricula at various levels, including certificate, diploma and degree levels.

Uganda National Coffee Strategy 2040 and Plan for 2015/16 - 2019/20

The first strategic pillar under Uganda's national coffee strategy focusses on increasing coffee production and productivity at farm level in a sustainable way that addresses the social, ecological and economic dimensions. Specifically, it seeks to improve coffee production by rejuvenating existing trees and optimizing density with at least 10% of coffee smallholder farms being rejuvenated per annum. The strategy also seeks to improve coffee production by expanding the total area under coffee production by 30%, including an expansion of 5% in traditional coffee growing districts and 25% in new areas mainly in northern Uganda. Furthermore, the strategy is geared towards improving productivity per tree by using the best agronomic practices and improved genetic materials so that yield per coffee tree can be increased by 50%. The CAU's Youth for Coffee in Uganda Initiative will make a direct contribution to most of these strategic objectives and interventions since it is focusing on renovation and rehabilitation of coffee farms. These interventions will have a direct positive impact on coffee production and productivity.

Other national coffee strategic interventions and the possible contribution of Youth for Coffee in Uganda Initiative are presented in the table 1 below.

Table 1: Other proposed strategic interventions

Proposed strategic interventions	Contribution of Youth for Coffee in Uganda Initiative
Promote intervention to make fertilizer more accessible	Integration of trees in coffee (coffee agroforestry) has the potential to improve and sustain soil fertility if coffee fields
Promote intervention systems for control and management of pests and diseases	Coffee agroforestry has potential to minimize the severity of pest and diseases if the right amount of shade is maintained in coffee fields.
Promote irrigation systems for small and large-scale coffee production	Coffee agroforestry facilitates moisture retention in the system and will have more positive effects under irrigation systems.
Promote and support climate change adaptation and environmentally responsible practices	Coffee agroforestry is highly recommended for climate-proofing coffee farming systems

Proposed strategic interventions	Contribution of Youth for Coffee in Uganda Initiative
Develop reward systems for farmers who practice good conservation practices and promote and document use of indigenous knowledge in coffee production	Coffee agroforestry is one of the good conservation practices and can be used promote specialty coffee in Uganda. CAU could document the indigenous knowledge on coffee agroforestry and use information gained to improve the systems and promote the concept of shaded coffee in Uganda
Mainstream gender and youth in coffee production by identifying and developing value chain activities for women and youth	The training and equipping of 150 Youth Coffee Service Providers (YCSPs) to promote climate-smart coffee production and coffee R&R, and shall subsequently operate as private youth coffee service providers for farmers is an innovative way of engaging the youth in the coffee value chain

National Agricultural Extension Strategy for Uganda (2015-2025)

Objectives 1 and 3 of the national Agriculture and Extension Strategy for Uganda emphasize establishment of an agricultural extension delivery system and a mechanism for technology information packaging and disseminating. Specific objective 1.1 provides for establishment of an effective organizational and institutional framework for pluralistic agricultural extension services. While specific objective 3.1 provides for technology development, packaging and dissemination, there is no deliberate inclusion or mention of agroforestry extension in the agricultural extension delivery system. Given the general lack of forestry or agroforestry extension system in the district and sub-counties, it may be prudent to explore ways on integration agroforestry extension within the existing agriculture extension at the sub-county. This can be achieved through enhancing the capacity of existing agriculture extension staff through training and provision of extension materials like manual and guides where necessary.

National REDD+ Strategy

Uganda concluded the development of a National REDD+ Strategy and Agroforestry and other tree-based systems can contribute to REDD+ in 2 ways; first as part of REDD+ under certain forest definitions and secondly as part of a strategy for achieving REDD+ in landscapes.

Strategic option 1 provides for Climate Smart Agriculture, while Strategic option 7 emphasizes livestock rearing in the cattle corridor. The strategic options generally aim at reducing the need for agricultural expansion to forest areas by intensifying agricultural production and livestock management that could be implemented through SLM and agroforestry.

In the context of REDD+, agroforestry has the potential for reducing degradation by supplying timber and fuel wood that would otherwise be sourced from adjacent or distant forests. In fact, agroforestry has been used in the buffer zones of protected areas and within conservation as one way of allevi-

ating pressure on forests, thereby reducing deforestation. However, enabling market infrastructure, policies on tree rights and ownership and safeguards would be necessary for agroforestry and other tree-based systems in the landscape to effectively contribute to the goals of REDD+ and Nationally Appropriate Mitigation Actions (NAMAs).

b) Laws

National Coffee Act, 2021

The Act provides for the institutional arrangement for regulating all on-farm and off-farm activities in the coffee value chain. Specifically, the Uganda UCDA regulates, promotes and oversees the coffee sub-sector.

The Act provides for Coffee Extension Officers to be appointed by the Authority for the purpose of carrying out the following functions (Sections 10-12):

- a. Implement and supervise coffee nursery development programs
- b. Oversee compliance with established standard procedures and operating guidelines
- c. Implementing coffee extension programs developed by UCDA
- d. Promote and disseminate new technologies developed by coffee research to farmers
- e. Maintain surveillance on coffee diseases and pests
- f. Advise farmers on the control of coffee disease and pest control measures
- g. Liaise with and ensure effective collaboration with local authorities and other bodies with an interest in matters of coffee development;
- h. Participate in the development of work plans and budgets
- i. Provide technical support in the collection of data for coffee production and marketing;
- j. Monitor the quality of coffee and enforce coffee regulations
- k. Compile monthly reports on coffee activities; and
- l. Carry out any other function as the Authority may from time-to-time assign

Section 13 – provides for cooperation with other agencies.
1. The Authority shall cooperate with other ministries, departments, agencies of Government, and other organizations in implementing this Act

2. The Ministry shall, in consultation with the Authority and the body responsible for provision of agricultural extension services, coordinate the provision of coffee specific extension services, improved and recommended coffee varieties and technical support to farmers.

3. For the purpose of subsection (1), all ministries, departments, agencies of Government and other organizations shall accord to the Authority such assistance as may be necessary to ensure proper discharge of the functions of the Authority. This provision enables UCDA to reach out to and collaborate with any MDAs, local governments and other organization in areas such as provision specialist technical support, such as training in agroforestry practices

3.1.3 International and national frameworks relevant for agroforestry implementation

Sustainable Development Goals (SDGs)

Agroforestry as a land use system can contribute to achieving at least 9 out of the 17 Sustainable Development Goals (SDGs). Agroforestry is regarded as a key tool for both climate mitigation and adaptation, as trees help store large amounts of carbon and agroforestry practices are a way for farming households to increase their resilience to climate-related shocks. Agroforestry can be used to fight poverty and hunger, as the approach contributes to sustainable agricultural crop yields while providing diverse livelihood options for smallholder farmers.

Agroforestry improves household food security through sustaining on-farm production of food through soil fertility improvement. Agroforestry also increases biodiversity, as trees in agroforestry systems provide a habitat for multiple flora and fauna species, provide a "buffer zone" against deforestation and can act as a "green corridor", allowing species to migrate across landscapes for their survival. Agroforestry strengthens women control over resources and free up women's time. An example is that implementing agroforestry means a family will spend less time walking long distances looking for firewood in the forests. Since this is traditionally looked upon as a woman's job, accessing firewood at the doorstep increases personal safety, and provides more time for other income-generating activities.

The United Nations Convention on Biodiversity (CBD)

Uganda has signed and ratified the United Nations Convention on Biodiversity (CBD) and is very active in supporting the convention globally and is committed to implementing the convention nationally. Uganda's sixth (6th) National Report to the CBD (July 2019)[21] specifically recognizes the value of trees on farms for biodiversity conservation (under National Target 12[22]). One of the output indicators of National Target 12 is '*Significant increase in area and distribution of agro-forestry practices in the country; and number of women and men engaged in agroforestry practices*'. Trees on farms also help Uganda to meet other international commitments including atmospheric carbon sequestration and mitigating climate change under the Paris Agreement, forest and land restoration under the Bonn Challenge, where Uganda committed to restore 2.5 million hectares of degraded land by 2030, and food and nutritional security and livelihoods under the Millennium Development Goals (MDGs). The power of trees on farms to achieve multiple objectives including biodiversity conservation makes investment in agroforestry particularly attractive.

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[21] NEMA (2019): Sixth National Report to the Convention on Biological Diversity, Kampala, Uganda

[22] By 2020, management plans are in place and implemented for areas under agriculture, aquaculture and forestry

National Development Plan III for Uganda (2020 – 2025)

Uganda's third National Development Plan (NDP III)[23] recognizes the role of agroforestry in the restoration of tree cover. The plan acknowledges that the current restoration of forests and tree cover by natural regeneration or by plantation and agroforestry has not kept pace with the annual loss of forest cover and loss of individual trees. As a result, the forest cover has declined from 24 % (or 4.9 million ha) of Uganda's total land area in 1990 to 9% (1.83 million ha) in 2018, a reduction of 57 % in just 25 years. The plan therefore recommends scaling up of agroforestry as a climate-smart agriculture practice and as a sustainable intervention that can contribute to increased forest and tree coverage, and restoration and protection of hilly and mountainous areas and rangelands in Uganda.

Two of the 18 programmes under the NDPIII are explicit on enabling agroforestry as an intervention i.e., program 15 on Agro-industrialization and program 16 on Natural Resources, Environment, Climate Change, Land and Water Management. Operationalizing agricultural extension system under program 15 provides an opportunity to scale up agroforestry in the landscapes, including in the coffee farming systems of Uganda.

Program 16 provides for strengthening of conservation, restoration of forests, wetlands, and water catchments and hilly and mountainous areas. It also provides for promotion of rural and urban plantation development and tree planting including the local and indigenous species.

