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Climate Technology Centre & Network

Federal Ministry of Environment - Department of Climate Change

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Technology Needs Assessment and associated action plan for climate change mitigation and adaptation in Nigeria's most vulnerable economic sectors

Adaptation technologies in the agriculture and land use sector

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Contents

1. Introduction/Overview

The objective of this assignment is to develop a comprehensive Technology Needs Assessment (TNA) and associated action plan for Nigeria's climate change mitigation and adaptation. To achieve this objective, it is necessary to identify the relevant technologies that can contribute to Nigeria's climate objectives, especially in the three priority sectors, namely, agriculture and land use, energy, and industry and commerce. From the three priority sectors, sub-sectors were pre-selected and identified for each sector by performing a thorough assessment and desktop review of key national strategies and sectoral policies in Nigeria. In this context, the next step is to identify and confirm the mitigation and adaptation technologies that can be applicable to each subsector, which will be the basis for Nigeria's TNA and action plan.

This report, therefore, will first discuss the sector and subsector prioritization process, including the process taken for sector and subsector selection and the results of the prioritization process. Then, the report will provide a general overview of gender considerations that are relevant to the sector and subsectors that have been prioritized. It will then shift the focus on agriculture and land use sector and its subsectors, and provide a list of technologies applicable to the subsectors. This section will include an assessment of how the technologies contribute to climate change mitigation/adaptation and identify the barriers and gaps of implementing the technology. Finally, the report will present a summary of adaptation technologies that were considered during the process.

2. Institutional arrangement and stakeholder involvement

As part of conducting the TNA, the TNA Project Committee was established representing the key stakeholders from each prioritized sector. The main objective of the TNA Project Committee is to oversee the progress of the TNA and to ensure the engagement of key stakeholders throughout the TNA process. In this regard, to determine the appropriate composition of the TNA Committee, the consulting team conducted a stakeholder mapping for the purpose of identifying key stakeholders in the public sector, private sector, civil society, academia, and NGOs to ensure proper sectoral, transversal and climate-relevant representation of stakeholders. The stakeholder analysis was later refined by stakeholder consultations, which was generally conducted bilaterally. In coordination with the National Project Coordinator and the Deputy TNA Project Coordinator of the TNA Project Committee, these stakeholder consultations and analysis supported the finalization of the TNA Committee in Nigeria and assured the full representations of key stakeholders in the TNA process. In this context, there was an emphasis on ensuring equal representation of women and men as well as participation of gender focal points and associations that promote gender equality and the empowerment of women (GEEW) and other vulnerable groups. Throughout the TNA process, the consulting team also made sure that there was an engagement and consultation with representations from the private sector.

3. Sector and subsector prioritization process

For Nigeria's TNA, the three priority sectors were selected in the inception workshop led by the Federal Ministry of Science and Technology (FMST), in collaboration with Federal Ministry of Environment's Department of Climate Change (FMEnv – DCC) in September 2018. As mentioned earlier, the three priority sectors for Nigeria's TNA are: agriculture and land use, energy, and industry and commerce. The three key sectors are not only significant for Nigeria's

long-term development, but also climate sensitive and vulnerable to the impacts of climate change. The subsectors, therefore, were identified and pre-selected from the three priority sectors.

To pre-select the subsectors, all key national strategies and sectoral policies were reviewed and analyzed to identify development priorities as well as climate change priorities. In this process, a total of 17 documents were reviewed and assessed, which led to the identification of the subsectors. For the agricultural and land sector, four sub-sectors were identified, namely, crop production, livestock production, forestry, and fish production. As for the energy sector, electricity supply, energy demand and energy efficiency were identified as the sub-sectors for this sector. Finally, for the industry and commerce sector, the subsectors are agribusiness and agro-allied sectors, solid minerals and metals, oil and gas-related industries, and construction and manufacturing.

Consequently, these subsectors were then pre-scored by the consulting team by using a set of criteria, which included (1) relevance to development priorities; (2) potential for climate change mitigation; (3) potential for climate change adaptation; and (4) overall enabling environment, including regulatory, institutional, and financial information. The purpose of the initial scoring was to assist the stakeholders in the actual selection and prioritization process that took place in the validation workshop on June 9th, 2021.

