Report on policy and BAU scenario for GHG, sustainable development and transformational change impacts, and MRV of policy

ICAT Initiative for Climate Action Transparency

Initiative for Climate Action Transparency – ICAT

Report on policy and BAU scenario for GHG, sustainable development and transformational change impacts, and MRV of policy

Deliverable #6

AUTHORS

Mirko Dal Maso
UNEP DTU Partnership

John Paul Alvarez
Kamil Salazar
Ide Sosa
National Climate Change Office of Belize

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List of Abbreviation

AF	Agroforestry
ECON	Economics
ETF	Enhanced Transparency Framework
GHG	Greenhous Gas
GOB	Government of Belize
ICAT	Initiative for Climate Action Transparency
MELS	Monitoring Evaluation Learning System
MFFESD	Ministry of Fisheries, Forestry, Environment and Sustainable Development
MPG	Modalities, Procedures and Guidelines
MSDCCDRM	Ministry of Sustainable Development, Climate Change and Disaster Risk Management
NAFP	National Agroforestry Policy
NCCO	National Climate Change Office
NDC	Nationally Determined Contributions
PA	Paris Agreement
R&D	Research and Development
SCAN	SDG Climate Action Nexus
SD	Sustainable Development
SDG	Sustainable Development Goals
TC	Transformational Change
UNFCCC	United Nation Framework Convention Climate Change

1 Introduction

The Paris Agreement (PA) under the United Nations Framework Convention on Climate Change (UNFCCC) requires countries to report and track progress made towards countries' Nationally Determined Contribution (NDC) in alignment with the Modalities, Procedures and Guidelines (MPGS) of the Enhanced Transparency Framework (ETF). The Initiative for Climate Action Transparency (ICAT), in partnership with the National Climate Change Office (NCCO) of the Ministry of Sustainable Development, Climate Change and Disaster Risk Management (MSDCCDRM) is enhancing Belize's National Monitoring, Reporting, and Verification system (MRV) for effectively tracking climate change mitigation and adaptation actions. As part of the country's effort in developing this national system, a component of the project includes a GHG, Sustainable Development and Transformational Change impact assessment of a selected NDC policy or action. Therefore, it has been decided that the assessment, which is currently in its preliminary stages, be conducted for Belize's recently developed National Agroforestry Policy.

The methodology provides a systematic approach that aims to assess the impacts that a climate policy or action has in reducing GHG emissions and ultimately contributes to the widespread transition for sustainable development. The methodology stems from the ICAT assessment guides for assessing policies and actions. It also enables users who are planning to assess GHG, sustainable development, and transformational impacts of a policy to do so in an integrated and consistent way within a single impact assessment process. In the context of Belize, the assessment is performed with the main goal of piloting the ICAT Sustainable Development and Transformational Change methodologies in order to understand better its applicability and potential for broader use. Furthermore, the analysis can be beneficial to improve the understanding around the agroforestry policy's contribution to the national mitigation and sustainable development targets. By shedding light on the potential mitigation, sustainable development, and transformational impacts of the policy, the assessment may also generate insights on how such agroforestry practices can be strengthened in the future.

The assessment consists of an ex-ante assessment, which means that it aims to analyse what the expected impacts of the National Agroforestry Policy would be. Impacts consists of expected changes (for mitigation of GHG emission[1], sustainable development and transformational change) brought by the policy in comparison to the baseline scenario. The baseline scenario is the most likely scenario to happen in the absence of the policy considered. In line with the main goal of the assessment, data availability and considering the time and resources available for carrying out the work, the assessment relies on qualitative approaches. For the same reasons, stakeholder participation could not be included in the assessment, which instead relied mostly on desk research based on available literature and the information provided in the agroforestry policy itself. To underline this and allow for improving the robustness of the analysis in the future, the report highlights the steps of the assessment where stakeholders' participation could be integrated. Considering all these limitations, it is important to stress that findings from this report should be viewed and used keeping in mind the goal of the assessment, which is to pilot the ICAT guidance, rather than to measure the actual impacts of the policy precisely and quantitatively. This notwithstanding the analysis should also be viewed for what it is: the application of a robust approach, that helps to highlight what would be the expected

1 GHG impacts are assessed as part of the sustainable development assessment.

impacts of a policy on mitigation of GHG emission, sustainable development, and transformational change, thus allowing for a more informed identification of hotspots to be monitored during project implementation, of opportunities, and possible areas of concern. This is highly relevant also considering the review and comparison with other outputs provided by the ICAT support in Belize, more specifically the identification and prioritization of GHG and sustainable development progress and impact indicators for the NDC actions.

A summary of the general information of the assessment is provided in Table 1.

Table 1. General information of the assessment.

General information	Assessment information
Name of the policy or action assessed	Belize National Agroforestry Policy
Person(s)/organization(s) that did the assessment	Mirko Dal Maso (UNEP DTU Partnership)
Date of the assessment	November 2021
Objective(s) of the assessment	To pilot the ICAT methodologies for sustainable development and transformational change
Intended audience(s) of the assessment	ICAT Belize team
Whether the assessment consists of a qualitative impact assessment, quantitative impact assessment and/or tracking progress of indicators over time	The assessment is a qualitative impact assessment. Indicators for monitoring are developed.
Opportunities for stakeholders to participate in the assessment	The assessment had to rely on limited time and resources. As the goal of the assessment was simply to pilot the guides, it was considered acceptable not to engage stakeholders at this stage. However, the assessment highlights where stakeholders' contribution would be needed.
Does the assessment apply to an individual policy/action or a package of related policies/ actions?	Individual policy.
Whether the assessment is ex-ante, ex-post, or a combination of ex-ante and ex-post	Ex-ante
The assessment period	2020-2030

The assessment follows the stepwise guidance of the ICAT Sustainable Development (SD) and Transformational Change (TC) methodologies[2]. ICAT defines transformational change as a fundamental, sustained change of a system that disrupts established high-carbon practices and contributes to a zero-carbon society, in line with the Paris Agreement goal to limit global warming to 1.5–2°C and the United Nations SDGs. Therefore, the definition of transformational change includes both mitigation and sustainable development. It follows the methodology which also includes assessment of mitigation and sustainable development. For the assessment of sustainable development, the TC guide references the SD guide. As the assessment presented in this report covers both SD and TC, and these have cross-cutting elements, the methodologies are applied together, to maximise synergies. Reporting tables presented throughout the report are taken from the ICAT templates, available on the ICAT websites, and adapted where needed for their use in this report. The structure of the report aligns with the stepwise flow of the methodologies, and the following chapters are therefore presented as follows. First, the National Agroforestry Policy is described (Chapter 2); impacts to be assessed with regards to SD and TC are then selected (Chapter 3); selection of relevant impact categories include several steps among which the identification of phase of transformation, barrier analysis, and description

2 Available here.

of the vision of the policy; the baseline scenario is then described (Chapter 4), and it is followed by the assessment of the impacts of the policy (Chapter 5); the SD impacts assessed are then linked to the SDGs to provide an overview of the expected contribution to the Agenda 2030 (Chapter 6); finally, a monitoring plan is developed (Chapter 7).

2 Description of the policy

The Food and Agriculture Organisation defines agroforestry as "a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence"3. This results in ecological and economical interactions between the different components and diversified and sustained production with the potential to increase social, economic, and environmental benefits especially for farmers. Example of agroforestry systems are agrisilvicultural systems (combination of crops and trees, such as home gardens), and silvopastoral systems (forestry and grazing of animals).

The Belize draft National Agroforestry Policy (NAFP)[3] was created under the then Ministry of Fisheries, Forestry, the Environment and Sustainable Development (MFFESD), initiated by NCCO along with other technical counterparts. The policy came into existence in November 2020 and was designed to enhance sustainable agricultural and forest practices such as silvo-agricultural, silvopastoral, and agro-silvopastoral systems, to be introduced to farmers and relevant stakeholders as environmentally suitable alternatives. Ultimately, the implementation of the policy will contribute to the Sustainable Development Goals (SDGs), the support of the adaptation efforts, and the reduction of GHG emissions nationally. To further comprehend the scope of the policy, the details of NAFP and its key characteristics are described in Table 2.

Table 2. Information on the National Agroforestry Policy of Belize.

Information	***Description***
Title of the policy or action	*Belize National Agroforestry Policy*
Type of policy or action	*Research, development, and deployment policies*
Description of specific interventions	*Agroforestry (AF) practices in Belize considers a wide range:* ***Mixed farming systems*** *(intercropping and alley cropping).* ***Regenerative agriculture*** *(improvement and conservation of water and soil quality).* ***Protein and energy*** *(discourages expanding grazing areas and improving animal nutrition through intensification).* ***Silvo-pastoral*** *(rotational grazing of animals within a pasture with scattered trees and riparian buffers). Agro-silvo-pastoral (crop production with livestock and trees).* ***Beekeeping****.* ***AF nursery*** *(tree seedlings to farmers).* *Principles that will contribute to the implementation of NAFP are as follows:* ***People-centred and inclusive development*** *– Centres on inclusivity of indigenous, marginal, and vulnerable people, private sector and civil society, and relevant sectors will be encouraged to participate with government AF programs.* ***Gender and youth participation*** *– The policy will provide gender empowerment for women, men and youth from all cultures in leadership and implementation of AF policy, R& D, training, education and economic opportunities, access to and ownership of land/tree resources. In addition, the policy will provide a safe, productive, and secure environment in the mainstreaming of AF.* ***System and inter-disciplinary approach*** *– Due to the complexity AF and it components it requires teamwork, involving the expert and practitioners in*

3 https://www.fao.org/forestry/agroforestry/80338/en/

	forestry, agroforestry, agronomy, livestock, soil/water management and socio economics ***Communication and transparency*** *– Free flow of information enables all collaborators and stakeholders to access, monitor, understand, and share results and views on the progress of AF programs in a timely manner.* ***Compensation and incentives*** *– Motivation for action or provision for a service or sacrifice, requires payment as part of the NAFP. There are multiple options to mobilize funds to provide incentives for adopters, for example commercial purposes, conservation of resources, environmental benefits, and community support programs.* *To also complement, there is an Agroforestry (AF) intervention, comprised of a socioeconomic feasibility analysis that would generate estimations of the productivity and adaptability of an improved and proposed AF system. This systematic approach requires analysis from household decision-making, resources, food and income, markets and prices for inputs, products, and services, etc. Fundamentally, the analysis can create customized AF interventions to circumstances and abilities of small and medium or large farmers.*
Status of the policy or action	*Adopted*
Date of implementation	*November 25th, 2020*
Date of completion (if applicable)	*Ongoing. The policy does not have an end date and is to be updated in 5 years' time.*
Implementing entity or entities	*Forest Department, Ministry of Sustainable Development, Climate Change and Disaster Risk Management*
Objectives and intended impacts or benefits of the policy or action	1. *Resolve the legislative and regulatory impediments and mainstream AF in the policies of relevant sectors.* 2. *Strengthen institutional capacities for research, training and education, public awareness, and promotion to provide science-based data to relevant stakeholders in the field of AF,* 3. *Advocate for widespread adoption of agroforestry and promote tree planting in farming systems, villages, and urban areas, to meet the ever-increasing demand for timber and non-timber products.* 4. *Develop AF alternatives to the shifting cultivation and unsustainable farming system, recover degraded lands, improve the resilience/risk management of agriculture and forest ecosystems due to climatic change, disasters, biological attacks, or socio-economic shocks.* 5. *Develop AF as a way of reducing the pressure on exiting forest incursion, thereby complementing the REDD+ target of increasing forest/tree cover for ecological and environmental services.* 6. *Apply market-driven approaches and develop value-adding, processing, and packaging of a range of AF products and by-products to penetrate domestic and international markets.* 7. *Mobilize investment and resources for AF programs and projects to provide appropriate incentives for AF beneficiaries from local, national, and international donors to complement the resources of GOB and relevant stakeholders.* 8. *Organize a review, planning, and learning conference at least every 2 years, with relevant stakeholders*
Level of the policy or action	*National and Sector level*
Geographic coverage	*Belize*
Sectors targeted	*Agriculture and Forestry*
Other related policies or actions	*-CITIES Convention* *-Forest Act Rev. Edition 2003*

Table 3: Additional information on the National Agroforestry Policy

Information	***Description***
Relevant SDGs	*The NAFP can contribute to 9 out of the 17 SDGs. The greatest contribution is as follows:* *SDG1- poverty reduction* *SDG2- hunger alleviation*

	SDG5- gender equality *SDG13- climate action, and* *SDG15- biodiversity conservation and sustainable land management* *Other contribution includes* *SDG3- improving human health* *SDG6- increasing access to clean water* *SDG7- sustainable energy solutions* *SDG12- responsible agricultural production*
Specific intended targets, such as intended level of indicators	*- Improve food security, nutrition, and health, affecting at least 10,000 households after every 5 years.* *- Improve interactions and recycling processes in the productive components which will enable higher income and profits value at least BZ $100 million in income every year.* *- Develop supply value chains and value adding capacities for efficient input supply processing, and marketing by the private sector, affecting 5,000 enterprises over the next 10 years.* *- Improve the trade balance in terms of increasing exports of agriculture, food and timber products reducing the import of same product, valued at some B$300 million over 10 years.* *- Train farmers and producers, at least 5,000 in all districts of whom at least 30% are female, in 5 years.* *- Train staff in public institutions and civil society, at least 50 with at least 20 professionals with MSc and 5 with PhDs; approximately 50% female, in 5 years.* *- Mobilize resources for investment and financing of AF programs and projects, targeting at least $5 million per annum during the first 5 years.*
Title of establishing legislation, regulations, or other founding documents	*National Land Use Policy* *National Forest Policy* *National Agriculture and Food Policy*
Monitoring, reporting, and verification procedures	*The NAFP reference the monitoring, evaluation, and learning system (MELS) to be implemented following six steps:* *1. Agree on SMART indicators for each AF system or component under evaluation, based on the expected results and outputs.* *2. Select the appropriate tools and methods to measure each indicator.* *3. Assign roles for resources allocation, data collection, analysis, and reporting* *4. Analyze results among the team, disseminate results to all relevant stakeholders* *5. Base on the analysis make recommendations to improve the AF interventions for follow up actions* *6. Use the information learned to enhance AF programs, projects, NAFP, and the agriculture and forest sectors.*
Enforcement mechanisms	*No enforcement mechanism in place*
Reference to relevant documents	*N/A*
The broader context or significance of the policy or action	*In the broader context of the NAFP, three aspects are highlighted.* *1) Mitigate unsustainable agriculture and forest management practices.* *2) Adopt sustainable techniques that can contribute to sustainable development, while* *3) Generating and maintaining funds, in turn, will boost the economy, and the welfare and income of the population.*
Key stakeholders	*Indigenous farmers, Forest Department, Agriculture Department, Trio Farmers Cacao Growers Association, Belize Livestock Producers Association (BLPA), University of Belize (UB)*
Other relevant information	*N/A*

3 Selection of impacts to be assessed

This chapter presents the selection of SD and TC impact categories. SD impact categories are impacts on sustainable development, where sustainable development is defined as the development that meets the present needs without compromising the ability of future generations to meet their own, and it is more recently framed by the 2030 Agenda for Sustainable Development. Transformational change impacts, on the other hand, are, in line with the ICAT definition, impacts that allow a fundamental, sustained change of a system that disrupts established high-carbon practices and contributes to a zero-carbon society, in line with the Paris Agreement goal to limit global warming to 1.5–2°C and the United Nations SDGs. The ICAT TC methodology classifies TC impacts as either Processes or Outcomes, where processes are to be understood as those drivers of change fuelling the transformation, and the outcomes are the results of such changes on climate change mitigation and sustainable development, measured in terms of their scale and sustained nature (Figure 1).