The Uganda Vision 2040

Chapter 5 of the Uganda Vision 2040 addresses elements of social transformation and includes a section 5.8 on Environment and Natural Resources. Paragraph 295 highlights the need to restore degraded lands through tree planting on private land. Paragraph 300 highlights the role of civil society organizations in environmental management. Paragraph 301 highlights the roles of women in environmental management and agroforestry interventions require participation of women at all decision levels.

3.1.4 Provisions that prohibit or are obstacles to agroforestry

The main obstacle of the existing laws and policies to agroforestry is the lack of explicit focus or reference to 'coffee agroforestry', where general terms such as farm forestry, are used. While UCDA has made effort to document the importance of incorporating trees in coffee (promoting shaded coffee), the *National Coffee Act (2021)* does not explicitly highlight coffee agroforestry in the different provisions of the Act. There is also no deliberate emphasis on the value of trees, their management and the resultant impact on coffee yield and quality.

Although Uganda's *Forest Policy (2001)* recognizes 'farm forestry' as one of its pillars, strategies to implement the same seem to be limited or incoherent.

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23 http://www.npa.go.ug/development-plans/national-development-plan-ndp/

3.1.5 Key actors in promotion of coffee agroforestry in Uganda

Uganda's coffee sector has a number of players that operate along the coffee value chain, including both state and non-state actors. This section of the report provides a highlight on each of the key coffee sector actors in Uganda, key intervention areas (such as coffee agroforestry), their role in coffee research and extension (including coffee extension structures) and associated challenges, with a focus on those interacted with during the field visits to the different CUA project sites.

a. Uganda Coffee Development Authority (UCDA)

The Uganda Coffee Development Authority (UCDA) is a government agency mandated to regulate, promote and oversee the quality of coffee along the entire value chain. The agency is also mandated to support research and development, promote production, and improve the marketing of coffee in order to optimize foreign exchange earnings for the country and payments to the farmers. UCDA field interventions are implemented through Regional Coffee Extension Officers (RCEO), who coordinate the raising and distribution of quality coffee seedlings to farmers. While UCDA encourages coffee agroforestry, the shortcoming is that UCDA only registers and certifies coffee nurseries, with limited focus on tree seedling nurseries. There is hardly any technical support to tree nurseries in terms of recommendation on appropriate coffee agroforestry trees, tree seedling raising and management of trees in coffee plantations.

Field interactions with the UCDA regional coffee extension officers revealed key challenges such as (i) lack of guidance on selection of appropriate coffee agroforestry tree species, (ii) conflicting messages on the value and impact of trees on coffee yield and pest and disease incidences, (iii) lack of an appropriate design of coffee agroforestry systems, (iv) poor quality tree seedlings and other planting materials and (v) poor management of trees in coffee by farmers. In terms of operational structure, the RCEO works directly with the respective District Production Department and the corresponding sub-county agricultural extension officers, with minimum interaction with the District Natural Resources Department. The Natural Resources Department (which is poorly staffed and funded), is where the District Forest Officer (DFO) falls that would be instrumental in supporting coffee agroforestry interventions. The DFO only develops a register of tree nurseries in the district but has no mandate to certify them, a key policy gap in the Department.

There are now calls to increase budgetary support to the natural resources department (including recruitment of forestry/ agroforestry extension officers at lower local governments) and create synergies for collaboration with the production Department. One of such opportunities for synergies could be realized for example where the Natural Resources Department undertakes environmental and climate change screening of projects for strengthening compliance with safeguards requirements[24]. This is the mandate of the Natural Resources Department under Section 19 of the Environment Act. 2019. UCDA is also in the final stages of recruiting Parish Coffee Development Assistants (PCDAs) to support coffee extension at the lower local government levels.

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24 https://www.mwe.go.ug/library/environmental-guidelines-local-governments-strengthening-compliance-safe-guards-requirements

b. National Coffee Research Institute (NaCORI)

The National Coffee Research Institute (NaCORI) is one of the 16 Public Agricultural Research Institutes (PARIs) under the umbrella of the National Agricultural Research Organisation (NARO). NaCORI's mandate is to conduct and manage basic and applied research of strategic nature and national importance in all fields pertaining to coffee and cocoa. NaCORI came into existence in 2014 in response to the National Coffee Policy (2013) geared towards generating, developing and promotion technologies, methods and knowledge to improve production and productivity of coffee and cocoa in Uganda. NaCORI has developed an investment roadmap and tools to enable the modernization of coffee breeding, including molecular and biochemical tools to support variety improvement and seed systems in Uganda. The institute is also developing effective coffee seed systems that enhance farmer access to improved coffee varieties through establishment of multi-locational trials around the country.

NaCORI delivers its technologies to the intended users through existing government structures and institutions such as UCDA and none state actors such as farmer cooperatives.

c. National Forestry Resources Research Institute (NaFORRI)

The National Forestry Resources Research Institute (NaFORRI) is the NARI mandated to undertake research in all aspects of forestry, including agroforestry. Research in NaFORRI aims at increasing the benefits derived from trees and forests through conservation and sustainable management of the forest and tree resources for improving livelihoods, economic growth and natural resource conservation. NaFORRI conducts research in forestry and allied resources, to ensure their efficient and sustainable use. The overall objective of NaFORRI is to enhance scientific innovations, skills, information and policy advice for increased productivity, conservation and sustainable use of forest and tree resources.

The agroforestry research program is one of four research programs of NaFORRI and aims at unlocking the vital potential for agroforestry to increase productivity, profitability and diversity of farm production in Uganda. The mandate of the Agroforestry Research Program (ARP) is to generate and disseminate technologies for growing trees on farms in order to optimize crop and livestock productivity, provide multiple tree products and conserve natural resources. This mandate involves working closely with farmers and other stakeholders in developing options and approaches for maximizing benefits from integration of trees on farms. The program is also responsible for developing strategies for wide-scale adoption of agroforestry technologies for impact, as well as strengthening stakeholder capacities to interface with agroforestry interventions at different levels.

The ARP at NaFFORI has implemented a number of projects and studies related to coffee agroforestry, including the T4FS project, VIP4FS project and the ROBUST projects. The different studies and interventions implemented under each of these projects have been highlighted in section 3.1.6 of this report.

d. Uganda Coffee Farmers Alliance (UCFA)

The Uganda Coffee Farmers Alliance (UCFA) is a farmer owned apex organization of various producer

organizations that serves as a marketing agent for its constituent farmer organizations. The primary objective of UCFA is to increase farmer incomes through supporting the development of competitive-ness of farmer organizations through efficient market linkages. UCFA acts as their principal support unit at regional and national levels, while assisting in the establishment of direct commercial contact with exporters and traders. The alliance also facilitates cooperation and strategic exchange with local support structures as well as providing coaching of farmer organizations to strengthen performance in their operations.

UCFA seeks to continue creating opportunities for smallholder coffee farmers to process and trade their coffee more competitively by promoting cooperation among their farmer organizations. The ul-timate goal for the UCFA is to sustainably increase net farm incomes of dedicated coffee farmers by creating an efficient market channel for their organizations. The field interactions held with UCFA staff in Luwero revealed the tremendous work being implemented within coffee growing communities. In Luwero, UCFA is currently working with 24 farmer cooperatives and each cooperative has 300-400 members. The alliance has the capacity to process and grade coffee at the factory located in Luwero, offer extension services, provide agricultural inputs to members and market their coffee.

UCFA emphasizes the need to integrate trees in coffee farming systems, since shade is important for coffee. However, the management of shade is equally important, because too much shade affects proper growth and performance of the coffee trees. Communities are generally not aware about the good practices of tree management and selection of appropriate tree species. "*The farmers who have full shade or no shade usually experience low coffee production, while those with medium shade have high production*" said the UCFA Team Leader for greater Luwero region. High shade tends to increase incidence of fungal diseases and pests which thrive under the cool local environment, while lack of shade increases desiccation. The performance of the coffee in the field is eventually reflected in the coffee quality in terms of the weight of the coffee milled at the factory. The main grades are, Screen 18 (best), Screen 15 and Screen 12 (Figure 3).

Figure 3: *Different coffee quality categories at the UCFA factory in Luwero*

Generally, the coffee under poor agronomic practices, e.g. under heavy shade produces coffee beans of low weight. According to UCFA team leader, the weight of coffee is a function of farming practices. The team is able to tell which farmer is using good agronomic practices on their farm from the quality of coffee delivered to the factory.

The incentives provided by UCFA to encourage farmers to undertake good agronomic practices include provision of fertilizers, recruitment of an agroforestry extension officer to provide free extension services to member organizations, lower coffee processing charges for members, free demonstration of coffee R&R to at least 20% of the coffee garden of selected members. UCFA acknowledges that there is only a loose link among different coffee partners and coffee extension is usually done in isolation, sometimes with conflicting messages, especially on the role of trees in coffee farming systems.

e. Ankole Coffee Producers Cooperative Union (ACPCU)

The Ankole Coffee Producers Cooperative Union (ACPCU) is a farmer-owned export coffee co-operative union that was founded in 2006, currently with over 8,200 members. The union is composed of multi-ethnic communities stretching across the mountains of South-Western Uganda working together as progressive, forward-thinking farmers to market their coffee and improve their livelihoods. ACPCU is deliberately taking measures to adapt sustainable farming practices: for example, reducing soil erosion by building terraces and planting trees; boosting soil fertility with nitrogen-fixing plants, mulch, homemade compost and animal manure; and promoting biogas to reduce the need for cutting down trees for firewood for cooking.

The union has adopted a trust policy that builds trust by ensuring tailor made products and consistency to satisfy companies, individuals and families by appreciating what they value. It strives for perfect production and no waste by creating opportunities to apply sustained improvement attitude to deliver a competitive advantage while guaranteeing excellent quality and total compliance and involving everybody's commitment and teamwork across the value chain at all levels to build the union firmly. The union processes, grades and markets coffee, making use of local human resources through the value chain. For example, the union employs coffee agronomists that support on farm activities and women are employed at the last phase of coffee cleaning prior to packaging and export (Figure 4).