The stakeholders' validation workshop was conducted as hybrid meeting in Abuja, Nigeria and on the virtual platform, in which a total of 47 stakeholders participated in the workshop, 26 physical participants and 21 virtual participants. The stakeholders' validation workshop provided an opportunity for the stakeholders to have an overview of the subsector prioritization process, to discuss on issues regarding each subsector, and to revisit the scoring of the subsectors. In this regard, the stakeholders provided valuable inputs or feedbacks including, but not limited to, whether to incorporate the latest political negotiations as well as gender implications in the prioritization process, to add another subsector reflecting the results of agricultural activities, and to change the subsector from "construction, light manufacturing and services" to "construction and manufacturing". In addition, as part of the interactive session of the validation workshop, the initial scoring of each subsector was assessed by the stakeholders, mainly taking into account all discussions raised across the criteria, including the potential for climate change mitigation and adaptation, as well as the role of enabling environment.

The scoring was confirmed as shown in the table below:

Sector	Sub-sector	Potential for climate change mitigation (GHG emissions)	Potential for climate change adaptation (vulnerability)	Relevance to development priorities	Overall enabling environment	Total score
Agriculture and land	Crop production	3	3	3	2	11

Sector	Sub-sector	Potential for climate change mitigation (GHG emissions)	Potential for climate change adaptation (vulnerability)	Relevance to development priorities	Overall enabling environment	Total score
use	Livestock production	3	3	3	2	11
	Fish production	1	3	3	2	9
	Forestry	3	3	3	2	11
Energy	Electricity supply	3	3	3	3	12
	Energy demand	3	3	3	2	11
	Energy efficiency	3	3	3	1	10
Industry and commerce	Agribusiness and agro-allied sectors	2	2	3	1	8
	Solid minerals and metals	3	1	3	1	8
	Oil and gas-related industries	3	2	3	1	9
	Construction and manufacturing	3	1	3	1	8

As a result, the prioritized subsectors were confirmed with consensus from the TNA Committee: crop production, livestock production, forestry, electricity supply, energy demand, energy efficiency, agribusiness and agro-allied sectors, solid minerals and metals, construction and manufacturing. Therefore, the preliminary long-list of technologies was prepared by the

consulting team based on the prioritized subsector and the discussions from the validation workshop. In this context, the subsequent sections will identify and assess the technologies for each subsector that can contribute to climate change mitigation in Nigeria.

4. Methodology

After the prioritized sectors and subsectors were confirmed with consensus from the TNA Committee, the consulting team developed the preliminary long-list of technologies.
These technologies were then evaluated against the following criteria:

(a) **Potential impact on climate change adaptation,** if any, in the context of Nigeria's climate change targets. Indicators may include the size of population and economy (e.g., sub-sectoral GDP) which could be affected by the climate change related events that the technology tackles with, and theoretical or practical effects of the technology itself on adaptation to climate change.

3: High	The sub-sector is a major industry and the potential for the technology to enhance climate resilience is expected to be large.
2: Moderate	While the sub-sector is a major industry, the expected impact of the technology on climate resilience is not particularly large. Or, the size of population and/or economy of the sub-sector is moderate, but the technology could bring about a large positive impact on climate resilience.
1: Low	The effect on adaptation to climate change is negligible.
0: Null	Not applicable.

(b) **Potential impact on climate change mitigation/greenhouse gas emissions reduction** in the context of Nigeria's climate change targets. Indicators may include GHG emission share of sub-sector in which the technology could be applied, and theoretical or practical effects of the technology itself in the reduction of GHG emissions.

3: High	The sub-sector is a major source of GHG emissions, and the technology could bring about a large emission reduction effect.
2: Moderate	The sub-sectoral emission share is moderate, but the technology could bring about a large emission reduction effect. Or, while the sub-sector accounts for a large portion of GHG emissions, the expected emission reduction effect of the technology is not particularly large.
1: Low	The emission reduction effect is negligible.
0: Null	Not applicable.

(c) **Alignment with climate change policies and priorities**: Evaluates to what extent the technology aligns with key national strategies and sectoral policies, and climate change priorities. Strategies and priorities to be reviewed are those analyzed for the sub-sector selection. Indicators may include whether the technology is mentioned in the policies or

priorities and whether the technology could be expected to address the major challenges identified in the policies or priorities.

3: High	The technology is mentioned in several (more than one) key policies or priorities.
2: Moderate	The technology is mentioned in one of the key policies or priorities. Or, the technology is related to several focus areas of investment in the key policies or priorities.
1: Low	The technology itself is not mentioned in any policy or priority, but it could be related to one of the focus areas of investment in the key policies or priorities.
0: Null	Implementation of the technology is not necessarily prioritized in the key policies or priorities.