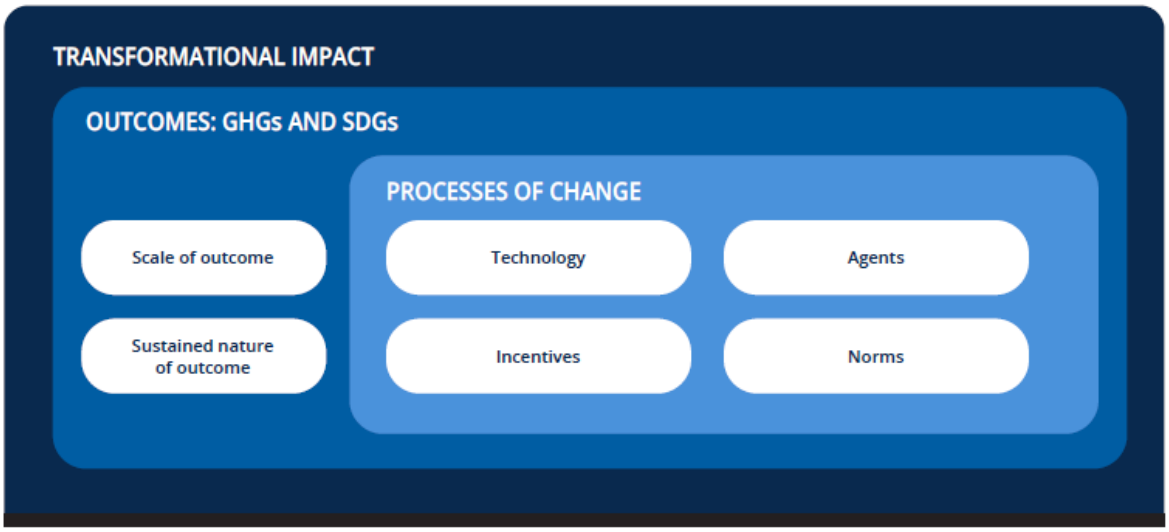

Figure 1. Layers of transformational impact assessment.

3.1 Selection of sustainable development impacts

Sustainable development impacts are selected, in line with the approach outlined by the ICAT SD methodology, based on their:

- Significance: based on evidence, impact categories significantly affected
- Relevance: impacts that are relevant from the decision makers' and stakeholders perspective
- Comprehensiveness (of the assessment): include positive and negative impacts from all three dimensions of sustainability (environmental, social, economic) to have a comprehensive assessment

The selection of significant sustainable development impact categories relied on literature review on the impacts of agroforestry on the sustainable development[2–8]. The review draws on papers that have performed extensive literature review on agroforestry and have

performed field analysis, including stakeholders' interviews. Furthermore, the review had a focus on developing country context, which is considered in line with the focus of this assessment. Additional resources consulted were the SDG Climate Action Nexus (SCAN) tool which presents an overview of the links between climate actions (among which actions on sustainable land management, including agroforestry) and the SDGs, also based on extensive literature review.

Impacts considered relevant include the ones that are considered relevant by the National Agroforestry Policy as well as impacts that are relevant development priorities for Belize[9] and other relevant policies such as the National Forest Policy and the National Agriculture and Food Policy[10,11]. Based on a paper on the benefits of agroforestry for the SDGs[8], the agroforestry policy mentions expected impacts on SDG 1 (no poverty), SDG 2 (zero hunger), SDG 5 (gender equality), SDG 13 (climate action), SDG 15 (life on land), as well as other possible impacts on improving human health (SDG 3), increasing access to clean water (SDG 6), sustainable energy solutions (SDG 7), and responsible agricultural production (SDG 12). It also reports expected impact from policy implementation related to tourism, deforestation, land management and land degradation, Participation of women and youth, food security, health, economic activity, increase agricultural productivity, soil conservation, climate mitigation, and climate adaptation.

Table 3 presents a summary of the selection of sustainable development impact categories.

Table 3. Selection of sustainable development impact categories (R=relevant, S=significant, I=included).

Dimension	Impact category	R?	S?	I?	Justification
Environmental	Climate change mitigation	Y	Y	Y	Agroforestry can contribute storing carbon aboveground in biomass and belowground through litter fall and enhanced root production. It stores more carbon than crops, pastures, and grassland, but less than forests[7].
	Biodiversity	Y	Y	Y	Agroforestry supports more biodiversity compared to agriculture. It can also act as buffer zone between agricultural fields and the forest. However, some species can be endangered if a forestry area is turned into agroforestry.
	Freshwater (security and quality)	Y	Y	Y	Agroforestry can improve the use of rainwater and produce more "crop per drop" compared to monocultures. However, trees can also compete with crops for water and reduce yields, especially in dry climates. Trees are important for water distribution and for the formation of rain.
	Soil quality and land degradation	Y	Y	Y	Agroforestry trees and practices add organic material to the soil, which is important for many ecosystem services, contribute to reduced erosion levels and can provide nutrients that can increase yields significantly.
	Deforestation	Y	Y	Y	Agroforestry can help avoid deforestation by providing forest products and managing more sustainably the soil. However, it can also have negative effects if it leads to transforming forests in agroforestry areas.
Social	Climate change resilience	Y	Y	Y	Agroforestry contributes to diversify farming activities and thus increase sustainability and resilience to shocks by reducing the consequences of crop-failure. Trees also

					provide a number of ecosystem services important for resilience such as erosion control, flood control and pest control.
	Food security	Y	Y	Y	Agroforestry can increase crop yields. However, it can also have negative effects if resources are available and species compete with each other. Agroforestry can help in having a more diverse diet and ensuring food security all year long.
	Healthy lives and well-being	Y	Y	Y	Agroforestry can require less use of fertilizers. It can also provide a more diverse diet.
	Empowerment of women	Y	Y	Y	Agroforestry can provide risk and opportunities for women empowerment.
	Energy access	Y	Y	Y	Agroforestry can provide resources such as wood.
	Conflict				Agroforestry can lower pressure on communal resources.
	Human-environment interactions	Y	Y	Y	Connection with the natural surroundings, use of plants and animals, cultural heritage, living in symbiosis with nature.
Economic	Poverty	Y	Y	Y	Agroforestry can help diversifying income.
	Economic activity	Y	N	Y	Promoting agroforestry can lead to increase economic activity. It can also lead to people becoming more self-sufficient.

Note: stakeholder participation could not be carried out as part of the selection of sustainable development impact categories. However, it is advised to include stakeholder participation in this process to inform the selection of relevant impact categories.

3.2 Selection of transformational change characteristics

3.2.1 Identification of the phase of transformation

The first step in selecting relevant TC impact categories, or characteristics, is to understand the context in which the policy or action is being planned or implemented. This is important as different drivers become relevant at different stages of the transformation. The agroforestry policy is a special case, as the policy lies in between two sectors: the agriculture and forestry sector. It is therefore the transformation of both sectors, and their interactions, that should be considered to identify the phase of transformation.

The agroforestry policy comes in aid to an expanding agriculture sector. The expansion of agriculture puts increasing pressure on the forest areas of Belize. In response to this, a forestry policy was adopted in 2015[10]. Agroforestry is mentioned only in a couple of instances in the forestry policy. According to the forestry policy, forest resources still appear to be mostly used sustainably, although studies claim this could be reduced to 56% in 2025.

Looking at the agriculture sector, it is reported in Belize's National Agriculture and Food policy[11] that there is an urgency to prioritize income generation and the domestic productive sectors to promote the development of the local economy and substitute imported products, and even increase exports.

Belize's natural heritage attracts vast numbers of tourists. Local communities are major beneficiaries of forest environmental services such as watershed protection, biodiversity conservation, atmospheric regulation, and scenic beauty; however, these services are also extremely valuable for ecotourism. It is believed that AF systems can create, protect, and

expand these environmental services.

Agriculture can grow through intensification to meet the increased demand for food, jobs, and income, since growth by expansion into the natural forest is no longer a desirable option. A national land-use policy, drafted in 2019, aims to comprehensively address the use, management, distribution, enhancement, and conservation of Belize's land-based resources, to achieve a well-ordered, effective and sustainable management of its land resources.

Several government departments or units (Agriculture, Forestry, and Environment), the University of Belize and non-government organizations (e.g., Program for Belize and Ya'axche Conservation Trust (YCT)) are engaged individually in AF initiatives, because they can appreciate the valuable contributions AF can make to their missions and mandates (CATIE, 2020c). However, there is not enough inter-ministerial coordination and collaboration among these AF initiatives. The usual strategy of each ministry is to work independently, and therefore in the absence of a national AF policy, there is no reason and no motivation or effort to do otherwise. Furthermore, because of the small size of each ministry or organization, there is limited capacity to mount the minimum interdisciplinary team in each institution. A minimum "critical mass" is necessary in AF to have competent programs to produce the scope and quality of work required to make a credible impact on the productive sector and, more so, on the national economy.

AF cannot grow and be mainstreamed without investment, hence the highest priority of any NAFP is precisely to stimulate and secure investments from those who have resources. The argument to be made is about income, profits, and better return on the limited resources of land and capital in Belize. AF can offer good economic returns for all, even for low-income families.

If we look at the evolution of the forestry policy and agriculture policy over the years, we can see how in the mid of the 20th century, when the first forestry policy was developed, forests were seen as sources of inputs and income. The policy adopted in 2015 recognized the importance of the sustainable management of forests. The agriculture policy also recognizes the importance of sustainable agriculture. Nevertheless, the need for expansion and growth is still paramount. Afforestation and increasing the forest coverage are not explicit, although somehow implicit in these statements. The focus seems to be on sustainable economic growth, rather than a balance between growth and the preservation of nature, although again, this is implicit in some statements.

The stage of transformation is therefore considered the take-off stage (), although with the new policies approved (for example the agroforestry policy) there are some signals that the acceleration phase may not be that far (see Annex). The take-off stage is a phase that characterizes observable moves to change the system towards more openness and acceptance of new ideas and concepts that question or challenge existing high-carbon paradigms. There is an increasing awareness of problems and issues relating to unsustainable development and concrete attempts to devise possible solutions. Experimentation, innovation, and alternatives are expanding and gaining momentum. However, there is still no consensus or common understanding about suitable solutions. Lobbying against the new and alternative solutions remains strong, fueled by current regime elites who benefit from the existing system.

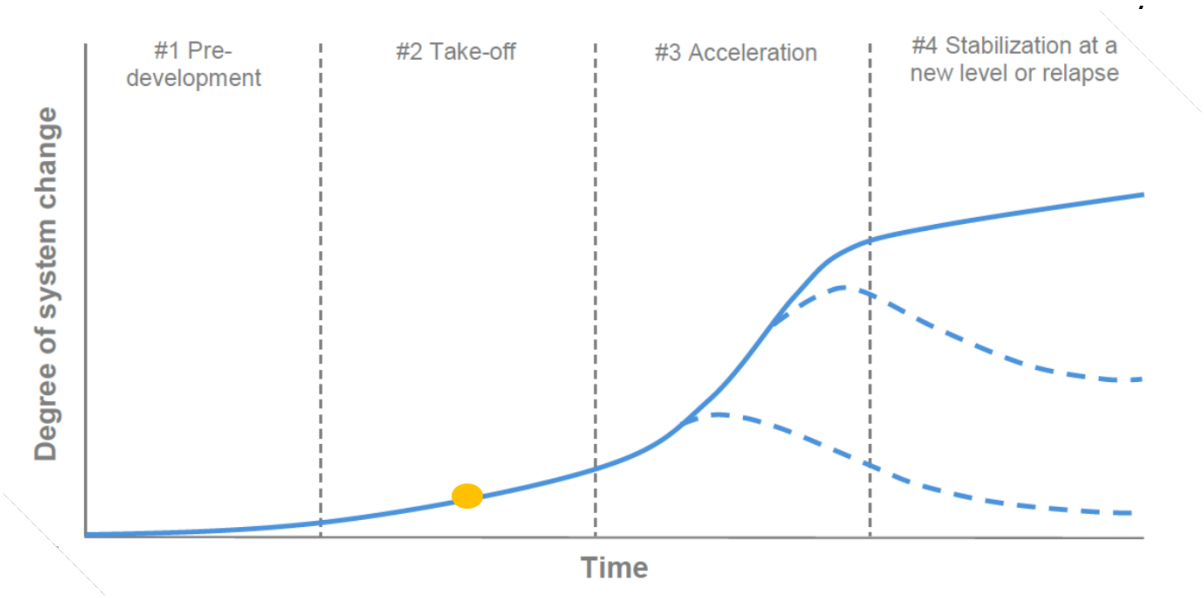

Figure 2. Phase of transformation of the systems (forestry and agriculture sectors) in which the policy is implemented

Note: stakeholder consultations could be included to identify the phase of transformation.

3.2.2 Describe the vision for transformational change

The second step to understanding the context better and informing the selection of relevant TC characteristics is to describe the vision of transformational change put forward by the policy, for the short, medium, and long-term.

Again, for this step, it is also useful to comprehend the broader picture envisioned by current forestry and agriculture policies, to better comprehend the role of the agroforestry policy to support transformational change.

The vision of the forestry policy (2015) is to create a thriving and integrated forest sector, where the forests of Belize are valued for their significant economic, socio-cultural, and environmental benefits, and are sustainably managed for the lasting benefit of the nation.

The vision of the agriculture policy (2015-2030) is to engender a conducive environment for the development of an Agriculture and Food Sector that is competitive, diversified, and sustainable, enhances food security and nutrition, and contributes to the achievement of the socio-economic development goals of Belize.

In this context, the agroforestry policy whose vision is to mainstream the use of agroforestry systems that are productive, competitive, and adoptable by small, medium and large farmers, producers and land users, aims to enhance food and nutrition security, conserve natural resources (i.e., lands, forests, biodiversity and water), improve the environment, and strengthen the resilience of the agricultural sector to climate change.

In order to mainstream AF in Belize, the goals of the national agroforestry policy are two-fold:

1. To propose and advocate for enabling legislation, legislative reforms, and complementary policies, and to coordinate and build synergies among the relevant

sectors, institutions, and programs for its widespread adoption and development as a viable and sustainable option for Belize.

2. To improve the total productivity, resilience and sustainability of agriculture and forestry through the adoption of agroforestry systems in Belize, to improve the livelihood and wellbeing of present and future generations, with particular attention to the participation of the youth, women, the poor and indigenous peoples across the country.

The policy also describes what is the change envisioned in the short and medium term. The policy does not mention what is the vision for the long-term (>15 years). A description of the vision of the agroforestry policy is provided in Table 4.

Table 4. Description of the vision of the agroforestry policy.