Figure 4: *A section of women sorting coffee at ACPCU factory in Sheema*

The union has taken deliberate steps towards promotion of coffee agroforestry by raising and supplying tree seedlings to members. The predominant tree species being promoted for coffee agroforestry are *Grevillea robusta* (Figure 5), *Cordia africana* and *Measopsis eminii*. Some coffee farms also have Albizia coriaria, which have been raised from wildings. However, the existing *Grevillea robusta* trees appear to be predominantly planted as boundary trees, rather than scattered in coffee gardens. The tree also appears to be over pruned in the field for firewood and stakes for climbing beans. Despite ACPCU efforts to promote tree growing in coffee systems, most of the coffee farms in the communities are still majorly banana-coffee systems, as farmers argue that bananas are integrated for household food security and provide better shade for young coffee in the field.

Figure 5: *A section of a tree nursery run by ACPCU within the factory premises*

f. The Coffee Gardens

The Coffee Gardens is a private entity that collaborates with smallholder farmers to secure higher incomes and grow their businesses for themselves and future generations. The company produces specialty arabica coffee that is fully traceable and produced to high ethical standards (Figure 6). In 2018, the company set up micro-coffee processing station in the Bukyabo valley in Sironko district, with strict processing practices using state of the art equipment and mobile tools to track each batch of coffee from the gardens to the store. Working with over 500 farming households, the company offers above market prices, undertakes trainings and access to finance, as a motivation to farmers for higher cup scores, creating an incentive to improve coffee growing practices.

Figure 6: *A section of the coffee drying area at the processing station*

In terms of farmer extension, the company has employed about 5 full-time staff that provide technical support to farmers, while playing key roles at each stage of the processing station (Figure 7). A number of local communities are also employed including (i) the 'Runners' who carry coffee from the buying centre down to the processing station, and (ii) women carefully turn and sort the coffee on the driers. Farmers sign contracts to provide good quality coffee to the station and are assured of good prices. This in a way has built the trust of farmers that are now willing to only harvest ripe cherries for delivery to the station. Farmers are willing to look at the long-term benefits due to the incentives that come with the contracts signed with the company. They are also able to access tree seedlings and credit.

Figure 7: *Some of the Coffee Gardens staff interacting with the consultants at the station*

The company has supported farmers through provision of free seedlings totaling to 8,000 comprising *Albizia coriaria, Measopsis eminii, Ficus natalensis* and a variety of fruit trees. The main challenges faced by the company while dealing with farmers include (i) lack of adequate training content on coffee agroforestry, (ii) majority of the existing trees in coffee farms are mature trees, this deters farmers from planting new trees, (iii) there are negative attitudes towards tree growing as some farmers think trees grow by themselves and prefer planting only fruit trees and (iv) low seedling survival in the field. The company envisages that having a sustainability component such as having community tree nurseries, instead of buying seedlings would encourage tree growing in the community. This could be supplemented by having ToTs on tree management in the community to enable adequate management of trees in coffee systems. The company also encourages transparency, through their annual Impact and Transparency reports through which the company is able to share what they do with the farming community, the breakdown of the costs directly **associated with producing coffee, how much farmers earn and who** the partners are. Such undertakings build trust of the farming communities towards the company and the information shared with them.

3.1.6 Projects and programs on coffee agroforestry in Uganda

a. Youth for Coffee in Uganda project (on-going)
The GCP Youth for Coffee Initiative in Uganda is a collective action undertaking that aims at reducing the living income gap for small holders and increase sustainable coffee production through the development, testing and dissemination to public and private coffee extension programmes of a Rehabilitation and Renovation (R&R) delivery model for traditional coffee farmers in Uganda. Café Africa Uganda is implementing this Global Coffee Platform (GCP) Youth for Coffee Initiative in Uganda via the Uganda Coffee Platform (UCP). The program aims at testing and sharing a universally applicable delivery model for R&R and Agroforestry practices in smallholder mixed coffee farms. This is being

done through training and equipping 150 Youth Coffee Service Provider businesses (YCSPs). The YCSPs are trained in coffee climate-smart coffee production and R&R, and subsequently operate as private youth coffee service providers for farmers at a fee. The YCSPs are also being assisted to set up shade and agroforestry tree nurseries for distribution to participating farmers, with a view of increasing shade and multipurpose tree cover in coffee. The initiative is currently being rolled out in the Districts of Gomba, Luweero, Sheema and the Elgon region for both robusta and arabica farming communities. The project also intends to create convening spaces for stakeholders in Uganda to explore agroforestry and landscape forest governance as possible climate-smart investment pathways in the coffee sector.

b. Trees for Food Security Project (2014 – 2021)

The 'Developing integrated options and accelerating scaling up of agroforestry for improved food security and resilient livelihoods in Eastern Africa' project also known as Trees for Food Security phase 2 (T4FS-2) was an Australian Centre for International Agricultural Research (ACIAR) funded project that aimed at improving food security and smallholder livelihoods through the widespread implementation of appropriate locally adapted agroforestry practices in key agricultural landscapes in Uganda, Rwanda and Ethiopia. In Uganda, the project was implemented around Mount Elgon region from 2017 to 2021. The project was coordinated by ICRAF in partnership with: NaFORRI; Makerere University (MAK); World Vision Uganda (WVU); Mount Elgon Tree Growers Enterprise (METGE); African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE) and Commonwealth Scientific and Industrial Research Organization (CSIRO). The project undertook several studies relating to tree adoption, management of tree-crop interactions in coffee agroforestry systems, youth and women empowerment in agroforestry and facilitated an agroforestry curriculum assessment for universities and colleges in Uganda.

Establishment of farmer participatory trials by the project enhanced an understanding of factors influencing smallholder farmers' intention to adopt agroforestry[25]. Findings from this study indicated that farmers' positive evaluation of shading coffee and the perceived capability to overcome tree planting barriers reinforced their intention to integrate trees in coffee. This renders attitude and perceived behavioral control as reliable predictors of farmer tree planting behavior. Another related study to identify differences in farmer motivations to adopting agroforestry practices in the Mt. Elgon region of Uganda[26] showed that 40% of the variation in farmer motivation to integrate trees in their coffee plantations was explained by the significant variables of 'attitude' and 'perceived behavioural control' among farmers actively participating in the project. However, farmer motivation resulting from social pressure was strongest among farmers who had never interacted with the project, and in the absence of project interventions, rely on existing social structures to drive change in their community. The findings indicate that psychological factors are key drivers to the farmers' internal decision-making process in agroforestry technology adoption and can be context specific. The adoption behaviour of

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25 Buyinza, J., Nuberg, I. K., Muthuri, C. W., & Denton, M. D. (2020). Psychological factors influencing farmers' intention to adopt agroforestry: a structural equation modeling approach. Journal of Sustainable Forestry, 39(8), 854-865.

26 Buyinza, J., Nuberg, I. K., Muthuri, C. W., & Denton, M. D. (2020). Assessing smallholder farmers' motivation to adopt agroforestry using a multi-group structural equation modeling approach. Agroforestry Systems, 94(6), 2199-2211.

smallholder farmers is mainly shaped by existing community social norms and beliefs that tend to promote knowledge exchange, as opposed to the conventional knowledge transfer extension approaches.

Through the project, sap flow meters were deployed on stems of three selected trees each of *Cordia africana* and *Albizia coriaria* on-farm. Results showed that there was a significant main effect of the interaction between tree species and season on daily water use[27]. The two species showed contrasting patterns of seasonal water use across leaf shedding stages characterized by episodes of reverse flow in *Albizia coriaria* at specific periods of the year. In another study, sap flow meters (SFM1s) were used to monitor the impact of pruning on tree water use in *Cordia africana*, *Albizia coriaria* and *Coffea arabica* trees in two farms in Eastern Uganda. The trees were subjected to a 50% pruning regime at a 6-month interval over a period of 20 months. The results showed that agroforestry tree canopy pruning reduced the water demand of trees, triggered reverse flows in the water conducting xylem tissue of Cordia trees and altered the leafing phenology of Albizia trees to recharge the coffee rooting zone. The knowledge generated can be used to match smallholder farming systems' water requirements with expected soil water availability, to manage competition for water.

Another project study on factors affecting adoption of agroforestry by women and youths showed that land size and family size affected adoption decisions. Land scarcity, seed shortage, lack of market and limited technology were among the challenges identified. The motivations however, involved farmer trainings, rising demand for tree products and access to free seedlings. The project also facilitated an assessment of the curriculum on agroforestry and extension for eight tertiary institutions, including: Busitema University, Bukalasa Agricultural College, Ndejje University, Makerere University, Gulu University, Nyabyeya Forestry College, Busoga University and Uganda Christian University. Findings from the assessment revealed that the agroforestry curriculum is comprehensive and rich in content though most of the teaching has been delivered in theory. Some relevant agroforestry content is missing in the curriculum notably: developing agroforestry interventions, biodiversity conservation, environment management, landscaping, modelling agroforestry systems and nutrition and food security.

c. Value chain Innovation Platforms for Food Security (VIP4FS) Project (2016 – 2019)

This ACIAR supported Value chain Innovation Platforms for food security (VIP4FS) project was implemented in Uganda and Zambia by ICRAF, in partnership with NaFORRI, Makerere University, World Vision Uganda (WVU) and Kapchorwa District Landcare Chapter (KADLAC). The project identified key issues in unlocking the potential of smallholders and rural entrepreneurs as lack access to innovations, appropriate skills and market information. Through this project, a better understanding on what makes value-chain Innovation Platforms (IPs) successful (including institutional, partnership, technological, market and policy) was achieved. Three strategic IPs namely honey, coffee and dairy were formed in Uganda.