Time periods	*Vision of the policy*
Short-term (<5 years)	*Strengthen all the human resources with current or potential interest in agroforestry. Improve skills and knowledge through education and capacity building. Leverage leaders to coordinate different institutions to get their commitment and support, and to mobilize and motivate stakeholders. Improve the knowledge of the science and practice, through the collection of empirical data for the ex-ante or ex-post analysis of the AF systems. Understand the consumer demand and market conditions. Develop processing and value-adding operations that can be integrated into agroforestry projects. Leverage investment and financing.* *The agroforestry policy mentions these quantitative targets for the short-term:* • *Train farmers and producers, at least 5,000 in all 6 districts of whom at least 30% are female. In 5 years.* • *Train staff in public institutions and civil society, at least 50 with at least 20 professionals with MSc and 5 with PhDs; approximately 50% female, in 5 years.* *Mobilize resources for investment and financing of AF programs and projects, targeting at least $5 million per annum during the first 5 years.*
Medium-term (≥5 years and <15 years)	*Establish a proposed National Agroforestry Council. Continue strengthening and developing skills. Continue to leverage finance. Identify and understand policies and legislation that can promote or discourage agroforestry and bring necessary policy and legal changes. Achieve impacts on sustainable development.* *The agroforestry policy mentions these quantitative targets for the medium-term:* • *Bring about innovative, diversified enterprises, hence improving food security, nutrition, and health of the people, affecting at least 10,000 households after five years.* • *Improve interactions and recycling processes (e.g., bring up water and nutrients from deep in the ground and build soil organic matter and thus soil carbon) in the productive components which will enable higher productivity and higher income and profits from the sale of crops, fruits, livestock, tree products, and non-timber forest products, valued at least B$100 million in income every year.* • *Increase the asset base with planted trees reaching maturity stages, creating better microclimates and rendering agricultural landscapes more attractive and resilient, thereby improving the value of some 20,000 acres in 10 years.* • *Increase forest cover, conservation of flora and fauna species, and protect the biodiversity and water resources at the national level, affecting 50,000 acres in 10 years.* • *Sequester carbon from the atmosphere and estimated captured CO_2 at 40 million tons every year.* • *Fortify our ecosystems and environmental services, such as providing wind barriers, restoring degraded lands (with established targets), improving water conservation, preventing soil erosion, and adapting to and building resilience to climate change, affecting another 50,000 acres in 10 years.* • *Develop supply value chains and value-adding capacities (plant capacity) for efficient input supply, processing, and marketing by the private sector, affecting some 5,000 enterprises over the next 10 years.* • *Improve the trade balance in terms of increasing exports of agricultural, food and timber products and reducing the import of the same products, valued at some B$300 million over 10 years.*

Long-term (≥15 years)	• *The policy does not have to include a long-term vision. It is assumed that the policy expects to bring further impacts on sustainable development.*

Note: stakeholder consultations could be carried out to gain insights on the vision of the policy.

3.2.3 Identify barriers to transformational change

Lastly, before the selection of relevant transformational characteristics, barriers to transformation are analyzed. This helps to understand the transformational characteristics that are more relevant to be tackled by the policy, and to correctly assess the impacts of the policy on transformational processes.

Sustainable land management practices, such as agroforestry, are not widely adopted due to insecure land tenure, lack of access to resources and agricultural advisory services, insufficient and unequal private and public incentives, and lack of knowledge and practical experience[4]. This is also the case in Belize, where several of these barriers exists, as reported in the Agroforestry Policy. Table 5 reports a summary of these, including which characteristics of transformation are affected by the barrier, and if the policy targets the removal of that barrier.

Table 5. Barriers to agroforestry in Belize, according to the National Agroforestry Policy.

Barrier	Explanation	Characteristics affected	Barrier directly targeted by the policy
Lack of awareness of the benefits of agroforestry	Farmers and producers have inadequate knowledge and awareness of the benefits of agroforestry. Farmers need training, and time to develop agroforestry practices.	Awareness Behaviours Beneficiaries	Yes
Lack of data on the benefits of agroforestry	There is a need for sound empirical data, to better understand the impacts of agroforestry locally.	Awareness Behaviour	Yes
Expert knowledge in agroforestry	Expert knowledge of agroforestry is low. Few if any institutions can provide technical assistance or training. There is a need to build the capacities in education, R&D, etc. to forge a "critical mass" to guide, plan and evaluate AF development.	Awareness Research and Development Coalitions of advocates	Yes
Inputs for agroforestry	Farmers need quality seedlings/nurseries, inputs and water, finance, fast returns, and land for agroforestry adoption.	Adoption Entrepreneurs	No
Limited financial support	There is limited financing and the costs of borrowing is prohibitive for agriculture. Hence the levels of investment are low, profits are low and investment risks are high due to climatic, biological, and economic factors.	Economic and non-ECON. incentives Adoption Entrepreneurs	Yes
Competitive market for agroforestry products	Prices for agroforestry products are low and unstable. Lack of complementary activities in the product value chain adds value to all the main products and by-products and make them more competitive in the market.	Other/Incentive – market Economic and non-ECON. incentives Beneficiaries Entrepreneurs Adoption	Yes

Lack of broader engagement in agroforestry	Certain customary practices and beliefs present challenges for agroforestry, i.e., working in groups, poor business practices, engaging the women and the youth.	Social norms Scale-up	Yes
Legal and regulatory frameworks discourage agroforestry practices	Harvesting wood requires an application and granting of a permit/license. The land tax regime of the country does not offer incentives to producers and farmers to support new development and conservation priorities.	Institutional and regulatory	Yes

***Note**: stakeholder consultations could be carried out to complement the identification of the barriers.*

3.2.4 Relevant transformational change characteristics

Transformational change impacts are divided into processes and outcomes. Both process and outcomes are further broken down in characteristics (

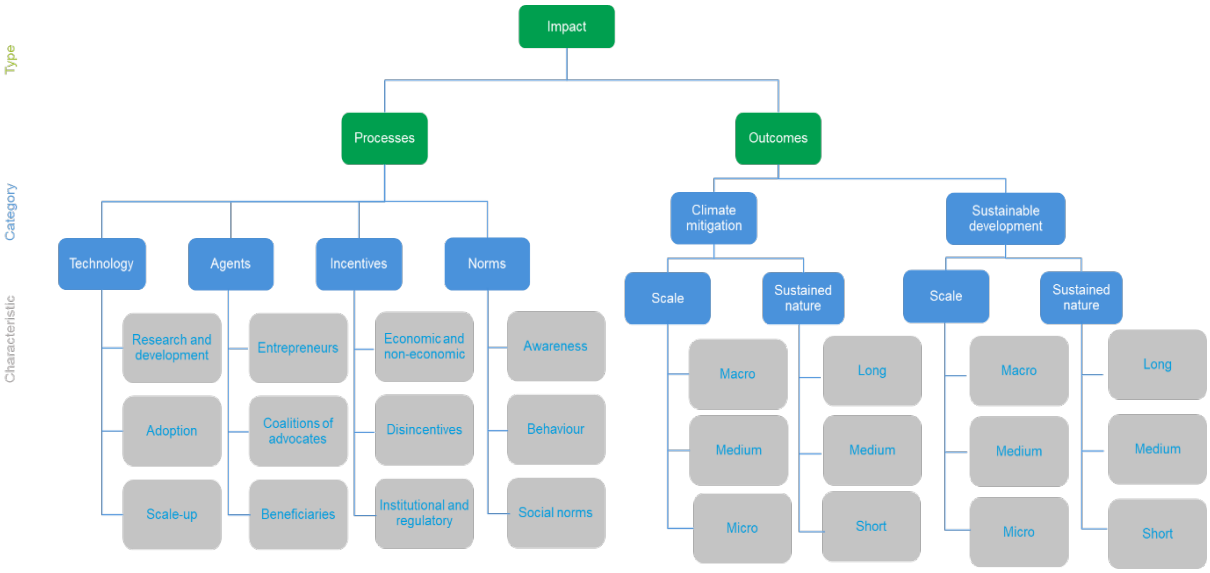

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Figure 3. Characteristics of transformational impact in the TC taxonomy.

Several drivers of change are mentioned in agroforestry literature, as the focus of interventions is intended to promote agroforestry, which can be connected to process characteristics of the TC taxonomy. Examples of these are capacity building for farmers, enhancing access to tree germplasm, community-level campaigning and advocacy, incentive provision, market linkage facilitation, institutional and policy change, securing land tenure, factoring environmental costs into food, making payments for ecosystem services, and enhancing local and community collective action, promoting diets based on public health guidelines, empowering women, raising awareness, promoting availability and accessibility of data and information relating to the effectiveness, co-benefits and risks of agroforestry[4,6]. The agroforestry policy also mentions several of these drivers of change, with some specific considerations for the context of Belize.

Based on this, relevant process characteristics are selected. Relevance should not be intended as "relevance for the policy" or "affected by the policy", but as the relevance of the process in the context in which the policy is implemented, i.e., agroforestry development, to achieve transformational change. The results of the selection of process characteristics are presented in Table 6.

Table 6. Relevant process characteristics.

Category	Process characteristics	Relevance	Justification
Technology	Research and development (R&D)	Yes	R&D is important in the context of the policy. It can generate knowledge and data for understanding the impacts of AF. It is also directly addressed by the policy.
	Adoption	Yes	Adoption of AF systems is necessary at this stage of the transformation. This need is also addressed by the policy.
	Scale up	Yes	Scale-up of current solutions is important in this context. Some local AF solutions exist, but are not mainstreamed.
Agents	Entrepreneurs	Yes	Entrepreneurs are key to support R&D and adoption of AF and innovation on smart agriculture.
	Coalitions of advocates	Yes	Coalitions that can coordinate, bring knowledge, and spearhead the development of agroforestry are needed.
	Beneficiaries	Yes	It is important that beneficiaries such as farmers are engaged for AF to succeed.
Incentives	Economic and non-economic	Yes	The lack of economic incentives is broadly mentioned as one of the main barriers for AF development. It is also explicitly addressed by the policy.
	Disincentives	No	Disincentives do not seem to be relevant in the context in which the policy is implemented.
	Institutional and regulatory	Yes	Institutional and regulatory impediments are mentioned as barriers for AF development. Improvements are needed.
Norms	Awareness	Yes	A low level of awareness on AF benefits is mentioned as an important constraint for AF development.
	Behaviour	Yes	Change in behaviour related to agricultural practices are necessary for AF development.
	Social norms	Yes	Certain social norms such as the engagement of women and youth can hamper the scale-up and adoption of AF.

Similarly, outcomes characteristics are selected, taking into account the scope of agroforestry in Belize, and the impacts that are expected to be relevant for an agroforestry intervention such as the one envisioned by the policy. Results are presented in Table 7. The following definitions of scale and sustained nature should be kept in mind.

- Macro level: GHG outcome is large in magnitude at international/global level
- Medium level: GHG outcome is large in magnitude at national or sectoral levels. For example, at national level, for the agriculture and forestry sectors.
- Micro level: GHG outcome is large in magnitude at subnational, subsector, city or local levels. For example, for the areas affected or potentially affected by agroforestry.
- Long term: GHG outcome is achieved and sustained ≥15 years from the starting situation

- Medium term: GHG outcome is achieved and sustained ≥5 years and <15 years from the starting situation
- Short-term: GHG outcome is achieved and sustained <5 years from the starting situation

Table 7. Relevant outcomes characteristics.

Category	Outcome characteristics	Relevance	Justification
Scale of outcome GHGs	Macro level	Yes	Avoided GHG emissions through agroforestry in Belize will contribute to the Paris Agreement goal in a minor way.
	Medium level	Yes	Avoided GHG emissions will have an impact on the national GHG inventory and at sectoral level.
	Micro level	Yes	Avoided GHG emissions through agroforestry in Belize may be significant at the local level.
Scale of outcome Sustainable development	Macro level	No	Sustainable development impacts expected from the policy will not have a relevant impact at global level.
	Medium level	Yes	Sustainable development impacts expected from the policy may impact the country's economy on several development objectives.
	Micro level	Yes	At micro level, the policy is expected to bring several development benefits.
Outcome sustained over time GHGs	Long term	No	The policy does not explicitly mention if and how it will impact GHG reductions against baseline in the long-term.
	Medium term	Yes	The policy is expected to impact GHG reductions against baseline in the medium-term.
	Short-term	Yes	The policy is expected to impact GHG reductions against baseline in the short-term.
Outcome sustained over time Sustainable development	Long term	No	The policy does not explicitly mention if and how it will impact sustainable development in the long-term.
	Medium term	Yes	The policy is expected to bring some development benefits in the medium-term.
	Short-term	Yes	The policy is expected to bring some development benefits in the short-term.

Based on the selection of relevant characteristics, the TC taxonomy for the agroforestry policy is presented below.

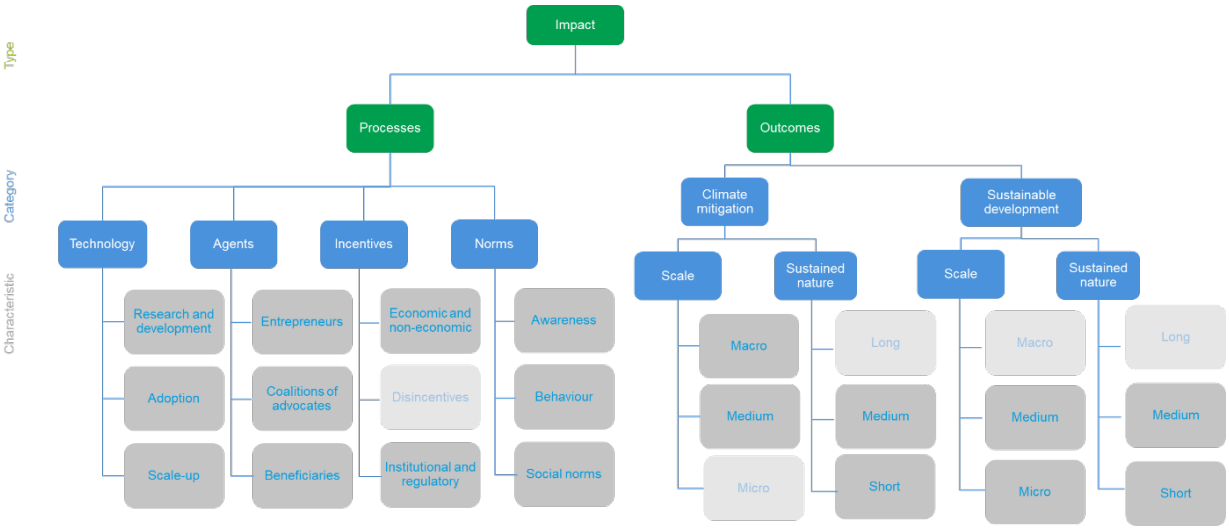


Figure 4. Relevant transformational characteristics for the agroforestry policy in Belize

Note: stakeholder consultations could be carried out to inform the identification of relevant impact categories.

4 Definition of baseline scenario

4.1 Description of the baseline scenario

As this analysis mostly relies on a qualitative assessment, a general description of the baseline scenario is sufficient. A detailed description of the baseline situation for the selected sustainable development categories are not required. Moreover, a description of the starting situation and relevant indicators are provided for the transformational change characteristics.

The baseline scenario is the situation most likely to happen in the absence of the policy (in this case, the agroforestry policy). In our case, the most likely situation in the absence of the policy is a result of the mix of the current policies (excluding the agroforestry policy) and actions, and of those socio-economic trends that characterise the area.

The forestry policy highlights several ways to support the conservation of the forests. The agriculture policy supports the development of agriculture as one of the main sources of income in Belize. Studies reported in the forestry policy show that deforestation is increasing in Belize and expected to lead to shrinking of the forest area from 61% in 2015 to 56% in 2025. Agroforestry actions can be found in different areas and contexts in Belize. However, these actions are not coordinated, leading to the impression that the full potential of agroforestry is not currently harvested. Agroforestry is also briefly mentioned in a couple of points in the forestry policy, specifically:

- As one of the strategies under policy statement 6: develop capacity of individuals including landowners, women, and youth groups, to develop agroforestry initiatives through the management of private forests and integration of trees into farming systems, and
- As one of the strategies under policy statement 9: promote the development of agroforestry in forest areas which directly buffer community lands where the pressure for agriculture expansion may be strongest thereby maximizing the economic output of forest buffers.

However, no more details are provided to address this topic.

The baseline scenario is therefore assumed to be a scenario in which agriculture will keep putting pressure on the forests, slowly gain land, mostly through the areas which are not labelled as conservation areas although trespassing on certain important conversation areas is not to be excluded. Deforested land would be, for the most, fully transformed into agricultural land composed of monocultures or traditional forms of agriculture, although smart-agriculture (including agroforestry) initiatives would be developed ad-hoc, but not in a coordinated way aimed to mainstream those practices.

Table 8 and Table 9 provide a description of the starting situation for the process and outcome characteristics. An additional table including suggested indicators is provided in the appendix.

Table 8. Description of the starting situation for transformation change process characteristics.

Process category	Process characteristic	Description of the starting situation
Technology	Research and development	There is little data available on agroforestry nationally due to low levels of R&D on this topic
	Adoption	Agroforestry projects are adopted locally and ad-hoc, in a few communities and programs (e.g., YCT, TFCGA, etc.)
	Scale-up	Agroforestry is not adopted at scale in Belize.
Agents	Entrepreneurs	There is low level of innovation and entrepreneurship in this area in Belize
	Coalitions of advocates	A few associations focusing on agroforestry exist
	Beneficiaries	It is unclear how many people currently engage in AF. Some communities are involved and practice, mostly following traditions.
Incentives	Economic and non-economic incentives	There are currently no government incentives to practice agroforestry
	Institutional and regulatory	No specific institutional and regulatory measures to favor the development of agroforestry. Current frameworks do not make it easy for AF to be developed
Norms	Awareness	The current level of awareness on these practices is low. Agroforestry-related knowledge mostly comes from traditions, and it is not seen as a modern practice
	Behaviour	Most farmers adopt traditional forms of agriculture.
	Social norms	Youths and women are largely left out.

Table 9. Description of the starting situation for transformation change outcome characteristics.

Category	*Outcome characteristics*	*Description of the starting situation*
Scale of outcome GHGs	*Macro level*	*Agroforestry practice at the moment are so small that there is no impact at the global level*
	Medium level	*Agroforestry practice at the moment not that widespread and the impact at national/sectoral levels is considered to be very small*
	Micro level	*The impacts on avoided GHG emissions at local levels are probably minor*
Scale of outcome Sustainable development	*Medium level*	*There are very minor impacts at the moment on sustainable development from agroforestry, in terms of agriculture and forestry sector.*
	Micro level	*Some sustainable development impacts from the current projects*
Outcome sustained over time GHGs	*Medium term*	*Small avoided emissions in the medium term*
	Short-term	*Small avoided emissions in the short term*
Outcome sustained over time Sustainable development	*Medium term*	*Small sustainable development impacts in the medium term*
	Short-term	*Small sustainable development impacts in the short term*

Note: stakeholder consultations could be carried out to inform the assessment of transformational change in the baseline.

5 Assessment of the impacts of the policy

In the policy scenario, agroforestry is assumed to spread more widely. If in the baseline scenario agroforestry is only implemented ad-hoc, in areas turned from forest to agriculture, or current agriculture areas, in the policy scenario a wider adoption is expected to be seen. In this scenario, some of the existing agriculture systems will be transformed into agroforestry, especially buffer zone areas. Some of the areas that are turned from forests to agriculture during the assessment period (2020-2030) would instead be transformed into agroforestry, especially buffer zone areas. However, this scenario also considers a minor part, in proportion, of the forest areas that were not, in the baseline to be transformed into agriculture, to potentially be transformed into agroforestry due to attractiveness of agroforestry as a more environmentally sustainable compromise.

5.1 Impacts of the policy on sustainable development

5.1.1 Selection of specific impacts

As a first step, specific impacts for each SD impact category are identified. These are positive or negative impacts, long or short-term impacts, within or outside jurisdiction, etc. which are expected to affect more specifically each impact category. Specific impacts are defined based on literature review. A comprehensive table referencing the literature used is available in the appendix, and Table 10 presents the summary of the identification of specific impacts.

Table 10. Identification of specific impacts.

Dimension	Impact category	Specific impact
Environmental	Climate change mitigation	Increase in CO2 sequestered due to increase in biomass (in comparison to pure agriculture)
		Decrease in GHG emissions due to reduced nutrient leaching
		Decrease in GHG emissions from less production of fertilizers
		Decrease in CO2 sequestered if more forest area is converted to agroforestry
	Biodiversity	Increase in biodiversity in agroforestry area (in comparison to pure agriculture)
		Conservation of biodiversity in forestry areas due to less deforestation
		Protection of forest's biodiversity through agroforestry areas acting as buffer zones
		Ecosystem services and support (pollination, pest and disease control)
		Loss of biodiversity if more forest areas are converted into agroforests
	Freshwater (security and quality)	Maintenance and increase in water quality
		Decrease in use of water resources
		Hydrological cycle maintenance (e.g., groundwater recharge)
		Higher water-use from agroforestry due to higher competition for water
	Soil quality and land degradation	Improved quality of soil in agricultural systems that are converted to agroforestry
		Maintenance of quality of soil (in comparison to pure agriculture)
	Deforestation	Increase in vegetation cover (if agricultural systems are

		turned into agroforestry)
		Decrease in the need to cut forests due to production of wood products from farmers' fields
		Decreased in long-term need for deforestation due to longer term productivity of agroforestry
		Higher deforestation due to attractiveness of agroforestry
Social	Climate change adaptation	Contribution to climate change adaptation due to development of resilient modes of agriculture (diversified yields)
		Contribution to climate change adaptation due to development of resilient modes of agriculture (less water intensive)
		Contribution to climate change adaptation due to development of resilient modes of agriculture (mitigation of impacts of EWE related to high temperatures and wind)
	Food security	Increase productivity and yields
		Decrease in productivity and yields
		Diversification leading to more diverse and healthy diet
		Diversification leading to more resilience
		Increased food security in relation to climate change
		Reduced risk of disease and pests
	Healthy lives and well-being	More diverse and healthy diet
	Empowerment of women	Increased women participation in land management
	Energy access	Improved access to wood as fuel
	Conflict	Reduced conflicts due to privatization and pressure to communal resources
		Increased risk of conflicts due to inequalities
	Human-environment interactions	Preserved or increased physical, spiritual, and intellectual interactions with nature
		Loss of interaction physical, spiritual, and intellectual interactions with nature if more forest is lost
Economic	Poverty	Increased income of small-scale farmers and households from increased yields
		Reduced expenditures of small-scale farmers and households from higher reliance on own products or decreased reliance on external products (e.g. fertilizers)
		Decreased income of small-scale farmers and households from lower yields
	Economic activity	Increased economic activity due to higher and more diverse yields
		Increased economic activity due to accessibility of agroforestry

Note: it is advised to include stakeholder consultations to identify specific impacts.

5.2 Qualitative impact assessment of sustainable development

5.2.2 Environmental impacts

Climate change mitigation

Agroforestry is recognised as having the potential to contribute to climate mitigation through sequestration of GHGs, as it increases below and above ground carbon storage compared to traditional agriculture[7]. This happens through increased coverage of trees as litter fall and enhanced root production, and organic material are incorporated into the soil.

However, the extent of the sequestration varies from areas according to the climate and the practices that are implemented[7] and the carbon sequestered is not stored indefinitely[4]. Nitrogen-fixing plants, which can be applied in agroforestry systems, can also decrease the leaching of N_20 derived from application of fertilizers back to the air[4]. Furthermore, agroforestry can decrease the need for fertilizers leading to a potential decrease in emissions from production of fertilizers (which is a very GHG intensive process)[2].

Agroforestry systems can accommodate a higher tree coverage compared to pure agriculture systems (such as monocrops cultivations), thus increasing biomass and carbon sequestration. As, in comparison to the baseline scenario, the policy scenario considers the possibility of current agricultural systems to be transformed into agroforestry and forests areas to be turned into agroforestry instead of agriculture, the likelihood of the above-mentioned impacts is likely. However, the policy scenario also considers, in comparison to the baseline, the possibility of some forest areas to be transformed into agroforestry while they would have not been turned into agriculture in the baseline. In this possible scenario, one negative specific impact could be observed, specifically the decrease in above ground biomass and decrease in CO_2 sequestered, as agroforestry systems sequester less carbon than forests[7]. The magnitude of this impact is considered minor, due to the difference between carbon storage capacity of forests and agroforestry (which is significant) and the size of the systems that would be interested by this impact, and the likelihood is considered Very likely as the impact will be very likely to materialise in those situations where additional forests are cut to make space for agroforestry.

Overall, there are likely to be moderate impacts on climate change mitigation from the policy.

Biodiversity

In the case where forestry areas are transformed into agroforestry instead of agriculture, or current systems based on pure agriculture would be turned into agroforestry systems, there are very likely positive impacts for these systems to host more biodiversity, at least with regards to some of the species that can adapt to more fragmented landscapes[2,7]. The impact is considered of moderate/minor magnitude due to the type of size of the species considered. Furthermore, the increase in agroforestry systems is likely to lead to a decrease in the need for cutting forest wood, and for deforestation, which is likely to impact the loss of biodiversity moderately[5,7]. Agroforestry areas are also expected to be deployed in certain areas where they can act as buffer zones, and likely contribute to the protection of the forest area and biodiversity (moderate magnitude)[7]. Agroforestry systems are also reported to potentially contribute to supporting a range of ecosystem services in comparison to traditional agriculture, such as providing a better habitat for pollinators and contributing to pest control[5–7]. These impacts are considered likely and of moderate magnitude.

Finally, in those cases where additional forests would be cut to make space for agroforestry, in comparison to the baseline scenario, this is very likely to lead to a loss of biodiversity[7] with minor to moderate magnitude, considering the size of the systems interested and the wide biodiversity in Belize.

Overall, there are likely to be moderate impacts on biodiversity from the policy.

Freshwater

In terms of impact on freshwater, in comparison to the baseline scenario, there are likely

and moderate positive impacts on maintenance (in comparison to forests) and increase (in comparison to agriculture) in water quality, due to a reduction in the relation of N and P from fertilizer application that would lead to eutrophication [2,6]. Agroforestry is also likely to lead to a more efficient use of water resources/decreased water demand from crops, with minor to moderate consequences of water use[7]. Agroforestry is also reported to help maintaining the hydrological cycle, as trees help support groundwater recharge, improve water retention and regulate water flow [5–7]. Impacts on maintenance of hydrological cycles are considered possible and minor. Finally, studies report a possible increase in competition for water, as sometimes (e.g. in dry seasons), trees can increase water consumption. This impact is however highly dependent on the climate and the systems implemented. Considering the area of Belize, this impact is considered unlikely and of minor magnitude.

Overall, there are likely and moderate impacts on water.

Soil quality and land degradation

As for soil quality and land degradation, the literature reports a very likely impact on improved soil quality in agroforestry systems in comparison to pure agriculture[2,4–7]. This happens as a result of reduced use of artificial fertilisers and more use of organic ones, reduced soil erosion and increase in soil fertility maintenance through increase of organic matter, microflora and fauna, and water infiltration. Magnitude is considered moderate looking at the magnitude of improvement in the soil quality and size of the systems considered.

Deforestation

Impacts on deforestation include increase in vegetation cover in agricultural systems that are turned in agroforestry systems (very likely and of minor to moderate magnitude due to the number of trees planted)[7]; decrease in the need to cut forests due to production of wood products from farmers' fields (likely, moderate); and decreased in long-term need for deforestation due to longer term productivity of agroforestry (possible, moderate).

Higher deforestation due to attractiveness of agroforestry can also happen. The impact of this possibility on deforestation is considered likely and moderate.

Summary of environmental impacts

Impact category	Specific impact	L	M	+/-	S	Overall assessment
Climate change mitigation	Increase in CO2 sequestered due to increase in biomass (in comparison to pure agriculture)	Very likely	Moderate	+	Yes	Likely, moderate, positive
	Decrease in GHG emissions due to reduced nutrient leaching	Likely	Moderate	+	Yes	
	Decrease in GHG emissions from less production of fertilizers	Possible	Moderate		Yes	
	Decrease in CO2 sequestered if more forest area is converted to agroforestry	Very likely	Minor	-	No	
Biodiversity	Increase in biodiversity in agroforestry area (in comparison to pure	Very likely	Moderate	+	Yes	Likely, moderate, positive

	agriculture)					
	Conservation of biodiversity in forestry areas due to less deforestation	Likely	Moderate	+	Yes	
	Protection of forest's biodiversity through agroforestry areas acting as buffer zones	Likely	Moderate	+	Yes	
	Ecosystem services and support (pollination, pest and disease control)	Likely	Moderate	+	Yes	
	Loss of biodiversity if more forest areas are converted into agroforests	Very likely	Moderate	-	Yes	
Freshwater (security and quality)	Maintenance and increase in water quality	Likely	Moderate	+	Yes	Likely, moderate, positive
	Decrease in use of water resources	Likely	Minor	+	No	
	Hydrological cycle maintenance (e.g. groundwater recharge)	Possible	Moderate	+	Yes	
	Higher water use from agroforestry due to higher competition for water	Unlikely	Minor	-	No	
Soil quality and land degradation	Improved quality of soil in agricultural systems that are converted to agroforestry	Very likely	Moderate	+	Yes	Very likely, moderate, positive
	Maintenance of quality of soil (in comparison to pure agriculture)	Likely	Moderate	+	Yes	
Deforestation	Increase in vegetation cover (if agricultural systems are turned into agroforestry)	Very likely	Minor	+	No	Likely, moderate, positive
	Decrease in the need to cut forests due to production of wood products from farmers' fields	Likely	Moderate	+	Yes	
	Decreased in long-term need for deforestation due to longer term productivity of agroforestry	Possible	Moderate	+	Yes	
	Higher deforestation due to attractiveness of agroforestry	Likely	Moderate	-	Yes	

5.2.2 Social impacts

Climate change adaptation

The links between agroforestry and climate change adaptation is reported widely in the literature. However, such impacts are site specific[4]. Resilience through climate change, can be improved through agroforestry as it helps diversifying yields [2,4] (very likely, moderate), may requires less water resources (possible, moderate), and mitigate impacts of extreme weather investments, for example, due to trees providing protection to the crops in case of high temperature and shelter from the wind (likely, minor).

Overall, impacts on climate change adaptation can be considered likely and moderate.