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27 Buyinza, J., Muthuri, C. W., Downey, A., Njoroge, J., Denton, M. D., & Nuberg, I. K. (2019). Contrasting water use patterns of two important agroforestry tree species in the Mt Elgon region of Uganda. Australian Forestry, 82(sup1), 57-65.

The coffee innovation platforms (whose members had shaded coffee) registered high success in Kapchorwa, where different coffee farmer groups came together to form an IP. The project facilitated multi-stakeholder meetings where IPs were able to identify solutions to challenges faced along the coffee value chain. The IP members were then trained on coffee harvesting and drying, and were subsequently connected to a coffee roaster in Australia who would provide a better price. The coffee roaster was mainly interested in specialty coffee, which was harvested from shaded coffee. The project promoted coffee agroforestry through raising and distributing tree seedlings (including *Albizia coriaria, Cordia africana* and *Calliandra calothyrsus*) to the IP members. The coffee roaster also developed a mechanism where he would share part of the profits with the IP members as a motivation to keep harvesting ripe cherries. There was a demonstrated interest from key coffee stakeholders to integrate IPs into agricultural extension programs. However, there is still need to strengthen and operationalize the coffee IPs for sustainable food and income production systems beyond the project lifespan.

d. Robusta coffee agroforestry to adapt and mitigate climate change in Uganda (ROBUST) Project (On-going)

This EU funded project aims at promoting coffee agroforestry, and protect it against the negative impact of climate change. The intervention follows a multi-stakeholder approach to demonstrate innovation and demand-led steering of research for improved resilience of robusta agroforestry systems to reduce climate change impact on coffee production. Considering future needs of the sector, the project is also undertaking measures to initiate the selection of drought resistant germplasm. The project partners include the French Agricultural Research Centre for International Development (CIRAD), Makerere University, UCFA, NaCORI, NaFORRI, Strand Ltd., and the International Centre of Insect Physiology and Ecology (ICIPE).

The implementation of the project uses a two-tier approach; Tier 1 focuses on conducting research through scientific collaboration between local and international institutions to improve coffee productivity. The three pillars of research are (i) tree-based diversification and restoration, (ii) selection and conservation of drought tolerant robusta coffee germplasm), (iii) soil health preservation (including carbon-sequestration ability) and (iv) control of invasive/emerging pest and disease (including climate data collection and management). Pillar 2 is concerned with promoting adoption of Good Agronomic Practices (GAPs) for coffee-agroforestry systems through capacity building, knowledge-sharing, and improved access to market.

One of the key decision support tools under the project include use of microbial indicators as guidelines for a better agroecological management of coffee agroforestry systems surveillance strategy for predicting plant behaviour regarding future pathogen attacks based on plant microbiota monitoring. The capacity building initiatives include long -term on-station agronomic coffee agroforestry trial installed at the NaFORRI research station, establishment of community tree nurseries, train at least 20,000 farmers on various aspects of climate-smart coffee product (Pest IPM, soil science) and agroforestry and train at least 4 masters and 8 PhD students.

3.2 Farmers' opinion, pressures and challenges faced in implementing forest and agroforestry practices in the coffee growing areas

3.2.1 Pressures farmers face

a. Increasing demand for forest and tree products

Forests and trees support livelihoods of the majority of communities, including provision of fuelwood, timber, poles, etc. the increasing demand for these products is forcing many farmers to cut down trees from their farms at rates higher than they are replanted. Therefore, the shade trees within the coffee-agroforestry systems are threatened.

b. Increasing land fragmentation

The small household land size has a significant influence of the size of land allocated to tree planting because of the competing pressure for agricultural land. Nationally, approximately 80 percent of households hold less than three hectares (7.5 acres). According to the Annual Agricultural Survey[28] the average landholding in Bushenyi is 1.31 ha (3.32 acres), and that of Mt. Elgon region is 0.77 ha (about 2 acres). The stakeholders in Luwero indicated an average landholding of 1-3 acres. With the population growth rate of 3.1%, the already small pieces of land are likely to be fragmented to smaller pieces.

3.2.2 Challenges

a. Institutional arrangements and associated challenges

The review revealed that agricultural extension service and advisory service delivery is generally scattered under (i) Mainstream MAAIF, (ii) Uganda Coffee Development Authority, NAADS/ Operation Wealth Creation (OWC), (iv) Local government structures – Departments of Production, Natural Resources and Community Development, and (v) a number of non-state actors, all reaching out to the same farmers. This has led to distorted messages to farmers regarding agroforestry in general and coffee agroforestry in particular, and the importance of trees in coffee systems.

b. The choice of the coffee-agroforestry combination

Farmers' opinion, perceptions and attitudes towards coffee agroforestry have some commonalities and differences across the four project sites (Luwero, Gomba, Sheema and Sironko). The role of shade trees in coffee is well appreciated across all the sites as farmers are aware of the advantages of integrating trees with coffee, including provision of organic matter, modification of the micro climate and ultimately leading to better performance of coffee, as well as the contribution of fruit trees to food and nutritional security. The key cross-cutting issue with shade trees is selection of appropriate agroforestry tree species, lack of good quality tree planting materials and poor management of the existing trees in coffee. These issues have not been given priority in the existing government extension structures as the focus has been given to agricultural crops.

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28 Uganda Bureau of Statistics (UBOS), 2020. Uganda Annual Agricultural Survey 2018. Kampala, Uganda; UBOS

While there were differences in opinion about which trees are good/ friendly and bad to coffee across the sites, there is a general belief that all fruit trees are friendly trees and easily acceptable by farmers. Other trees considered friendly to coffee include A*lbizia coriaria, Ficus natalensis, Ficus mucuso, Cordia africana, Melicia excelsa* and Grevillea robusta. The trees considered bad/not friendly to coffee are those that are believed to harbour and promote pests and diseases (especially black coffee twig borer), and those with high water uptake and tend to dry up the land. Majority of the farmers reported *Albizia chinensis, Measopsis eminii* and Eucalyptus spp as 'bad trees' for coffee.

Some communities prefer shading their coffee with bananas as opposed to trees. This was predominant in Sheema, where farmers tend to prefer having coffee-banana systems as opposed to coffee-tree systems (Figure 8). The main driver for this appears to be its contribution to household food security. Some farmers claim that bananas provide a better and faster shade than trees, thus providing cover to young coffee gardens and ultimately improving coffee seedling survival in young coffee plantations.

Figure 8: *A typical coffee – banana system with trees planted at the boundaries in Sheema district (Photo by Joel Buyinza)*

The choice of a coffee agroforestry combination (whether with bananas or trees) is mainly driven by household food security and potential for generating additional income. Most communities prefer integrating bananas in their coffee systems as a way of ensuring food security (Figure 9). Other farmers reported that bananas provide better and quick shade to young coffee seedlings in the field, while a tree seedling would take a while to create the much-needed shade by the tender coffee.

Figure 9: *A mature coffee garden integrated with bananas in Sironko*

The other option farmers have is to have bananas and trees all integrated in the coffee but care should be taken to avoid overcrowding the garden. This would require an appropriate design of such a system. For example, farmers may need to first introduce the bananas in the young coffee and subsequently replace them with tree seedlings. Some farmers have innovated a way to maximize the temporal existence of bananas and trees in the coffee systems. Here farmers first introduce the banana in the young coffee, then the tree seedlings are later introduced in the garden after the first harvest of the bananas. Tree seedling survival is enhanced by planting the seedling just next to the banana plant, but care taken to ensure adequate spacing of the tree seedlings, depending on species.

For farmers with both bananas and trees in their coffee, they reported that broad leaved trees such as *Cordia africana* and *Milicia excelsa* are unfriendly to the bananas in such a system. This may be attributed to the excessive shading that such broad-leaved trees provide, leading to etiolation (extended vertical growth) of banana plants in search for light.

c. Conflicting extension information to farmers

Interactions with a number of stakeholders in the field revealed that there were conflicting extension messages about the value of tree shade in coffee systems and their management, including recommended tree species to be grown under coffee-agroforestry system, the spacing, maintenance and associated social and economic benefits. As an example, the focus group discussion with stakeholders in Luwero District observed what they considered to be conflicting messages, saying,

"...... at one time Government (UCDA and local governments) informed is to cut down the trees from coffee gardens. And now, the same agencies are promoting tree growing in coffee systems."

To the farmers, this appeared like the same Government sending conflicting messages to them. When government told farmers to remove all trees in their coffee, the intension was to eliminate the species that were known to host coffee pests and diseases, such as the black coffee twig stem borer. However, this was not effectively communicated to farmers and may affect subsequent government tree planting interventions.

d. Limited knowledge and skills for integrating agroforestry in coffee farming landscape

Farmers need the right information on the most appropriate tree species to be integrated under the coffee farming system. Many tree species that had been planted by farmers visited in Luwero were not suitable apparently because they are alternative hosts of coffee diseases and pests, such as the black coffee twig stem borer, and these needed to be eliminated from gardens. Such trees are now being replaced by the tree species that are not hosts. Also, some tree species were associated with high water uptake and tend to dry the land and stress the coffee, others.

The communities are generally not aware about the good practices of determining appropriate tree species, spacing them and pruning to ensure maximum coffee yield. It is increasingly becoming difficult for farmers to select the appropriate tree species for integration in their coffee systems. In some communities, for example in Gomba, it was difficult for farmers and other stakeholders to identify what they would regard a friendly tree as almost every tree species suggested was queried during field discussions. It was however observed that the lack of deliberate management of shade may have led to such divided opinions.

e. Lack of deliberate effort to manage shade trees

It was reported that some actors have openly portrayed trees as the main cause of increase pest and disease incidences in coffee under shade. Our findings from field observations and stakeholder consultations indicate some relationship between dense shade and increased pest and disease incidences (Figure 10). This is mainly attributed to limited knowledge on required tree density on coffee fields and poor management of shade by farmers.