Food security

Food security is expected to be widely impacted through a series of links. First, agroforestry can bring additional production as new crops or trees are cultivated, increase production due to conservation of soil and water resources, and support pollinators [5–7] (possible, moderate). At the same time, the simultaneous possible increase in competition for water and nutrients and the reduction in the cropped area may lead to decreased yields in certain cases, especially in dry climates (possible, minor) [5,7]. Diversification of yields, achieved by cultivation of more diverse crops and trees can lead to a more diverse and healthy diet [5–7] (possible, moderate), and increase resilience [4](likely, moderate). Resilience and food security in the face of climate change can also be improved due to agroforestry, particularly through trees helping to mitigate extreme weather events, and by enhancing soil and water quality[5,7](possible, minor). Finally, additional food security benefits could be achieved as agroforestry helps with avoiding pests and with disease control [6,7] (possible, minor).

Overall, possible moderate impacts are expected on food security.

Healthy lives and well-being

As highlighted in the food security sections, agroforestry could provide a more all-round harvest, contributing to more diverse and healthy diets[7]. This impact is considered possible, as it depends on a variety of factors including products consumed outside agroforestry products, and of moderate magnitude considering the size of the systems considered.

Empowerment of women

Empowerment of women is one of the goals of the policy. However, in the literature, a correlation between agroforestry and women participation in land management is not found, although it is a desired outcome[4]. Lower initial capital costs and the type of work performed in certain agroforestry systems can favour women engagement. This impact is considered possible, as not enough information is available, and moderate, considering the size of the systems and the magnitude that it could have on women empowerment.

Energy access

Compared to the baseline, agroforestry can offer new ways of sourcing wood for fuel, which instead of being cut from the forest, can be harvest in the fields. This can likely lead to minor improvements of access to wood-fuelled energy, for example for heating and cooking [5,7].

Conflict

Literature reports possible links between agroforestry and conflicts due to decreased pressure on communal resources. As fields become privatized and owned by farmers, pressure on communal resources decreases, including through illegal logging, leading to decreased risk of disputes between farmers[7] (possible, minor). At the same time, inequalities could rise due to farmers claiming ownership on resources that have for a long time been known to be commons, leading to increase tensions (possible, minor).

Human-environment interactions

Interaction with nature can be preserved or increased in comparison with the baseline if fields are either turned from agriculture to agroforestry or transformed from forestry into

agroforestry instead of agriculture. Physical, spiritual, and intellectual interaction between humans and nature for example related to use of plants and animals (also in spiritual contexts), interaction with nature for scientific, education purposes, heritage/cultural and aesthetic interactions[6]. Such impacts are expected to be possible and minor, based on expert judgement. At the same time, loss of interaction can happen if additional forest is lost, in comparison to the baseline scenario (possible, minor). This impact could be of major magnitude in case sacred forests areas are lost, for example areas inhabited by indigenous people.

Summary of social impacts

Impact category	Specific impact	L	M	+/-	S	Overall assessment
Climate change adaptation	Contribution to climate change adaptation due to development of resilient modes of agriculture (diversified yields)	Very likely	Moderate	+	Yes	Likely, moderate, positive
	Contribution to climate change adaptation due to development of resilient modes of agriculture (less water intensive)	Possible	Moderate	+	Yes	
	Contribution to climate change adaptation due to development of resilient modes of agriculture (mitigation of impacts of EWE related to high temperatures and wind)	Likely	Minor	+	No	
Food security	Increase productivity and yields	Possible	Moderate	+	Yes	Possible, moderate, positive
	Decrease in productivity and yields	Possible	Minor	-	No	
	Diversification leading to more diverse and healthy diet	Possible	Moderate	+	Yes	
	Diversification leading to more resilience	Likely	Minor	+	No	
	Increased food security in relation to climate change	Possible	Minor	+	No	
	Reduced risk of disease and pests	Possible	Minor	+	No	
Healthy lives and well-being	More diverse and healthy diet	Possible	Moderate	+	Yes	Possible, moderate, positive
Empowerment of women	Increased women participation in land management	Possible	Moderate	+	Yes	Possible, moderate, positive
Energy access	Improved access to wood as fuel	Likely	Minor	+	No	Likely, minor, positive
Conflict	Reduced conflicts due to privatization and pressure to communal resources	Possible	Minor	+	No	Possible, minor, positive
	Increased risk of conflicts due to inequalities	Possible	Minor	-	No	
Human-environment interactions	Preserved or increased physical, spiritual, and intellectual interactions with nature	Possible	Minor	+	No	Possible, minor, positive
	Loss of interaction physical, spiritual, and intellectual interactions with nature if	Possible	Minor	-	No	

	more forest is lost					

5.2.3 Economic impacts

Poverty

Poverty alleviation has been found to be possibly linked with agroforestry through Increased income of small-scale farmers and households, which may happen from increased and more diverse yields [4,6,7] (possible, moderate), and reduced expenditures from higher reliance on own products or decreased reliance on external products (e.g., fertilizers, wood, food, etc.)[2,6] (likely, minor). Moreover, these activities could start being profitable only after 10 years[4]. A minor decrease in income could also be possible, if yields do not increase and crop area is reduced[5] (possible, minor). Overall, possible minor impacts on poverty alleviation could be observed.

Economic activity

Economic activity could also increase, as a result of higher and more diverse yields [2,5,6] (possible, minor), and due to a larger base of farmers that can be engaged in these activities as they have lower capital costs to start (possible, moderate). Overall, possible, and moderate positive impacts could be observed with regard to economic activity.

Summary of economic impacts

Impact category	*Specific impact*	*L*	*M*	*+/-*	*S*	*Overall assessment*
Poverty	*Increased income of small-scale farmers and households from increased yields*	*Possible*	*Moderate*	*+*	*Yes*	*Possible, minor, positive*
	Reduced expenditures of small-scale farmers and households from higher reliance on own products or decreased reliance on external products (e.g. fertilizers)	*Likely*	*Minor*	*+*	*No*	
	Decreased income of small-scale farmers and households from lower yields	*Possible*	*Minor*	*-*	*No*	
Economic activity	*Increased economic activity due to higher and more diverse yields*	*Possible*	*Minor*	*+*	*No*	*Possible, moderate, positive*
	Increased economic activity due to accessibility of agroforestry	*Possible*	*Moderate*	*+*	*Yes*	

Note: it is advised to include stakeholder consultations to qualitatively score the sustainable development impacts.

5.3 Impacts of the policy on transformational change

With regard to the assessment of transformational change impacts, not much evidence could be gathered so the assessment reflects the author's expert judgement based on the understanding of the policy. As this was the approach, it was important to find a coherent way for scoring characteristics based on the language used by the policy. Hence, for example in regards to the process characteristics, a score of 4 would be assigned when the policy was absolutely clear about how a certain action affecting a process characteristic would be undertaken, and targets would be assigned; a score of 3

was assigned when in addition to stating a goal, there was a somewhat clear description of how this would be achieved; a score of 2 is assigned when the policy is only mentioning the intention of affecting a certain process but not describing a way forward for how this will be achieved, etc. Scoring also considers the barriers for agroforestry mentioned identified in the earlier section. More information should be gathered through stakeholder participation. Explanation on the scoring system can be found below.

Score[a]	Description
Process characteristics	
4	It is very likely (e.g. a probability of 90–100%) that the policy will have a significant positive impact on this characteristic over the assessment period.
3	It is likely (e.g. a probability of 66–90%) that the policy will have a significant positive impact on this characteristic over the assessment period.
2	It is possible (e.g. a probability of 33–66%) that the policy will have a significant positive impact on this characteristic over the assessment period. Instances where the likelihood is not fully known or cannot be determined with certainty should be considered possible.
1	It is unlikely (e.g. a probability of 10–33%) that the policy will have a significant positive impact on this characteristic over the assessment period.
0	It is very unlikely (e.g. a probability of 0–10%) that the policy will have a significant positive impact on this characteristic over the assessment period.
Outcome characteristics – scale (for GHG and sustainable development impacts)	
3	The policy will result in GHG impacts that represent large emissions reductions, relative to the starting situation, at the level of assessment targeted. The policy will result in large net positive sustainable development impacts, relative to the starting situation, at the level of assessment targeted.
2	The policy will result in GHG impacts that represent moderate emissions reductions, relative to the starting situation, at the level of assessment targeted. The policy will result in moderate net positive sustainable development impacts, relative to the starting situation, at the level of assessment targeted.
1	The policy will result in GHG impacts that represent minor emissions reductions, relative to the starting situation, at the level of assessment targeted. The policy will result in minor net positive sustainable development impacts, relative to the starting situation, at the level of assessment targeted.
0	The policy will not result in GHG impacts relative to the starting situation at the level of assessment targeted. The policy will not result in sustainable development impacts, relative to the starting situation, at the level of assessment targeted.
–1	The policy will result in GHG impacts that represent a net increase in emissions, relative to the starting situation, at the level of assessment targeted. The policy will result in net negative sustainable development impacts, relative to the starting situation, at the level of assessment targeted.

Score[a]	Description
Outcome characteristics – time for which outcome is sustained (for GHG and sustainable development impacts)	
3	The policy will result in GHG impacts that are very likely (e.g. a probability of 90–100%) to be sustained over the assessment period. The policy will result in sustainable development impacts that are very likely (e.g. a probability of 90–100%) to be sustained over the assessment period.
2	The policy will result in GHG impacts that are likely (e.g. a probability of 66–90%) to be sustained over the assessment period. The policy will result in sustainable development impacts that are likely (e.g. a probability of 66–90%) to be sustained over the assessment period.
1	The policy will result in GHG impacts that will possibly (e.g. a probability of 33–66%) be sustained over the assessment period. Instances where the likelihood is unknown or cannot be determined should be considered possible. The policy will result in sustainable development impacts that will possibly (e.g. a probability of 33–66%) be sustained over the assessment period. Instances where the likelihood is unknown or cannot be determined should be considered possible.
0	The policy will result in GHG impacts that are less likely (e.g. a probability of 10–33%) to be sustained over the assessment period. The policy will result in sustainable development impacts that are less likely (e.g. a probability of 10–33%) to be sustained over the assessment period.
-1	The policy will result in GHG impacts that are unlikely (e.g. a probability of 0–10%) to be sustained over the assessment period and risk being reversed to negative impacts. The policy will result in sustainable development impacts that are unlikely (e.g. a probability of 0–10%) to be sustained over the assessment period and risk being reversed to negative impacts.

Table 11. Scoring of process characteristics.

Category	Characteristic	Score	Rationale justifying the score	Relevant indicators mentioned in the policy
Technology	Research and development	3	The policy has a strong focus on R&D to increase the knowledge of agroforestry. Strengthening capacities to provide science-based data to professionals is one of the objectives of the policy. One of the goals of the proposed National Agroforestry council (NAFC) will be to generate knowledge, conduct evaluations and solve problems identified on AF. The policy has impact targets on how much personnel will be trained in these issues, but it is a bit unclear R&D will be supported in practice.	Train staff in public institutions and civil society, at least 50 with at least 20 professionals with MSc and 5 with PhDs; approximately 50% female, in 5 years
	Adoption	3	Adoption is hindered by lack of inputs (e.g. seedlings), financial support, market preparedness, complementary activities. Adoption of agroforestry systems is one of the main objectives of the policy, which advocates for widespread adoption of agroforestry and promote tree planting in farming systems, villages and urban areas, to meet the ever-increasing demand of timber, food, fuel, fodder, fertilizer, fiber, and other products. Furthermore supports the goal to develop AF alternatives to the	Bring about innovative, diversified enterprises, hence improving food security, nutrition and health of the people, affecting at least 10,000

			current farming systems, and recover degraded lands, and as a way of reducing the pressure on existing forests. It expects to mobilize resources for investment and financing of AF programs and projects, targeting at least $5 million per annum during the first 5 years.	households after five years
	Scale up	2	There is a lack of broader engagement in AF. This is also due to certain customs and beliefs (e.g. working in groups, poor business practices, engaging the women and the youth). Similarly to adoption the policy is likely to support the scale up of agroforestry initiatives in the areas where they are already present. It aims to achieve an increase the asset base with planted trees reaching maturity stage.	Increase forest cover, conservation of flora and fauna species, and protect the biodiversity and water resources at the national level, affecting 50,000 acres in 10 years.
Agents	Entrepreneurs	2	The policy states among the expected outcomes that it aims to bring about innovative, diversified enterprises. However, it is unclear how these new enterprises will be supported or created.	Bring about innovative, diversified enterprises, hence improving food security, nutrition and health of the people, affecting at least 10,000 households after five years
	Coalition of advocates	4	Expert knowledge on agroforestry is low. Few if any institutions can provide technical assistance or training. Coalitions of advocates can help in sharing good practice. The policy recognises that agroforestry is already present in the territory but that its full potential is not harvested because institutions do not collaborate and instead work in silos. As a response to that, it aims to establish a National Agroforestry Council (NAFC) who will be the main organizational authority for implementing the NAFP is a proposed National AF Council (NAFC) to be established with representation of the key organizations with interest and capacity to participate. Furthermore, the policy puts forward the objective to organize a review, planning and learning conference, at least every 2 years, with representatives of the main AF stakeholders, which can helps building coalitions of advocates. It also expresses a concrete desire for engaging agroforestry professional at all levels, starting from leaders at governmental institutions, to farmers.	NAFP: The main organizational authority for implementing the NAFP is a proposed National AF Council (NAFC) to be established with representation of the key organizations with interest and capacity to participate
	Beneficiaries	3	Beneficiaries lack awareness of the benefits of agroforestry and need to be engaged in training, and through provision of incentives. The policy expresses the goal to train	Train farmers and producers, at least 5,000 in all 6 districts of whom at least

			farmers and producers, through a variety of ways.	30% are female. In 5 years
Incentives	Economic and non-economic incentives	2	Barriers such as limited financial support, high prices, and market competition from abroad are hindering uptake of AF. The policy recognises that motivation for action or provision for a service or sacrifice requires payment or compensation. It highlights that in the short to medium terms, the market-driven approach must receive increased attention to ensure that AF can be profitable. The consumer demand/market conditions must be understood, processing and value adding operations must be developed and integrated into AF projects. One of the objectives of the policy is to resolve impediments pertaining to monetary and fiscal measures that hamper adoption of agroforestry. It also aims to apply market-driven approaches and develop value adding, processing and packaging of a range of AF products and by-products, and provide the appropriate incentives for AF beneficiaries. However, clear schemes are not developed as part of the policy.	Mobilize resources for investment and financing of AF programs and projects, targeting at least $5 million per annum during the first 5 years.
	Institutional and regulatory	3	Legal and regulatory frameworks discourage agroforestry practices. The policy proposes to establish the NAFC: The main organizational authority for implementing the NAFP. The council will also look at policy, legislation identify and understand polices and legislation that can promote or discourage AF, and work to bring about policy and legal changes that will enable the success of the NAFP.	The main organizational authority for implementing the NAFP is a proposed National AF Council (NAFC) to be established with representation of the key organizations with interest and capacity to participate
Norms	Awareness	3	Barriers such as lack of awareness of the benefits of agroforestry, lack of data on the benefits of agroforestry, and lack of expert knowledge in agroforestry are hampering the uptake of AF. The policy recognises that knowledge and awareness should be strengthened at all levels of society. It sets the target of training farmers and producers, as well as staff in public institutions and civil society. The NAFC itself will be tasked with building capacity in AF.	Train farmers and producers, at least 5,000 in all 6 districts of whom at least 30% are female. In 5 years Train staff in public institutions and civil society, at least 50 with at least 20 professionals with MSc and 5 with PhDs; approximately 50% female, in 5 years
	Behaviour	2	Behaviour, as awareness, is affected by	

			the lack of knowledge on AF. The NAFC will be tasked with transmitting AF recommendations and information to all stakeholders, especially famers and producers. As mentioned for other categories, people will be trained in the use of AF which can help is changing behaviour.	
	Social norms	2	Certain customary practices and beliefs present challenges for agroforestry, i.e. working in groups, poor business practices, engaging the women and the youth. The policy aims to empower men, women, and youth through their participation in the leadership and implementation of the AF policy, R&D, access to training and education opportunities, creation of economic opportunities, and their access to and ownership of land and tree resources. Special measures will be used to ensure that women and youth, boys and girls are safe, productive and secure in the mainstreaming of AF. However, such measures are not mentioned in the policy as they are likely to be implemented on a case-by-case basis.	Train farmers and producers, at least 5,000 in all 6 districts of whom at least 30% are female. In 5 years

The scoring of the outcomes characteristics is undertaken with a similar methodology as the scoring of the process characteristics. For the outcomes characteristics the following targets of the agroforestry policy are considered:

- Bring about innovative, diversified enterprises, hence improving food security, nutrition, and health of the people, affecting at least 10,000 households after five years
- Improve interactions and recycling processes (e.g., bring up water and nutrients from deep in the ground and build soil organic matter and thus soil carbon) in the productive components which will enable higher productivity and higher income and profits from the sale of crops, fruits, livestock, tree products, and non-timber forest products, valued at least B$100 million in income every year.
- Increase the asset base with planted trees reaching maturity stages, creating better microclimates and rendering agricultural landscapes more attractive and resilient, thereby improving the value of some 20,000 acres in 10 years.
- Increase forest cover, conservation of flora and fauna species, and protect the biodiversity and water resources at the national level, affecting 50,000 acres in 10 years
- Fortify our ecosystems and environmental services, such as providing wind barriers, restoring degraded lands (with established targets), improving water conservation, preventing soil erosion, and adapting to and building resilience to climate change, affecting another 50,000 acres in 10 years.