Figure10: *A coffee farm in Luwero with a dense canopy that hardly allows in sunlight (Photo by Joel Buyinza)*

The management of shade is important because too much shade affects proper growth and performance of the coffee trees. It was also observed that there were no known pruning regimes for shade management of most of the agroforestry tree species being promoted and no appropriate agroforestry designs were in place to guide farmers. Farmers usually scatter trees in their coffee gardens with no regard to spacing, species selection and combinations in coffee systems. This observation conforms with recent studies, which have demonstrated that farmers have not adopted tree canopy pruning as a deliberate on-farm practice, but only remove branches of trees when there is need for fuelwood, timber or poles[29]. Besides, there are no agroforestry designs and pruning regimes for agroforestry tree species. Farmers have to deal with the negative effects of the tree component well after their establishment. For example, a farmer is unable to cultivate below densely shaded systems as they lack knowledge on tree management (Figure 11).

Figure 11: *A section of a coffee garden with no coffee/crop below the dense shade of a mango tree in Luwero district*

f. Weak institutional arrangement for implementing agroforestry

In principle, tree growing is coordinated by the Ministry of Water and Environment through the Forestry Sector Support Department (FSSD) but coordination of agriculture is a function of the Ministry of Agriculture Animal Industry and Fisheries (MAAIF). However, the multi-sectoral nature of agroforestry demands multi-sectoral collaboration rather than working in silos. Agroforestry is well articulated in Uganda's national priorities, predominantly under MWE and some elements are in MAAIF under SLM strategy. In addition, research in forestry together with agroforestry is a mandate of the National Forestry Resources Research Institute (NaFORRI) which is one of the institutes under the National Agriculture Research Organization (NARO) that principally is under the MAAIF, and maintains rather adhoc and project-based linkages with other actors, especially local governments and communities, where implementation of agroforestry initiatives takes place.

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29 Buyinza, J., Nuberg, I. K., Muthuri, C. W., & Denton, M. D. (2021). Farmers' Knowledge and Perceptions of Management and the Impact of Trees on-Farm in the Mt. Elgon Region of Uganda. Small-scale Forestry. doi: 10.1007/s11842-021-09488-3

It is also noted that forestry extension services are decentralized to the local governments, which have a loose link to FSSD under MWE. The structure of local governments is such that extension service delivery is provided under the Department responsible for Agriculture (Production Department). While the Production Department has extension staff at sub county level, the department of Natural Resources is only staffed at the district level with some having one or two forest rangers and or guards. Both the Production department and UCDA extensively promote coffee growing with limited effort towards promotion of tree growing in coffee systems. Hence, service provides in districts have been supplying coffee seedlings to farmers but without catering for seedlings of tree species that provide shade to protect and enhance productivity of the coffee. This anomaly would not arise if UCDA and the departments of Production and Natural Resources in respective districts were closely working together. This situation has to a great extent hampered the wide-scale promotion of agroforestry in Uganda.

g. Transitory nature of farmer-based research and development projects in agroforestry

Farmers have to deal with challenges associated with the numerous research and development projects in their communities. The Short-term nature of such projects (usually lasting 2-5 years) is a key setback, yet benefits/ impacts from most agroforestry interventions take long to be realized. The packaging of research outputs has been done in ways difficult for the farmers to understand or comprehend. Additionally, the lack of sustainability strategies beyond project lifetime resulting from; (i) inadequate institutionalization of projects within existing government structures such as local governments at district and sub county levels and (ii) inadequate use of social networks in promoting the agroforestry research agenda.

h. Absence of a Uganda National Agroforestry Strategy

Majority of the stakeholders consulted contend that the lack of a national strategy on agroforestry is a key hindrance to promoting agroforestry in Uganda. However, there are on-going efforts to develop a national agroforestry strategy under MWE. The development of the National Agroforestry Strategy for Uganda has been spearheaded by MWE, VI Agroforestry, ICRAF and the Uganda National Farmers Federation (UNFFE). The final draft of the strategy is now undergoing high-level review and harmonization by the MWE and MAAIF. It's hoped that the two ministries will soon agree on the modalities for approval and implementation of the strategy. The strategy focuses on 6 key strategic interventions in the following thematic areas:

a. Coordination and institutional arrangements
b. Capacity development
c. Technology development and innovations
d. Knowledge management, extension and access to appropriate inputs;
e. Value Chain development, and
f. Financing

As this strategy is been completed, it's important to explore integration of key issues on coffee agroforestry so that it can receive attention during its implementation.

3.2.3 Stakeholder opinions on what needs to be done

Below we provide an outline of what farmers and stakeholders think should be done to promote forests and agroforestry in coffee growing areas in Uganda.

1. Review the approach to extension work to emphasize hands-on training. There is need for demonstrational learning to provide farmers with hands-on knowledge and skills on managing their coffee gardens and building linkages between good agronomic practices and quality of coffee. The farmers are usually convinced more easily by their fellow farmers than through the traditional extension staff. Therefore, policy interventions should aim at integrating farmer-to-farmer extension approach in collaboration with technical staff at sub-county level to enhance their knowledge in tree growing and shade management.

2. Agroforestry research and development projects should be institutionalized within government structures and ensure appropriate use of social network as channels of scientific information communication

3. There is an urgent call for the expeditious completion of the draft national agroforestry strategy that is currently under review in the Ministry of Water and Environment (MWE) and MAAIF. This will provide an avenue for a clear implementation roadmap for trees on farms.

4. Data on trees on farms need to be systematically collected and synthesized for public use. For example, the Annual Agricultural Survey and National Population and Housing Census conducted by the Uganda Bureau of Statistics (UBoS) needs to integrate assessment of the contribution of trees on farms to household needs, for example, nutrition and incomes. Additionally, the National Forest Management System needs to include trees on farms in the National Forestry Inventory and other environmental accounting systems for Uganda.

5. At household and farm levels, creating incentives will spur the growing of trees on farms. These include providing quality tree seedlings and other planting materials, extension support and practical training on undertaking good agronomic practices, provision of fertilizers, low-cost coffee processing services and development of agroforestry-based value chains to meet domestic and regional market demands.

6. Promote use of a cluster approach, where farmer groups jointly apply for a government intervention/ support. This was observed in Sironko district where an investment cluster (Mutufu Investment Cluster) is seeking government support to multiple farmer groups through the office of the Chief Administrative Officer. If funded, such an approach encourages collective action and ownership of the interventions.

7. Empowering the youth to actively participate in coffee agroforestry, e.g., the CAU approach of training and equipping the youth to undertake coffee rehabilitation and renovation should be supported.

3.2.4 Good practices and opportunities for advancing integration of forest and agroforestry practices in local policies

1. Participatory selection of appropriate tree species for integration in coffee farming systems is key to advancing coffee agroforestry among smallholder farmers. Farmers need to take a central role in selecting tree species for coffee agroforestry systems, since they interact with these systems on a daily basis. Farmers associate some tree species with coffee pests such as the black coffee twig borer associated with *Albizia chinensis* and *Maesopsis eminii*.

2. Appropriate agroforestry tree management practices include adequate spacing at planting, selection of good coffee variety for planting, appropriate application of organic fertilizers, appropriate weeding regimes and training of the coffee. Similarly, practices such as coffee stumping (rehabilitation and renovation of the old coffee stand (normally at 7 years and above) enhances coffee productivity.

3. Control of the tree shade is a fundamental on-farm practice that should be embraced by smallholder farmers. Farmers consulted noted that the gardens which had full shed had low production of coffee. Poor management of shade has been associated with increased pest and disease incidences in coffee agroforestry systems. We provide documented remedies for the coffee black twig borer in Table 2 below.

Table 2: Documented remedies for coffee black twig borer

Prevention	Monitoring	Direct control
• Keep a weed-free coffee field	• Use ethanol baited traps (pour the ethanol in empty water bottles and create two holes on each side) to monitor populations and outbreak	• Prune/cut and burn all infested branches/twigs.
• Apply organic manure/fertilizer to promote good plant health and vigour	• Check daily for the presence of wilting, yellowing, dry/dead small branches/twigs with small holes (bicycle spoke size) at the entry point especially during the dry season.	• Provide additional water if available during dry period.
• Promote good soil and water conservation practices	• Split the affected branches to check for presence of a white spongy (fungal) growth and small light brown to shiny black beetles	• Encourage other farmers within the area to control the twig borer

Prevention	Monitoring	Direct control
• Regularly monitor for the presence of twig borer symptoms on alternative host such as avocado, cocoa within proximity of a coffee field.	• Look out for light green leaves of infested branches on coffee plants	• Promote tree health and vigour. This will help with resistance to infestation or recovering from attack.
• Avoid alternative hosts in the garden – e.g Albizia chinensis, Maesopsis eminii, Ficus natalensis & Avocado	• Look out for withered leaves	• Use systemic chemicals on affected branches/ twigs.
		• Biological control through mass rearing of natural enemies – but still requires further knowledge of its biology and ecology

Sources of this information include[30,31]

There seems to be limited focus on deliberate shade tree management as an on-farm management option for BCTB control. Our field observations and the stakeholder interactions tend to point to poor management of tree shade as the major accelerator of BCTB infestations in shaded farming systems.

3.3 Lessons from other countries

In this section, we provide an international perspective with respect to on-going coffee agroforestry policy and practice intervention in Ethiopia and Costa Rica in Central America. The selection of these countries was primarily based on their current coffee production and export records[32] as well as key coffee related research, production and policy interventions that have spurred coffee production in these countries.