Table 12. Scoring of outcomes characteristics.

Scale of outcome-GHG	**Macro level**	**0**	**At global level, GHG emission avoided, and removals will be almost insignificant**	**GHG emissions avoided compared to baseline(tCO2e) CO2 sequestered (tCO2e) In the world, and in Belize**
	Medium level	1	At national sectoral level, avoided emissions and removals will be minor (around 0.6% increase in sequestration compared to today)	GHG emissions avoided compared to baseline(tCO2e) CO2 sequestered (tCO2e) In the AFOLU sector, and in Belize
	Micro level	2	In the areas affected by agroforestry, avoided emissions and removals will be moderate	GHG emissions avoided compared to baseline(tCO2e) CO2 sequestered (tCO2e) In the areas affected by agroforestry
Scale of outcome-sustainable development	Medium level	1	The sustainable development impacts that are likely to be achieved at local level can support the national sustainable development agenda in key areas, such as poverty alleviation, environmental conservation, and food security, with minor contribution on national scale.	Sustainable development contribution to the SDG goals and sustainable development agenda of Belize using relevant metrics
	Micro level	2	Agroforestry can bring likely and moderate positive impacts for climate change mitigation, biodiversity, freshwater, soil quality, deforestation and climate change adaptation. It can also bring possible and moderate impacts for food security, wellbeing, poverty alleviation and economic activity. Other minor impacts are possible.	Sustainable development impacts at local level using the specific metrics for the SD impacts selected
Outcome sustained over time-GHG	Medium-term	2	Impacts are likely to materialise after 5 years and withing 10 years.	Impacts between 5 and 10 years
	Short-term	1	Impacts are less likely to materialise before 5 years, but some impacts could already be seen.	Impacts within 5 years
Outcome sustained over time-sustainable development	Medium-term	2	Impacts are likely to materialise after 5 years and withing 10 years.	Impacts between 5 and 10 years
	Short-term	1	Impacts are less likely to materialise before 5 years, but some impacts could already be seen.	Impacts within 5 years

Next, impacts on transformational change characteristics are aggregated using weighting, to reflect the relative importance of each characteristic considering the phase of transformation of agroforestry in Belize.

Table 13. Weighting of transformational change process characteristics.

Category	Characteristic	Score	Weight	Justification
Technology	Research and development	3	0.35	There is need for sound empirical data, to better understand the impacts of agroforestry locally, so this should receive immediate attention
	Adoption	3	0.45	At this stage of transformation, is important to foster greater adoption of AF.

	Scale up	2	0.2	It is relevant to capitalise and expand on the AF activities that are already present.
Agents	Entrepreneurs	2	0.2	In this phase of transformation. It is relevant in order to foster R&D and adoption of AF to engage entrepreneurs.
	Coalition of advocates	4	0.35	In this phase of transformation, coalitions of advocates are important to create the critical mass for promoting AF.
	Beneficiaries	3	0.45	It is crucial to engage farmers at this stage to foster AF adoption.
Incentives	Economic and non-economic incentives	2	0.55	Barriers related to economic incentives and financial support must be urgently solved in order for AF to become attractive.
	Institutional and regulatory	3	0.45	Regulatory and institutional impediments should be resolved urgently to promote the use of AF.
Norms	Awareness	3	0.4	With many barriers affecting awareness, this driver should receive immediate attention. It is relevant in order to promote AF.
	Behaviour	2	0.25	Behaviour, as awareness, is affected by the lack of knowledge on AF. However, it appears to be less relevant for this policy to be addressed compared to awareness and social norms.
	Social norms	2	0.35	As some customary practices hamper the scale-up of AF, it is very important to address them in this phase of the transformation.

Table 14. Weighting of transformational change outcome characteristics.

Category	Characteristic	Score	Weight	Justification
Scale of outcome-GHG	Macro level	0	0.1	Impacts on the global scale are not the main goal of this policy.
	Medium level	1	0.2	Impacts at sectoral scale are somewhat relevant for this policy.
	Micro level	2	0.7	Impacts at local scale are the main goal of this policy.
Scale of outcome-sustainable development	Medium level	1	0.3	Impacts at sectoral scale are somewhat relevant for this policy.
	Micro level	2	0.7	Impacts at local scale are the main goal of this policy.
Outcome sustained over time-GHG	Medium-term	2	0.5	Short and medium term impacts are equally important, but it is known that the policy is more forward looking.
	Short-term	1	0.5	Short and medium term impacts are equally important, but it is known that the policy is more forward looking.
Outcome sustained over time-sustainable development	Medium-term	2	0.5	Short and medium term impacts are equally important, but it is known that the policy is more forward looking.
	Short-term	1	0.5	Short and medium term impacts are equally important, but it is known that the policy is more forward looking.

Table 15. Weighting of transformational change process categories.

Category	Weight	Justification
Technology	0.33	R&D, adoption, and scale up are quite important for the uptake of AF at this phase of the transformation.
Agents	0.33	Agents are also important, as it is necessary to create a

		critical mass for the adoption of AF.
Incentives	0.33	Lack of economic and regulatory incentives is mentioned as one of the main barriers for the uptake of AF.
Norms	0.33	Awareness should be fostered immediately, and behaviour and social norms should favours the uptake of AF.

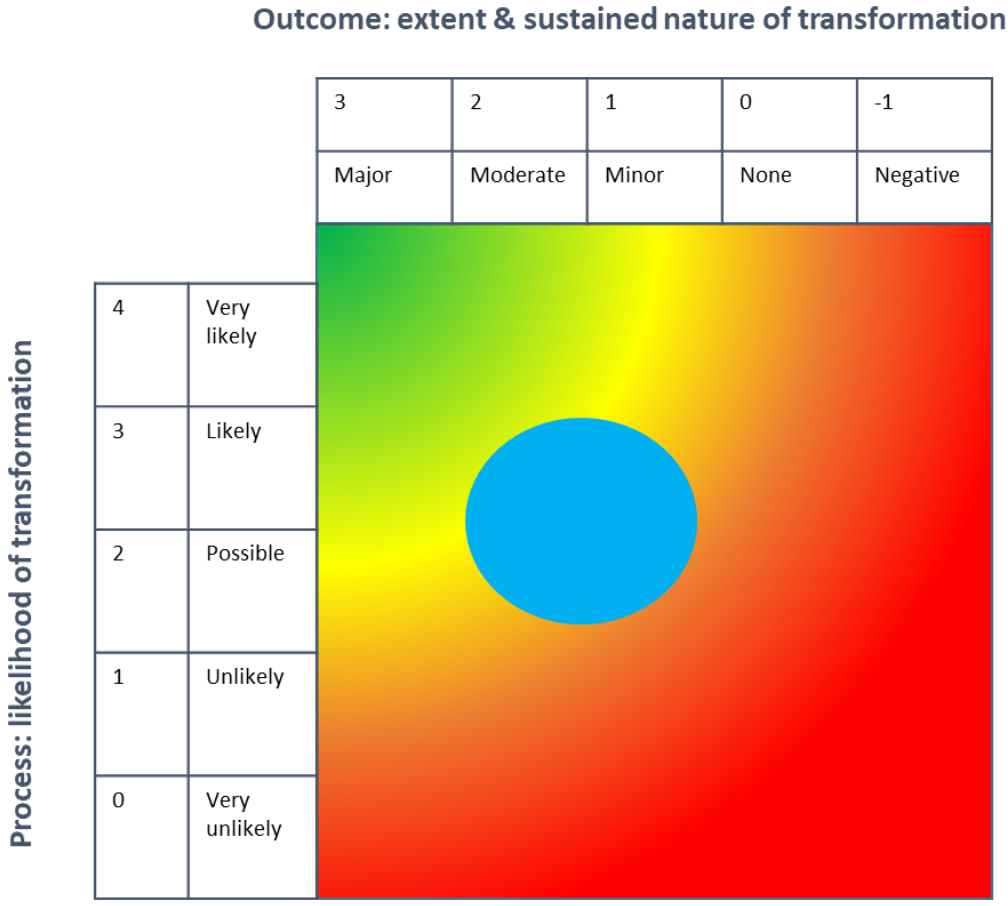
Table 16. Weighting of transformational change outcomes categories.

Category	Rationale for scoring	Weight	Justification
Scale of outcome- GHGs	Impacts on GHG are between minor and moderate considering the overall picture.	0.35	Climate change mitigation is important for this policy. However, AF is mostly adopted as practice for promoting a range of SD benefits, with mitigation co-benefits
Outcome sustained over time - GHGs	Impacts are quite likely to be sustained over time		
Scale of outcome – sustainable development	Impacts on sustainable development are between minor and moderate considering the overall picture.	0.65	Climate change mitigation is important for this policy. However, AF is mostly adopted as practice for promoting a range of SD benefits, with mitigation co-benefits
Outcome sustainable over time – sustainable development	Impacts are quite likely to be sustained over time		

Table 17. Aggregates scores for processes and outcomes

Type of impact	Score	Explanation
Processes	2-3 (2.7)	It is between possible and likely that processes will be affected by the policy.
Outcomes	1-2 (1.6)	Outcomes will be minor to moderate in scale, and possible to likely to be sustained over time.

Aggregated heatmap. Size of the dot represents the uncertainty around the analysis.



Note: it is advised to include stakeholder consultations to score and weigh the transformational change impacts.

6 Links with the Sustainable Development Goals (SDGs)

For assessing the links with the SDGs, the specific impacts are linked to relevant SDG targets from the 2030 Agenda. Here, the link is given only where there is a direct connection between the specific impact and the SDG target (e.g., the impact is explicitly mentioned in the SDG target).

Table 18. Links between specific impacts and SDG targets.

Impact category	Specific impact	SDG target
Climate change mitigation	Increase in CO2 sequestered due to increase in biomass (in comparison to pure agriculture)	13.2; 9.4
	Decrease in GHG emissions due to reduced nutrient leaching	13.2; 9.4
	Decrease in GHG emissions from less production of fertilizers	13.2; 9.4
	Decrease in CO2 sequestered if more forest area is converted to agroforestry	13.2
Biodiversity	Increase in biodiversity in agroforestry area (in comparison to pure agriculture)	15.1; 15.2
	Conservation of biodiversity in forestry areas due to less deforestation	15.1; 15.2; 15.4; 15.5
	Protection of forest's biodiversity through agroforestry areas acting as buffer zones	15.1; 15.2; 15.4; 15.5
	Ecosystem services and support (pollination, pest and disease	15.1

	control)	
	Loss of biodiversity if more forest areas are converted into agroforests	15.1; 15.2; 15.4; 15.5
Freshwater (security and quality)	Maintenance and increase in water quality	3.9; 6.3; 14.1
	Decrease in use of water resources	6.4
	Hydrological cycle maintenance (e.g., groundwater recharge)	6.4; 6.6
	Higher water-use from agroforestry due to higher competition for water	6.4
Soil quality and land degradation	Improved quality of soil in agricultural systems that are converted to agroforestry	2.4; 3.9; 15.3
	Maintenance of quality of soil (in comparison to pure agriculture)	2.4; 15.3
Deforestation	Increase in vegetation cover (if agricultural systems are turned into agroforestry)	15.1; 15.2; 15.4
	Decrease in the need to cut forests due to production of wood products from farmers' fields	15.1; 15.2
	Decreased in long-term need for deforestation due to longer term productivity of agroforestry	15.1; 15.2
	Higher deforestation due to attractiveness of agroforestry	15.1; 15.2
Climate change adaptation	Contribution to climate change adaptation due to development of resilient modes of agriculture (diversified yields)	1.5; 11.5; 13.1
	Contribution to climate change adaptation due to development of resilient modes of agriculture (less water intensive)	1.5; 11.5; 13.1
	Contribution to climate change adaptation due to development of resilient modes of agriculture (mitigation of impacts of EWE related to high temperatures and wind)	1.5; 11.5; 13.1
Food security	Increase productivity and yields	2.3; 2.4
	Decrease in productivity and yields	2.3
	Diversification leading to more diverse and healthy diet	2.2
	Diversification leading to more resilience	2.4
	Increased food security in relation to climate change	2.4
	Reduced risk of disease and pests	2.4
Healthy lives and well-being	More diverse and healthy diet	2.2
Empowerment of women	Increased women participation in land management	5.5; 8.5; 10.2
Energy access	Improved access to wood as fuel	n.a.
Conflict	Reduced conflicts due to privatization and pressure to communal resources	16.1
	Increased risk of conflicts due to inequalities	16.1
Human-environment interactions	Preserved or increased physical, spiritual, and intellectual interactions with nature	12.8
	Loss of interaction physical, spiritual, and intellectual interactions with nature if more forest is lost	12.8
Poverty	Increased income of small-scale farmers and households from increased yields	1.2; 1.4
	Reduced expenditures of small-scale farmers and households from higher reliance on own products or decreased reliance on external products (e.g., fertilizers)	1.2
	Decreased income of small-scale farmers and households from lower yields	1.2; 1.4
Economic activity	Increased economic activity due to higher and more diverse yields	8.2
	Increased economic activity due to accessibility of agroforestry	1.4; 8.2; 8.3; 9.3

Then, SDG targets found to be linked to the specific impacts are given a colour coding, which depends on the scoring of the specific impacts to which they are linked. As one SDG target can be linked to, and affected by, multiple specific impacts, possible overlapping and reinforcing effects are considered.