3.3.1 Coffee agroforestry in Ethiopia

As a leading coffee producer in Africa, Ethiopia has extensively promoted coffee agroforestry development, extension and governance over the years. Unlike in Uganda, studies in Ethiopia have reported high adoption levels of deliberate shade tree management among farmers (up to 70%) with shaded coffee[33]. The predominant tree species integrated in coffee farming systems in Ethiopia include *Cordia africana,*

30 Lina W (2016). Infestation and management of the Black coffee twig borer in Uganda - and the potential impact of the leguminous tree Albizia chinensis on robusta coffee. Independent project/Degree project / SLU, Department of Ecology. https://stud.epsilon.slu.se/9644/1/wu_l_161010.pdf

31 https://worldagroforestry.org/news/ecologically-inhibiting-black-coffee-twig-borer

32 List of countries by coffee production - Wikipedia

33 Waktola T.U, Fekadu K (2021). Adoption of Coffee Shade Agroforestry Technology and Shade Tree Management in Gobu Seyo District, East Wollega, Oromia. Advances in Agriculture, vol. 2021, Article ID 8574214, 13 pages, 2021. https://doi.org/10.1155/2021/8574214

Erythrina abyssinica, Albizia gummifera, Vernonia amygdalina and *Ficus sur*, although shade tree abundance and farmers' choices have been reported to differ across regions[34,35,36]. Management of natural resources is generally augmented by participatory management through incentive and market-based approaches[37]. Therefore, the importance of agroforestry is not only for increased productivity, but also as a way of improving household incomes and nutrition, protecting biodiversity and environmental services, and helping the rural poor to adapt to climate change. In terms of agroforestry governance, local organizations and cooperatives are more involved in the management of natural resources that are predominantly governed by by-laws than regular judiciary system. There is clear recognition that local institutions and groups are important partners in agroforestry governance, ecosystem and landscape management.

Unlike Uganda, Ethiopia has demonstrated a higher potential for REDD+ results-based payments for the carbon removed through agroforestry systems, application of fiscal instruments to improve profitability of agroforestry systems, for example, fiscal incentives (such as tax exemptions or input subsidies), and sustainable certification schemes, which are already in operation for coffee and cocoa[38]. However, Ethiopia still faces challenges related to volatility of commodity prices, unclear land and tree tenure and the current drive for more intensified full sun systems that are believed to be more productive.

3.3.2 Coffee agroforestry in Costa Rica

Coffee (predominantly shaded arabica coffee) is the third most important agricultural export product in Costa Rica, after bananas and pineapples[39]. Coffee farms are mainly integrated with nitrogen fixing tree species (such as Inga densiflora) that have been found to have a positive impact on water use and drainage in a coffee agroforestry system as compared to coffee monoculture in Costa Rica[40]. Coffee agroforestry has also been found to provide opportunities for reducing CO_2 concentrations in the atmosphere by increasing carbon stocks in agricultural lands. Climatic scenarios tested over the possible water competition in agroforestry systems detected no water competition risk between coffee plants and shade trees in a tree-based coffee agroforestry system[41].

34 Likassa, E., & Gure, A. (2014). Diversity of shade tree species in smallholder coffee farms of western Oromia, Ethiopia. African Journal of Geo-Science Research, 3(1), 01-03.

35 Nigussie, A., Taye, E., & Bukero, G. (2014). Survey on potentials and constraints of shade tree species for arabica coffee production in South Ethiopia. International Journal of Recent Research in Life Sciences, 1(1), 1-11.

36 Seid, G., & Kebebew, Z. (2022). Homegarden and coffee agroforestry systems plant species diversity and composition in Yayu Biosphere Reserve, southwest Ethiopia. Heliyon, 8(4), e09281.

37 Birhane, E (2014). Agroforestry governance in Ethiopia, Unpublished consultancy report. Consultancy Report. Available at Birhane, E. 2014. Agroforestry Governance in Ethiopa Report WP 5.pdf (worldagroforestry.org)

38 Namirembe S, McFatridge S, Duguma L, Bernard F, Minag P, Sassen M, Soersbergen A, Akalu E (2015). Agroforestry: an attractive REDD+ policy option? An exploratory study. 151pp Agroforestry – TEEBAgriFood (teebweb.org)

39 Hopfensitz, A., Miquel-Florensa, J. (2017). Mill ownership and farmer's cooperative behavior: the case of Costa Rica coffee farmers. Journal of Institutional Economics, 13(3), 623-648.

40 Hergoualch, K., Blanchart, E., Skiba, U., Hénault, C., & Harmand, J. M. (2012). Changes in carbon stock and greenhouse gas balance in a coffee (Coffea arabica) monoculture versus an agroforestry system with Inga densiflora, in Costa Rica. Agriculture, Ecosystems & Environment, 148, 102-110.

41 Cannavo, P., Sansoulet, J., Harmand, J. M., Siles, P., Dreyer, E., & Vaast, P. (2011). Agroforestry associating coffee and Inga densiflora results in complementarity for water uptake and decreases deep drainage in Costa Rica. Agriculture, ecosystems & environment, 140(1-2), 1-13.

Using the coffee-based agroforestry systems (coffee/shade trees) of central Costa Rica, a study emphasized the importance of applying an interdisciplinary approach to research when designing appropriate cropping systems[42]. The study applied a modeling approach that was enriched with a participative approach, using farmer and stakeholder knowledge as the basis for designing an appropriate cropping system. This enabled designing and adoption of highly specific scenarios to local issues, and communication with farmers, thus improving application of the cropping system design outcomes.

In terms of tree combinations in coffee farming systems, studies have revealed a coffee management strategy where farmers design a combination of timber and nitrogen fixing species in organic coffee agroforestry systems[43]. Apart from such organic systems promoting restoration and conservation of biodiversity, the system is relevant in regions where farmers are unable to afford chemical inputs and can benefit by selling organically produced coffee. Such a system would be applicable among Uganda's smallholder coffee farmers to boost their coffee yields while conserving biodiversity.

Shade management is a key on-farm management practice among coffee farmers in Costa Rica. A recent study in Costa Rica showed that high productivity could be achieved with moderate agronomic investment under moderate shade, and that higher levels of investment or lower shade did not lead to higher yield[44]. In this case, a moderate shade level of 38-48% (having a tree density of 200–250 trees/ha, and 3-6 tree species) would be optimal for coffee agroforestry production, a shade management regime that could be replicated and investigated in Uganda. Overall, it is important that coffee policies recognize that shaded coffee agroforestry systems are compatible with high productivity, and low productivity can occur under both excessive and inadequate shade as a result of farmers lack of capacity to optimally invest.

Lastly, there are ongoing efforts towards development of user-friendly tools for designing shade canopies in coffee agroforestry systems in Costa Rica. A recent study developed ShadeMotion, a simple to parameterize, yet powerful software, capable of calculating the spatial and temporal distribution of the shade cast by trees on a plot (horizontal or tilted) anywhere on Earth[45]. While using this software, shade patterns in an existing coffee agroforestry system may be calculated for one instant, 1 year or less, or for the entire life cycle of a plantation; in the latter case, tree growth data must be added as input. Shade can also be measured at ground level or at any height above the ground. Such a development would be relevant to Uganda's coffee agroforestry systems where farmers and extension agents lack both knowledge and access to user-friendly tools to optimally design shade canopies.

42 Meylan, L. (2012). Design of cropping systems combining production and ecosystem services: developing a methodology combining numerical modeling and participation of farmers: application to coffee-based agroforestry in Costa Rica (Doctoral dissertation, Montpellier SupAgro).

43 Rossi, E., Montagnini, F., & de Melo Virginio Filho, E. (2011). Effects of management practices on coffee productivity and herbaceous species diversity in agroforestry systems in Costa Rica. Agroforestry as a tool for landscape restoration. Nova Science Publishers, New York, 115-132.

44 Haggar, J., Casanoves, F., Cerda, R., Cerretelli, S., Gonzalez-Mollinedo, S., Lanza, G., ... & Ospina, A. (2021). Shade and agronomic intensification in coffee agroforestry systems: trade-off or synergy? Frontiers in Sustainable Food Systems, 5, 645958.

45 Somarriba, E., Zamora, R., Barrantes, J., Sinclair, F. L., & Quesada, F. (2022). ShadeMotion: tree shade patterns in coffee and cocoa agroforestry systems. Agroforestry Systems, 1-14.

There is need to shift from the traditional scattering of trees in farming systems to well-designed coffee agroforestry systems (temporal and spatial designs) that take into account shade designs that optimize productivity of coffee agroforestry systems in Uganda.

3.4 Key messages for integrating trees on-farm

The following messages are fundamental towards encouraging farmers, extension officers and the entire coffee sector to integrate trees in their coffee farming systems;

1. The majority of Ugandans depend on forest products such as firewood, poles, timber, fruits and other uses. The rate at which these resources are being lost is alarming. Agroforestry is key in the restoration of forest resources in Uganda, and provides opportunity for households to enjoy the multiple benefits from trees, including food and nutritional security (e.g., various fruit trees), firewood, poles, fodder (leaves, twigs), bee forage, shade, ornamental and mulch. Agroforestry also contributes to tree-based diversification of household economic activities and income generation. With the correct land-use planning approach and good agronomic practices, various tree species and identified and integrated on-farm to meet different social and economic needs.

2. Agroforestry is an important intervention that boosts production and productivity of coffee, and provides ambient conditions to shield coffee plants from direct sunshine and mitigation of adverse impacts of climate change and climate variability. It has been demonstrated that shade trees, when well-managed, contribute to better coffee yields. Falling leaves decompose and add organic manure to the soil, while some species fix nitrogen. Integration of trees in coffee farms improves the quality of beans which fetches higher market values and can support the speciality coffee market.

3. Agroforestry is one of the interventions that contributes to ecosystem restoration through assisted regeneration of forestry resources, improved land productivity, enhanced carbon dioxide sequestration and sustainable reduction of deforestation and/or forest degradation.

4. Lobbying for inclusion of existing agroforestry trees on farm in the carbon accounting as a contribution to Nationally Determined Contribution (NDCs) will encourage more tree planting on farm. The increased access to carbon markets will significantly encourage tree planting and retention on farm. Trees planted with coffee can offer the service of carbon sequestration for which carbon credits may be obtained

5. The multi-purpose nature of indigenous tree species, which have well developed root systems for effective soil and water conservation. However, this will require use of quality tree germplasm planting materials for valuable trees to ensure quality products are obtained.

6. Formulating regulations requiring planting of trees in fragile ecosystems such as Mt. Elgon and Rwenzori will also encourage farmers in these areas to plant and retain trees in these landscapes.

7.   Use of ICT to not only interest the youth but also enhance efficiency in providing advice to farmers on tree growing and agroforestry tree species selection. For example, a few initiatives already exist, such as the 'Shade Tree Advice' and 'Agroforestree Database' applications developed by IITA and ICRAF respectively.

8.   The main entry point should be the economic benefits not environmental as this is what makes sense to the smallholder farmer. However, deliberate tree management (especially canopy tree pruning) is key to minimizing negative impacts of shade and reduction of disease and pest incidences in coffee agroforestry systems. The youth could be trained to offer this service to coffee farmers.

9.   It is possible to sequence integration of bananas and trees to ensure household food security. Bananas can be integrated at the initial establishment of the coffee garden and then the tree component can be introduced later. This is because tree-based systems have been proven to be cheap and sustainable in nature.

10.   Gender and coffee Agroforestry; the Government of Uganda has put in place a number of policies, legal and institutional frameworks that support equality between men and women. However, they are in most cases not backed up by relevant legal provisions for ensuring compliance among the different sector ministries and institutions. The forest sector is still male dominated due to disparities in land and tree tenure, which favour men against women.

CHAPTER 4

CONCLUSION AND RECOMMENDATIONS

4.1 Conclusions

The following conclusions have been drawn from the review of different polices, practices, laws and regulations as well as field findings following interactions with farmers and selected agroforestry stakeholders;

1. Agroforestry is an important intervention that boosts production and productivity of coffee, and provides ambient conditions to shield coffee plants from direct sunshine and mitigation of adverse impacts of climate change and climate variability. However, there is limited knowledge among coffee farmers about appropriate agroforestry practices, including selection of suitable tree species for coffee, spacing and management of the shade to optimize the production system. The farmers are also not focus keenly on other benefits of agroforestry, such as improving land productivity and diversification of economic activities for income and food security.

2. Analysis of Uganda's laws and policies shows that only the Uganda Forestry Policy (2001) and the National Forestry and Tree Planting Act (2003) have provisions that are explicit on agroforestry and farm forestry. The Policy provides guidance on the needed extension and advisory services to support farm forestry/agroforestry and the supply on quality seedlings and planting materials. Although in some respects, different laws and policies provide for extension service and advisory service delivery, they don't explicitly address agroforestry. The agricultural laws and policies specifically deal with agricultural commodities (crop, animal and fisheries husbandry), and no clear linkage to forests and trees. This is a weakness, and creates a gap in the implementation of agroforestry under coffee system. It is noted that when coffee seedlings are distributed to farmers, there is no consideration for simultaneous supply of appropriate shade trees, and farmers have to look somewhere else for these. The laws anticipate coordination and collaboration among the sectors for effective implementation of policies, but this has practically proved difficult.

3. The institutional arrangement for the delivery of extension and advisory services is scattered under different Ministries, Departments and agencies and is highly commodity-based. Whereas the policies and laws anticipate coordination and collaboration among key actors, this is hardly feasible because of limited budgetary provisions

4. Beyond the laws and policies, there are issues that must be addressed in order to effectively integrate agroforestry in coffee growing areas. Key among these include: (i) awareness of the multi-purpose roles trees on-farm and their contribution to the wellbeing of communities; (ii) the appropriate model to be used to integrate trees in coffee system to realize the multiple benefits; (iii) creating awareness of coffee-tree relationship among all stakeholders (iv) building the capacity of extension workers and service providers for effective integration of trees in a coffee growing system (v) conducting research on the impact of agroforestry on coffee production and productivity to provide evidence-based guidance to decision making to integrate trees in a coffee farming system.

5. Community-based approach to advisory service delivery has potential benefits of facilitating farmer-to-farmer learning and retention of knowledge and skills within the local community for sustainability. The community extension workers are identified and selected by the community and trained in the different subject matter, including agro-forestry, and equipped to the needed services, initially under close supervision of the technical persons. Therefore, the training of farmers and farmer organizations, especially the selected extension providers such as the Youth for Coffee Service Providers should be targeted for training in agroforestry practices.

6. Shade tree management is currently not a deliberate on-farm management practice among majority of farmers and tree pruning has not been emphasized during farmer extension. The cornerstone of agroforestry practices is the active management of the tree component in the system so as to derive the desired benefits and the sustainability of the system.

7. Majority of on-farm interventions tend to focus on increasing food production (associated with excessive use of agricultural inputs such as fertilizers and agrochemicals) at the expense of sustainable farming practices such agroecology, agroforestry and climate smart agriculture. Coffee agroforestry offers opportunities for sustaining and climate-proofing coffee production in Uganda.

8. There seems to be varying information on tree species influence on coffee pests and diseases especially the Black Coffee Twig Borer. Some communities associate BCTB with tree species such as *Measopsis eminii* and *Albizia chinensis*. However, the overarching cause of the high infestation appears to be resulting from poor management of shade, a key management component that needs to be emphasized in farming systems with trees. There is need for research in pests and diseases in coffee agroforestry and selection of appropriate trees for integration in the different farming systems in Uganda.

9. The lack of shade is believed to be one of the key factors contributing to low coffee seedling survival. This particularly observed in the low land areas of Mt. Elgon region where only about 50% seedling survival has been observed in the last 4 years. Shade provides a buffer against harsh climatic conditions during the early stages of coffee establishment. The application of coffee agroforestry will even be more desirable under the current efforts to expand coffee cultivation into non coffee growing districts in northern Uganda given the harsh dry periods in those areas.

4.2 Recommendations

4.2.1 Recommended coffee agroforestry cropping patterns

1. Following a review of relevant literature and field interactions with farmers and other key coffee agroforestry stakeholders, we recommend the following tree species for integration in coffee farming systems. These include; Cordia africana, Albizia coriaria, Ficus natalensis and Maesopsis eminii. While some of them are location-specific (e.g Cordia is dominant in Mt. Elgon region, Albizia is cross-cutting), these tree species were found to be dominant and well adopted in most of the coffee agroforestry systems in Uganda. A description of these tree species and recommended management will be covered in coffee agroforestry training guide. Additionally, a recent study in Costa Rica recommended that a moderate shade level of 38-48% (having a tree density of 200–250 trees/ha, and 3-6 tree species) would be optimal for coffee agroforestry production[46], a shade management regime that could be replicated and investigated in Uganda. We therefore recommend further studies through on-farm participatory trials to assess tree compatibility and appropriate spatial and temporal arrangement and combinations in Uganda's coffee farming systems. Application of a user-friendly tool (ShadeMotion software) for designing shade canopies in coffee agroforestry systems could also be explored in Uganda. ShadeMotion is a simple to parameterize to calculate the spatial and temporal distribution of the shade cast by trees on a plot (horizontal or tilted) anywhere on Earth[47].

2. There is need for a shift from traditional to more systematic agroforestry options for smallholder farmers. For example, it is possible to sequence integration of bananas and trees in newly established coffee systems to ensure household food security. We recommend that bananas are integrated at the initial establishment of the coffee garden to not only provide quick shade for the young coffee, but also ensure availability of food from the bananas to the household. The tree component can then be introduced later (after 2 years) in the system. To enhance tree seedling survival, the tree seedlings should be planted just next to the now aging banana plant that would subsequently get eliminated as the trees grow. It is assumed that by the time the banana plants are unproductive and phasing out, the household will have started harvesting coffee that would further ensure sustained household income and food security. Introduction of the tree component is important because tree-based systems have been proven to be cheap and sustainable in nature.

3. In terms of tree combinations in coffee farming systems, we recommend increasing on-farm tree diversity by integrating both trees and nitrogen fixing shrubs in coffee gardens for soil fertility enhancement and soil erosion control. Studies in Costa Rica have revealed a practical coffee management strategy where farmers design a combination of timber and nitrogen fixing species in organic coffee agroforestry systems[48]. Such a system would be applicable among

46 Haggar, J., Casanoves, F., Cerda, R., Cerretelli, S., Gonzalez-Mollinedo, S., Lanza, G., ... & Ospina, A. (2021). Shade and agronomic intensification in coffee agroforestry systems: trade-off or synergy? Frontiers in Sustainable Food Systems, 5, 645958.

47 Somarriba, E., Zamora, R., Barrantes, J., Sinclair, F. L., & Quesada, F. (2022). ShadeMotion: tree shade patterns in coffee and cocoa agroforestry systems. Agroforestry Systems, 1-14.

48 Rossi, E., Montagnini, F., & de Melo Virginio Filho, E. (2011). Effects of management practices on coffee productivity and herbaceous species diversity in agroforestry systems in Costa Rica.

Uganda's smallholder coffee farmers to boost their coffee yields while conserving biodiversity. Some of the potential nitrogen fixing shrubs for Uganda include *Calliandra calothyrsus*, *Sesbania sesban* and *Gliricidia sepium.* A description of these species will be presented in the coffee agroforestry training guide. Increasing on-farm tree diversity may play a key role in lowering pest and disease incidences in coffee agroforestry systems but this will require further localized on-farm investigations.