		Magnitude (Negative)			Magnitude (Positive)		
	Score	Major	Moderate	Minor	Minor	Moderate	Major
Likelihood	Very likely						
	Likely						
	Possible						
	Unlikely						
	Very unlikely						

Figure 5. Colour coding for translating specific impacts in SDG targets.

Finally, the expected impacts of the agroforestry policy on the 2030 agenda are reported in .

Figure 6. Expected impacts of the National Agroforestry Policy on the 2030 Agenda

7 Monitoring plan

More important than the assessment is the monitoring of the policy. In fact, the assessment mainly serves at identifying impacts that are significant. These then will be evaluated within a five-year period, as indicated in table 19.

Inclusiveness in the measurement, reporting and verification of the performance of policy instruments can support sustainable land management.

7.1 Note on monitoring and ex-post assessment of GHG impacts

GHG impacts have been assessed as part of the sustainable development impact assessment. Due to the lack of data to quantitatively assess the potential impact of the policy, the GHG impacts of the policy could only be assessed qualitatively.

To gain a better understanding of the actual impacts of the policy on GHG emissions, it is advised to monitor relevant indicators. Some attributes of good indicators are simplicity,

clarity, manageable and not a long list; having an abundance of indicators can lead to excessive data and not much useful information.

Hence the selection of relevant indicators can be informed by the identification and analysis specific impacts presented in the previous chapters. Monitoring of indicators could then inform a quantitative ex-post assessment of the GHG impacts of the policy. While the monitoring of indicators simply looks at how a value is changing over time, the ex-post assessment would, as the ex-ante, assess the impact of the policy as the difference between the policy and the baseline scenario Figure 7.

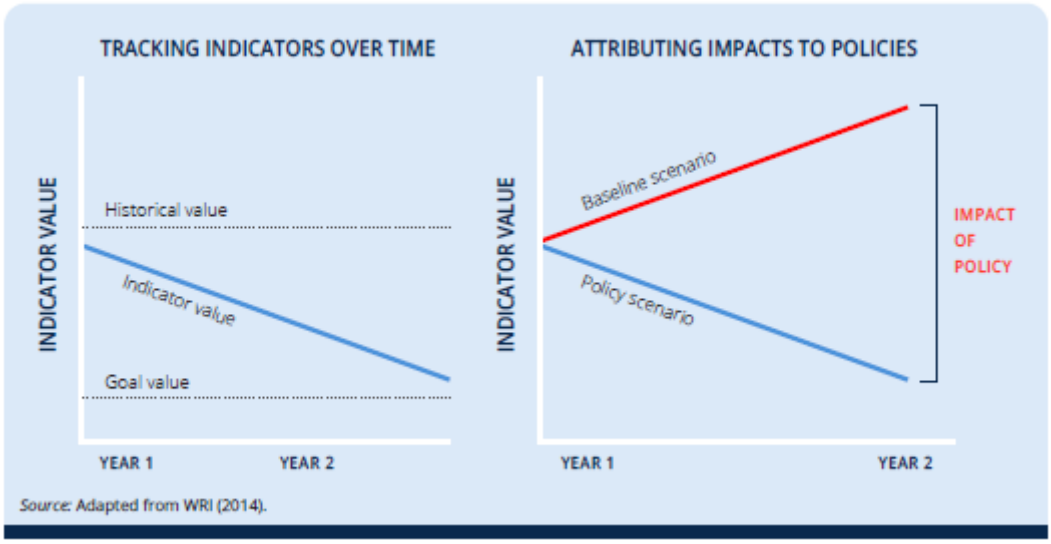


Figure 7. Tracking indicators over time versus attributing impacts to policies and actions (ICAT SD guide)

It is advised to monitor the following indicators (**Error! Reference source not found.**) to better understand the quantitative GHG impacts deriving from the implementation of agroforestry in Belize. The indicators are particularly suitable for supporting the analysis of mitigation impacts linked to changes in biomass.

If indicators for **Error! Reference source not found.** are filled in, ex-post for the policy scenario, and for the baseline scenario, they can be used to estimate the ex-post impacts of the policy, which is defined as the difference between the policy and the baseline scenario. Also included are SDG indicators developed from *table 22-23,* "Selection of sustainable development specific impacts with sources". Note: Not all impacts listed in annex (table 22-23) was used to develop the indicators.

The FRESCOS tool[4] is a free web tool that can be used to calculate carbon sequestration impacts from forest and agroforestry and could be used in the context of an ex-post assessment.

[4] Home | FRESCOS

Table 19. Suggested indicators to monitor GHG and non-GHG impacts.

	Indicators	Source of Data	Monitoring Frequency	Measurement Method	Responsible entity or institution	Goal Value for the year				
						Year1	Year2	Year 3	Year4	Year 5
GHG	*Ha of agriculture area converted from forest*	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of agroforestry converted from agricultural lands	Survey	Annually	Community-level assessment	Forest Department					
	Ha of agroforestry converted from other lands	Survey	Annually	Community-level assessment	Forest Department					
	Ha of alley cropping converted from forest	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of alley cropping converted from agricultural lands	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of alley cropping converted from other lands	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of fallows converted from other forest	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of fallows converted from agricultural lands	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of fallows converted from other lands	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of multistrata converted from forest	Survey	Annually	Community-level assessment	Forest Department					
	Ha of multistrata converted from agricultural lands	Survey	Annually	Community-level assessment	Ministry of Agriculture					

	Ha of multistrata system converted from other lands		Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of silovorable system converted from forest		Survey	Annually	Community-level assessment	Forest Department					
	Ha of silovorable system converted from agriculture		Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of silovorable system converted from other lands		Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of silvopasture system converted from forest		Survey	Annually	Community-level assessment	Forest Department					
	Ha of silvopasture system converted from agriculture		Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Ha of silvopasture system converted from other lands		Survey	Annually	Community-level assessment	Ministry of Agriculture					
Non-GHG	**Goals/Targets**	**Indicators**	**Source of data**	**Monitoring Frequency**	**Measurement Method**	**Responsible entity or institution**	**Goal Value for the year**				
							Year1	**Year2**	**Year 3**	**Year4**	**Year 5**
	Goal 13/13.2	Decrease KtCo2eq/yr proportion to forest area converted to agroforestry	Survey	Annually	Community-level assessment/Analysis	Forest department					
	Goal 9/9.4	Increase KtCo2eq/yr in comparison to pure agricultural areas	Survey	Annually	Community-level assessment/ Analysis	Forest department					
	Goal 15/15.1	# new species in agroforestry areas	Survey	Annually	Community-level assessment	Forest department					

		proportion to pure agricultural areas									
	Goal 15/15.4	# of Protected areas that covers agroforestry areas	Survey	Annually	Remote sensing	Forest department					
	Goal 15/15.5	Red list index/Species population	Survey	Annually	Community-level assessment	Forest department					
	Goal 6/6.4	Change in water-use efficiency over time	Statistical institute of Belize	Annually	Community-level assessment	Forest department					
		Level of water stress: freshwater withdrawal as a proportion of available freshwater source	Statistical institute of Belize	Annually	Community-level assessment	Forest department					
	Goal 1/1,5	# of resilient agriculture development initiatives that lessen water intensity	Survey	Annually	Community-level assessment	Ministry of Agriculture					
		# of resilient agriculture development initiatives that diversify yields	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Goal 13/13.1	# of resilient agriculture development initiatives that support EWE	Survey	Annually	Community-level assessment	Ministry of Agriculture					

	Goal 2/2.2	Average income of small-scale food producers	Statistical Institute of Belize	Annually	Community-level assessment	Ministry of Agriculture					
	Goal 2/2.4	Ha of agriculture area under productive and sustainable agriculture	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Goal 5/5.5	# of women in land management	Statistical Institute of Belize	Annually	Community-level assessment	Ministry of Agriculture					
	Goal 16/16.1	# of conflict-related incident from communal resources	Survey	Annually	Community-level assessment	Forest department					
	Goal 1/1.2	# Farmers with increase income from increased yield	Survey	Annually	Community-level assessment	Ministry of Agriculture					
	Goal 8/8.2	Increase employment rate from agroforestry related activities	Survey	Annually	Community-level assessment	Forest department	`				

Note. The column on the left is blank for there are no values as yet, but these values should be established and could be added later on.

7.2 Roles and Responsibilities

The roles and responsibilities of the different entities involved with the monitoring of the agroforestry policy, and its contribution to climate change mitigation is outlined in *table 19*.

The table is comprised of suggested GHG and non-GHG indicators to monitor. The entities responsible to monitor this information are the Belize Forest Department and the Ministry of Agriculture, Food Security and Enterprise. Whereas the Forest Department will act as the sector lead and the overall entity responsible for the implementation and improvement of Belize's agroforestry policy monitoring. Correspondingly, the National Climate Change Office, NCCO will provide support and guidance to the Forestry and Agriculture Department as it relates to monitoring and reporting to the overall national MRV system, seeing as it is a policy within the NDC.

The Forest Department will have to coordinate data collection and analysis together with the Agriculture Department, and draft and submit reports to NCCO in accordance with the national MRV system. Verification will be conducted by internal verifiers. Internal verifiers will stem from the Forest Department, in charge of quality control (QC) overseeing the data and methods used. While the Ministry of Agriculture will be in charge of quality assurance (QA) reviewing the monitoring system and adjusting for potential developments within the methodology and also do a final QC of submitted reports. Moreover, NCCO will oversee monitoring and provide support where necessary.

The verification process will enhance the internal capacity of data collection without compromising the credibility of future findings. Moreover, as a recommendation, transformational change indicators presented in (*Annex Table 20-21*) should also be monitored by the sector lead.

7.3 Conclusion

The contents of this monitoring plan cover's the context of sustainable development, GHG and transformational change. The plan provides and effective approach to monitor and thus assess emission reduction and sustainable development impacts of the agroforestry policy through targeted actions and monitored through selected indicators.

To ensure that this plan becomes effective, the relevant institutions are in need of guidance, partially provided by this report, but also of capacity building to enhance monitoring and reporting skills within the area of GHG and non-GHG/SDG impacts. The interdisciplinary nature of the agroforestry policy requires sectors to establish an effective collaboration and sharing of data and information. Finally, access to funds for capacity enhancement in the institutions, and for the recurrent monitoring and reporting is also needed to assess the progress of the outcome of the agroforestry policy

Annex 1

Figure 8. Phases of transformation. In green, characteristics that are relevant for the context in which the agroforestry policy is implemented.

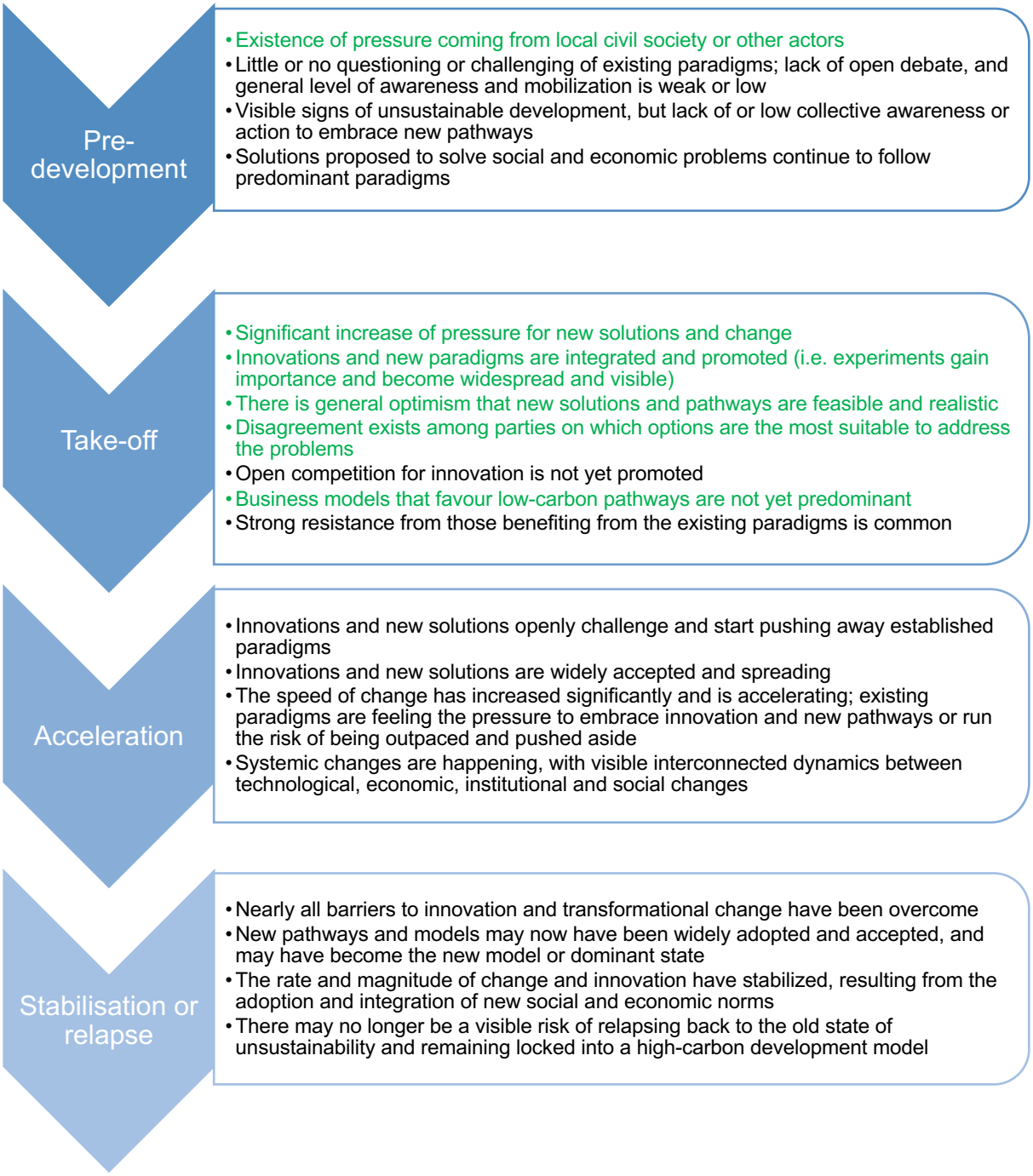


Table 20. Suggested indicators for transformational change process characteristics.

Process category	Process characteristic	Description of the starting situation	Indicators	Indicator value at starting situation
Technology	Research and development	There is little data available on agroforestry nationally due to low levels of R&D on this topic	Volume of R&D and university funds/expenditures on agroforestry topics (BZD)	
	Adoption	Agroforestry projects are adopted locally and ad-hoc, in a few communities and programs (e.g. YCT, TFCGA, etc.)	Land use for agroforestry (ha) for systems bigger than X ha	
	Scale-up	Agroforestry is not adopted at scale in Belize.	Land use for agroforestry (ha) for systems bigger than X ha	
Agents	Entrepreneurs	There is low level of innovation and entrepreneurship in this area in Belize	Volume of funds to agroforestry start-ups (BZD) GDP contribution of agroforestry start-ups (BZD)	
	Coalitions of advocates	A few associations focusing on agroforestry exist	Number of agroforestry associations and programs Number of people engaged through agroforestry associations and programs	4 (although not fully focused on AF)
	Beneficiaries	It is unclear how many people currently engage in AF. Some communities are involved and practice, mostly following traditions.	Number of people engaged in agroforestry activities on the ground	
Incentives	Economic and non-economic incentives	There are currently no government incentives to practice agroforestry	Subsidies, incentives, and other forms of support for agroforestry farmers (BZD)	
	Institutional and regulatory	No specific institutional and regulatory measures to favor the development of agroforestry. Current frameworks do not make it easy for AF to be developed	Policies, laws, and similar arrangements that favor agroforestry	1 (although not extensively)
Norms	Awareness	The current level of awareness on these practices is low. Agroforestry-related knowledge mostly comes from traditions, and it is not seen as a modern practice	Number of people trained and educated on agroforestry	
	Behaviour	Most farmers adopt traditional forms of agriculture.		
	Social norms	Youths and women are largely left out.	Number of youths in agroforestry enterprises	

			Number of youths in management positions in agroforestry enterprises Number of women in agroforestry enterprises Number of women in management positions in agroforestry enterprises	

Table 21. Suggested indicators for transformational change process characteristics

Category	Outcome characteristics	Description of the starting situation	Indicators	Indicator value at starting situation
Scale of outcome **GHGs**	Macro level	Agroforestry practice at the moment are so small that there is no impact at the global level	Avoided GHG emissions due to AF compared to the GAP[5] between NDC and 1.5	
	Medium level	Agroforestry practice at the moment not that widespread and the impact at national/sectoral levels is considered to be very small	Avoided GHG emissions due to agroforestry compared to total avoided emissions in Belize	
	Micro level	The impacts on avoided GHG emissions at local levels are probably minor	Avoided GHG emissions due to agroforestry	
Scale of outcome **Sustainable development**	Medium level	There are very minor impacts at the moment on sustainable development from agroforestry, in terms of agriculture and forestry sector.	Sustainable development impacts measured through the SD assessment at national level	
	Micro level	Some sustainable development impacts from the current projects	Sustainable development impacts measured through the SD assessment in areas with potential for agroforestry	
Outcome sustained over time	Medium term	Small avoided emissions in the medium term	Avoided emissions between 2025 and 2030	

[5] See UNEP GAP report

GHGs	Short-term	Small avoided emissions in the short term	Avoided emissions between 2020 and 2025	
Outcome sustained over time **Sustainable development**	Medium term	Small sustainable development impacts in the medium term	Sustainable development impacts between 2025 and 2030	
	Short-term	Small sustainable development impacts in the short term	Sustainable development impacts between 2020 and 2025	

Table 22. Selection of sustainable development specific impacts with sources.

Dimension	Impact category	Specific impact	Examples	Source
Environmental	Climate change mitigation	Increase in CO2 sequestered due to increase in biomass (in comparison to pure agriculture)	Mitigate climate change while combating desertification	IPCC SPM
			Building soil carbon	IPCC SPM
			Higher below and above carbon storage compared to traditional agriculture	Scaling up
		Decrease in GHG emissions due to reduced nutrient leaching	Reduce nutrient leaching	IPCC SPM
		Decrease in GHG emissions from less production of fertilizers	Reduced use of fertilizers through sustainable agriculture	SCAN Tool
		Decrease in CO2 sequestered if more forest area is converted to agroforestry	Less carbon capture compared to forests	Scaling up
	Biodiversity	Increase in biodiversity in agroforestry area (in comparison to pure agriculture)	Contributes to ecosystems and habitat conservation through sustainable agriculture and management of natural areas	SCAN Tool
			Capacity to host more biodiversity than traditional agriculture	Scaling up
		Conservation of biodiversity in forestry areas due to less deforestation	Local biodiversity conservation	Contributions of AEA
			Less biodiversity loss due to less deforestation	Scaling up
		Protection of forest's biodiversity through agroforestry areas acting as	Protection of forest's biodiversity through agroforestry buffer	Scaling up

		buffer zones	zones	
		Ecosystem services and support (pollination, pest and disease control)	Maintenance of physical, chemical, biological conditions (e.g. habitat, gene pool protection, including by pollination and disease control)	AF impacts
			Pest control	Contributions of AEA
			Pest control	Scaling up
			Support for pollinators by providing buffer zones	Scaling up
		Loss of biodiversity if more forest areas are converted into agroforests	Potential loss of species when forests are converted in agroforests	Scaling up
	Freshwater (security and quality)	Maintenance and increase in water quality	Reduced release of N and P (eutrophication) to water bodies due to reduced use of fertilizers	SCAN Tool
			Maintenance of physical, chemical, biological conditions (e.g. water conditions)	AF impacts
		Decrease in use of water resources	More efficient use of water resources	Scaling up
		Hydrological cycle maintenance (e.g. groundwater recharge)	Groundwater recharge	Contribution of AEA
			Formation of groundwater (possible/theory)	Scaling up
			Regulation and maintenance – mediation of flows (e.g. Hydrological cycle and water flow maintenance)	Af impacts
			Improved water retention	Contributions of AEA
		Higher water use from agroforestry due to higher competition for water	Competition for water	Contributions of AEA
			Trees can increase water consumption (e.g. in dry season)	
	Soil quality and land degradation	Improved quality of soil in agricultural systems that are converted to agroforestry	reduced use of fertilizers through sustainable agriculture	SCAN Tool
			Rehabilitation of degraded (crop) land	Contributions of AEA
			More use of organic fertilizer as wood substitutes dung as fuel	Contributions of AEA

		Maintenance of quality of soil (in comparison to pure agriculture)	Regulation and maintenance – mediation of flows (e.g. Mass stabilization and control of erosion rates)	AF impacts
			Maintenance of physical, chemical, biological conditions (e.g. Soil formation and composition)	AF impacts
			Combat land degradation (soil erosion and nutrient loss)	IPCC SPM
			Reduce soil erosion	Contribution of AEA
			Soil fertility maintenance	Contributions of AEA
			Increase soil quality due to creation of organic matter, nutrients, microflora and microfauna	Scaling up
			Increased soil quality as organic matter increase porosity, increasing water infiltration (lower runoff and erosion)	Scaling up
	Deforestation	Increase in vegetation cover (if agricultural systems are turned into agroforestry)	Increased vegetation cover	Contributions of AEA
		Decrease in the need to cut forests due to production of wood products from farmers' fields	Decrease in need to cut forests due to production of wood products from farmers' fields	Scaling up
		Decreased in long-term need for deforestation due to longer term productivity of agroforestry	Decreased in long-term need for deforestation due to longer term productivity of agroforestry	Scaling up
		Higher deforestation due to attractiveness of agroforestry	Higher deforestation due to attractiveness of agroforestry	Scaling up
Social	Climate change adaptation	Contribution to climate change adaptation due to development of resilient modes of agriculture (diversified yields)	contributes to adaptation measures (resilient agriculture and improved ecosystems)	SCAN Tool
			Adapt to climate change while combating desertification	IPCC SPM
			Reduce risks posed by	IPCC SPM

			climate change, by diversification of food system	
		Contribution to climate change adaptation due to development of resilient modes of agriculture (less water intensive)	Agroforestry may require less water resources and support the maintenance of the hydrological cycle	Expert judgement
		Contribution to climate change adaptation due to development of resilient modes of agriculture (mitigation of impacts of EWE related to high temperatures and wind)	Crop protection against EWE	Contributions of AEA
			Wind control	Contributions of AEA
			Mitigate high temperature for crops such as coffee wheat and rice	Contribution of AEA
	Food security	Increase productivity and yields	Contributes to improving agricultural productivity	SCAN Tool
			Productivity	Agroforestry impacts
			Additional production	Contributions of AEA
			Soil and water conservation leading to higher yields	Scaling up
			Higher, lower, or equal yield due to use of trees (lower due to competition)	Scaling up
			Potentially higher yields if more pollinators are present	Scaling up
		Decrease in productivity and yields	Higher, lower, or equal yield due to use of trees (lower due to competition)	Scaling up
			Due to competition for water and nutrients	Contributions of AEA
			Cropped area reduction	Contributions of AEA
		Diversification leading to more diverse and healthy diet	Diversify diets	Contribution of AEA
			More diversified diet leading to less malnutrition	Scaling up
		Diversification leading to more resilience	Food security	AF impacts
			Reduce risks by diversification of food system	IPCC SPM
		Increased food security in relation to climate change	Mitigate high temperature for crops such as coffee wheat and rice	Contribution of AEA
			Soil and water	Scaling up

			conservation leading to higher yields	
		Reduced risk of disease and pests	Pest control	AF impacts
			Pest control	Scaling up
	Healthy lives and well-being	More diverse and healthy diet	Nutritional benefits by diversifying diets	Contribution of AEA
			More diversified diet leading to less malnutrition	Scaling up
	Empowerment of women	Increased women participation in land management	Women participation in land management	(not found, but raised as important driver by IPCC SPM)
			Increased accessibility due to lower initial costs	Scaling up
			Higher opportunity for women participation in land management	Scaling up
	Energy access	Improved access to wood as fuel	Provisioning - energy	AF impacts
			Provision of energy	Contributions of AEA
			Bioenergy	Scaling up
	Conflict	Reduced conflicts due to privatization and pressure to communal resources	Reduced conflicts due to privatization	Scaling up
			Less pressure on communal resources (including illegal logging)	Scaling up
		Increased risk of conflicts due to inequalities	Increased risk of conflicts due to inequalities	Scaling up
			Less pressure on communal resources (including illegal logging)	Scaling up
	Human-environment interactions	Preserved or increased physical, spiritual, and intellectual interactions with nature	Use of plants and animals	AF impacts
			scientific, education, heritage/cultural, aesthetic interactions	AF impacts
			Symbolic, sacred, and religious use of plants and animals	AF impacts
			Existence, bequest of plants and animals	AF impacts
		Loss of interaction physical, spiritual, and intellectual interactions with nature if more forest is lost	scientific, education, heritage/cultural, aesthetic interactions Existence, bequest of plants and animals	AF impacts
Economic	Poverty	Increased income of small-scale farmers and	Contributes to improving agricultural	SCAN Tool

		households from increased yields	productivity and incomes of small-scale food producers	
			Profitability	AF impacts
			Income and household expenditures	AF imapcts
			Poverty eradication (synergies)	IPCC SPM
			Higher income in comparison to agriculture without trees	Scaling up
		Reduced expenditures of small-scale farmers and households from higher reliance on own products or decreased reliance on external products (e.g. fertilizers)	Contributes to improving agricultural productivity and incomes of small-scale food producers (e.g. reduced use of fertilizers)	SCAN Tool
			Income and household expenditures	AF imapcts
		Decreased income of small-scale farmers and households from lower yields	Crop area reduction	Contributions of AEA
	Economic activity	Increased economic activity due to higher and more diverse yields	Contributes to improving agricultural productivity and incomes of small-scale food producers	SCAN Tool
			Profitability	AF impacts
			Additional production	Contributions of AEA
		Increased economic activity due to accessibility of agroforestry		Expert judgement

Table 23. Linkages between specific impacts and SDG targets.

Impact category	Specific impact	L	M	+/-	SDG target
Climate change mitigation	Increase in CO2 sequestered due to increase in biomass (in comparison to pure agriculture)	Very likely	Moderate	+	13.2
	Decrease in GHG emissions due to reduced nutrient leaching	Likely	Moderate	+	13.2
	Decrease in GHG emissions from less production of fertilizers	Possible	Moderate		13.2
	Decrease in CO2 sequestered if more forest area is converted to agroforestry	Very likely	Minor	-	13.2
Biodiversity	Increase in biodiversity in agroforestry area (in comparison to pure agriculture)	Very likely	Moderate	+	15.1 15.2
	Conservation of biodiversity in	Likely	Moderate	+	15.1

	forestry areas due to less deforestation				15.2 15.4 15.5
	Protection of forest's biodiversity through agroforestry areas acting as buffer zones	Likely	Moderate	+	15.1 15.2 15.4 15.5
	Ecosystem services and support (pollination, pest and disease control)	Likely	Moderate	+	15.1
	Loss of biodiversity if more forest areas are converted into agroforests	Very likely	Moderate	-	15.1 15.2 15.4 15.5
Freshwater (security and quality)	Maintenance and increase in water quality	Likely	Moderate	+	3.9 6.3 14.1
	Decrease in use of water resources	Likely	Minor	+	6.4
	Hydrological cycle maintenance (e.g. groundwater recharge)	Possible	Moderate	+	6.4 6.6
	Higher water use from agroforestry due to higher competition for water	Unlikely	Minor	-	6.4
Soil quality and land degradation	Improved quality of soil in agricultural systems that are converted to agroforestry	Very likely	Moderate	+	2.4 3.9 15.3
	Maintenance of quality of soil (in comparison to pure agriculture)	Likely	Moderate	+	2.4 15.3
Deforestation	Increase in vegetation cover (if agricultural systems are turned into agroforestry)	Very likely	Minor	+	15.1 15.2 15.4
	Decrease in the need to cut forests due to production of wood products from farmers' fields	Likely	Moderate	+	15.1 15.2
	Decreased in long-term need for deforestation due to longer term productivity of agroforestry	Possible	Moderate	+	15.1 15.2
	Higher deforestation due to attractiveness of agroforestry	Likely	Moderate	-	15.1 15.2
Climate change adaptation	Contribution to climate change adaptation due to development of resilient modes of agriculture (diversified yields)	Very likely	Moderate	+	1.5 11.5 13.1
	Contribution to climate change adaptation due to development of resilient modes of agriculture (less water intensive)	Possible	Moderate	+	1.5 11.5 13.1
	Contribution to climate change adaptation due to development of resilient modes of agriculture (mitigation of impacts of EWE	Likely	Minor	+	1.5 11.5 13.1

	related to high temperatures and wind)				
Food security	Increase productivity and yields	Possible	Moderate	+	2.3 2.4
	Decrease in productivity and yields	Possible	Minor	-	2.3
	Diversification leading to more diverse and healthy diet	Possible	Moderate	+	2.2
	Diversification leading to more resilience	Likely	Minor	+	2.4
	Increased food security in relation to climate change	Possible	Minor	+	2.4
	Reduced risk of disease and pests	Possible	Minor	+	2.4
Healthy lives and well-being	More diverse and healthy diet	Possible	Moderate	+	2.2
Empowerment of women	Increased women participation in land management	Possible	Moderate	+	5.5 8.5 10.2
Energy access	Improved access to wood as fuel	Likely	Minor	+	n.a.
Conflict	Reduced conflicts due to privatization and pressure to communal resources	Possible	Minor	+	16.1
	Increased risk of conflicts due to inequalities	Possible	Minor	-	16.1
Human-environment interactions	Preserved or increased physical, spiritual, and intellectual interactions with nature	Possible	Minor	+	12.8
	Loss of interaction physical, spiritual, and intellectual interactions with nature if more forest is lost	Possible	Minor	-	12.8
Poverty	Increased income of small-scale farmers and households from increased yields	Possible	Moderate	+	1.2 1.4
	Reduced expenditures of small-scale farmers and households from higher reliance on own products or decreased reliance on external products (e.g. fertilizers)	Likely	Minor	+	1.2
	Decreased income of small-scale farmers and households from lower yields	Possible	Minor	-	1.2 1.4
Economic activity	Increased economic activity due to higher and more diverse yields	Possible	Minor	+	8.2
	Increased economic activity due to accessibility of agroforestry	Possible	Moderate	+	1.4 8.2 8.3