4.2.2 Other recommendations

1. Review the approach to extension to emphasize hands-on training. For example, there is need for participatory and demonstration learning to provide farmers with hands-on knowledge and skills on managing their coffee gardens. Café Africa Uganda should develop a holistic training manual that addresses the gaps in knowledge and skills, including the practices and wide range benefits of agroforestry and diversification of economic options to improve their social-economic wellbeing.

2. Involve local community leaders, especially opinion leader to build local capacity to provide community-based extension service system. This can further be strengthened by building linkages between different actors in extension service delivery, e.g., use of Community-Based Facilitators and agricultural extension staff.

3. There is need to undertake further investigations on the relationship between productivity of coffee and agroforestry practices. This should put in account adoption of shade tree management as a key on-farm agroforestry management practice as it appears that majority of the farmers only prune their trees when there is need for fuelwood or poles, with no deliberate effort to manage tree shade in the coffee farming systems.

4. Deliberately provide for the supply of adequate numbers of seedlings of suitable tree species per acre in all coffee growing programs in the country. This should be embraced in all interventions by state and non-state actors, including programs such as OWC, PDM and UCDA coffee seedling distribution programs. The DFO should certify the tree nurseries within the district that may supply agroforestry tree species to ensure quality assurance.

5. There exists a critical mass of extension service providers that can be leveraged on by the respective district local government and civil society as channels for promoting coffee agroforestry. These include the subcounty extension officers, sub county and parish chiefs (e.g., Sironko has over 55 parishes, each with a parish chief), and most NGO and CBOs have Community-Based Facilitators, UCDA is now introducing Parish Coffee extension officers. All these existing structures can be utilized for coffee agroforestry extension. What is needed is to build their capacity through ToTs, refresher training, sensitization campaigns and field demonstration and field exchange visits to equip them with the right information package and hands-on skills. The provision of manual or guides in coffee agroforestry is necessary as a source of reference materials.

6. The use of existing social networks including 'important others' and opinion leaders within the different communities as agents of change for promotion of coffee agroforestry is recommended. This is because such networks are trusted by the communities and they provide a platform for feedback.

7. Farmers should be organized in groups as nuclei of development, including knowledge sharing and resource mobilization. Promote use of a cluster approach where farmer groups jointly apply for a crowd government funding for a number of interventions. This would encourage ownership and collective action. A case where a cluster approach is being piloted is in Sironko with Mutufu Investment Cluster.

8. A number of opportunities exist at the local government level where coffee agroforestry can be brought at the forefront as well as platforms for sharing information on coffee agroforestry. These include district planning committees, and screening of projects by the Natural Resource Office. Section 19 of the Environment Act. 2019 gives mandate to the NR department to conduct environmental and climate change screening of projects for strengthening compliance with safeguards requirements. It is envisaged that during such activities, the NR department is able to identify opportunities/ synergies for coffee agroforestry interventions irrespective of the department or stakeholder undertaking the project in the district.

9. Harmonized extension information on appropriate tree species for integration into coffee farming systems, as well as information on tree spacing and spatial designs for different agroforestry systems, tree management such as pruning regimes for different tree species, marketing of tree products and services. With the current small landholdings, there is urgent need for appropriate coffee agroforestry designs for smallholder farming systems that optimize the tree benefits while minimizing the negative impacts of the tree component.

10. In addition to the BCTB monitoring, prevention and control measures documented in this report (Table 2) from literature, we recommend two additional interventions, i.e. (i) adequate management of tree shade in coffee agroforestry systems and (ii) designing coffee agroforestry systems that suppress the BCTB infestations –e.g., use of shade trees that exude sap upon injury.

11. There is need for sustainable financing arrangement (medium to long-term) for agroforestry related research and development activities. This will allow realization of livelihood and environmental impact resulting from such interventions.

12. There is need for effective communication to policy makers with simple and precise messages of the evidence generated from scientific studies for informed decision-making. This also applies to extension workers, who should package existing evidence for use by farmers.

13. Specific technical specifications (tree species, spacing and management) need to be provided to farmers and widely disseminated to extension staff and coffee farmers.

Annex 1: List of stakeholders consulted

No.	Name	Designation	Location/Organization	Contact
1.	Scovia Kayonga	Senior Env. Officer	Luwero DLG	0772020686
2.	Robert Sebuga	Chairman Kamuli-Kibose Coop. Society	Luwero	
3.	Ben Mayanja	Member of Kamuli-Kibose Cooperative Society	Luwero	
4.	George Sebuga	Member of Kamuli-Kibose Cooperative Society	Luwero	
5.	Esther Nabukera	Member of Kamuli-Kibose Cooperative Society	Luwero	
6.	Justina Nantaba	Member of Kamuli-Kibose Cooperative Society	Luwero	
7.	Deo Mijumbi	Senior Forest Officer	Luwero DLG	0772680598
8.	Wilberforce Semigga	Senior Agriculture Officer	Luwero DLG	0774201085
9.	Reagan Sembatya	District Environment Officer	Luwero DLG	0786382853
10	Enock Balamu	UCFA - Agroforestry Extension Officer	Luwero	0773621014
11.	Bosco Nsubuga	UCFA – Machine Operator	Luwero	0703206927
12.	Rogers Mutiibwa	UCFA – Team leader	Luwero	0783623655
13.	Morgan Kawalya A	District Community Development Officer	Gomba	0772993197
14.	Mathias Cyiza	UCDA- Regional Coffee Extension Officer	Gomba	0779359891
15.	Mathias Byakatonda	Farmer	Gomba	0706224751
16.	Allan Muwanga	District Forest Officer	Gomba	0778029923
17.	Joshua Minga	Café Africa – in charge of Gomba	Café Africa Uganda	0756719813
18.	John Nuwagaba	General Manager – Ankole Coffee Producers Cooperative Union (ACPCU)	Sheema	0772461876
19.	Nicodemus Bamuhangaine	Organic Supervisor - ACPCU	Sheema	0783217991
20.	Gladys Kyomugisha	Gender Officer - ACPCU	Sheema	0788132779

No.	Name	Designation	Location/ Organization	Contact
21.	Dina Nabusumba	Agroforestry Scientist/ Research Officer. Mbarara Zonal Agricultural Research and Development Institute	Mbarara	0782991576
22.	Gilbert Twesigye	District Forest Officer	Sheema DLG	0755006064
23.	Patrick Turyatunga	District Natural Resource Officer	Sheema DLG	
24.	Nobert Ahebwa	UCDA Regional Coffee Extension Officer	Sheema	0777398073
25.	David Twinamatsiko	District Agricultural Officer	Sheema DLG	0772335490
26.	Nambozo Grace	Bumalimba Bee Farmer and Tree Planting Group	Sironko	0778018436
27.	Robert Giduyi	Bumalimba Bee Farmer and Tree Planting Group	Sironko	0789362383
28.	Sam Kisolo	The Coffee Gardens	Sironko	
29.	Dana Siedem	The Coffee Gardens	Sironko	0772546216
30.	Shakeel Padamsey	The Coffee Gardens	Sironko	0784582193
31.	Charles Patrick Okori	District Production Officer	Sironko DLG	0772847439
32.	Rashid Mafabi	Senior Environment Officer	Sironko DLG	0772435518
33.	Joseph N Ojiambo	District Community Development Officer	Sironko DLG	0702440726
34.	Ben Fungo	Agroforestry Research Program Leader	NaFORRI/NARO	0701380592
35.	Jane Magombe	INTERNATIONAL WOMEN; SCOFFEE ALLIANCE	Sironko	0779831785
36.	Erik F Acanakwo	CIFOR – ICRAF Uganda	Uganda Country Representative	0774635173
36	Stephen Khaukha	Private Consultant	Havilah Company Ltd	0772561227

Annex 2: Interview guide for FGDs

1. List the tree species commonly integrated in coffee systems in this area?
2. Are there any specific trees that are considered unfriendly to coffee? If yes, list them and give reason.
3. Are there any benefits associated with growing of trees in your coffee gardens? If yes outline them. If no, please give reasons.
4. What challenges have you faced with growing trees in your coffee plantations?
5. Why do you think some farmers are hesitant to plant trees in their coffee plantations?
6. Could you be aware of any government interventions/ initiatives geared towards promoting growing trees in farming systems? If yes, please highlight them.
7. What do you think needs to be done at local government level to encourage farmers to integrate trees in their coffee plantations?
8. What can be done by government to encourage coffee agroforestry in the country?

Annex 3: Interview guide for Key informant interviews

1. What is your general opinion on integration of trees in coffee plantations?
2. Are you aware of any benefits a farmer can get when he/she incorporates trees in their coffee systems? If yes, give examples of the benefits. If no, why do you think so?
3. Why do you think some farmers are hesitant to plant trees in their coffee plantations? OR, what are the pressures, obstacles or challenges for growing trees with coffee?
4. What do you consider to be the good practices of growing trees in a coffee system?
5. Could you be aware of any government interventions/ initiatives geared towards promoting growing trees in farming systems? If yes, please highlight them.
6. What do you think needs to be done at local government level to encourage farmers to integrate trees in their coffee plantations?
7. What key message or incentives can convince farmers to plant and retain trees in their coffee?
8. Could you have any suggestions on how coffee agroforestry extension could be improved in Uganda? Kindly share with us if any.

Annex 4: Template for capturing gaps during literature review

Reference Policy, law or Guideline	Provision	• What to determine • Does the provision define agroforestry? • Do the provisions support agroforestry practices or trees on-farm? • Do the provisions flag a policy gap that needs to be addressed to support agroforestry? • Does the provision prohibit or establish obstacles to achieving successful agroforestry practices?
A. Policy		
B. Laws		
C. Strategic Plans		
D. Regulations		

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