(d) **Consideration of co-benefits** (environmental, social, and economic):

i. Environmental: the potential impact on Nigeria's environment

ii. Social: the potential impact on Nigeria's employment/poverty reduction

iii. Economic: the potential impact on Nigeria's economy

3: High	Implementation of the technology could bring about co-benefits in three categories.
2: Moderate	Implementation of the technology could bring about co-benefits in two categories.
1: Low	Implementation of the technology could bring about co-benefits in one of the three categories.
0: Null	Implementation of the technology is not expected to bring about any co-benefit.

(e) **Technological constraints**: Evaluates how practical or realistic the implementation of the technology is in general. Indicators may include the maturity level of the technology, the number of use cases around the globe or in developing counties, and the magnitude of barriers to implementing the technology.

3: High	The technology has already been widely used commercially, and no or only minor barriers are expected in implementing the technology.
2: Moderate	There are some use cases but not yet widely used commercially.
1: Low	The technology is still at the pilot test stage.
0: Null	The technology is still at the research/study stage and is not expected to be used in practice as of now.

(f) **Readiness of Nigeria for the technology**: It evaluates to what extent Nigeria has the appropriate and sufficient environment to implement the technology. The indicators may include the number of use cases in the country, policy environment which could facilitate the implementing of the technology, and acceptability of stakeholders.

3: High	There are several use cases in Nigeria, and no or only minor barriers are expected in implementing the technology.
2: Moderate	There is/are (a) use case(s) in Nigeria. Despite the existence of some challenges in implementing the technology, these could be addressed in the short-term.
1: Low	There is no use case in Nigeria, but there is the environment which could support the implementation of the technology.
0: Null	There is no use case or policy which could promote the use of the technology in Nigeria, and there are many challenges to overcome to implement the technology as of now.

The result from this exercise will provide a total score for each technology, which will be used as a reference to guide the actual section and prioritization of technologies by the stakeholders in the next step.

5. Gender considerations

The UNFCCC and Federal Government of Nigeria recognize the importance of developing national-level climate change policies that are gender-responsive. This section provides an overview of gender priorities, issues and concerns for the prioritized TNA sectors and subsectors. According to the World Economic Forum's 2021 World Gender Gap Report, Nigeria ranks 139 of 156 countries on gender equality.[1] As of 2019, women held 5.6 percent of seats in the lower house of parliament and 6.4 percent of seats in the upper house.[2] A woman has never held the position of governor of any of Nigeria's 36 states. According to the World Bank data for 2019, men's participation in the workforce in Nigeria was 60.89 percent, and women's participation was 48.52 percent.[3]

The majority ethnic groups in Nigeria - the Hausa-Fulani, Igbo and Yoruba – make up around 60 percent of the country's population.[4] Minority groups face political, economic and cultural marginalization.[5]

The population of persons with disabilities in Nigeria was at 3.3 million - 2.32 percent of the population - at the 2006 Nigerian census.[6] Persons with disabilities face environmental,

[1] World Gender Gap Report: http://www3.weforum.org/docs/WEF_GGGR_202117.pdf
[2] Inter-Parliamentary Union, Women in national parliaments: http://archive.ipu.org/wmn-e/classif.htm
[3] https://data.worldbank.org/indicator/SL.TLF.CACT.FE.ZS?locations=NG
[4] The World Factbook: Explore All Countries – Nigeria: https://www.cia.gov/the-world-factbook/countries/nigeria/
[5] An International Journal of Arts and Humanities. Ethnic Minorities and The Nigerian State. Page 90
[6] Nigeria-Population Census 2006 : http://nigeria.opendataforafrica.org/xspplpb/nigeria-census

institutional, and social challenges,[7] limiting their opportunities to actively participate in society in general, and in the workforce in specific.[8]

Almost half of Nigeria's population is under the age of 15.[9] Older adults (65 years and above) make up 3.1 percent of the total population.[10] Seventy-five percent of children live in poverty,[11] while 40.1 percent of Nigeria's total population lives below the poverty line.[12]

5.1. Agriculture and land use sector

Agriculture accounted for 22.35 percent of Nigeria's Gross Domestic Product (GDP) in the first quarter of 2021.[13] The sector employed 35 percent of Nigeria's labor force in 2019,[14] over 75 percent of which were women.[15] There is a general lack of knowledge and skills among both women and men farmers when it comes to modern technologies, access to capital, market information and more.[16] Gender, poverty, geographical location and disability status compound these issues.[17] [18] The government of Nigeria has a national gender policy for the agricultural sector. Agriculture, forestry, and land use have been identified as priority sectors for Nigeria's National Action Plan on Gender and Climate Change.

5.1.1. Crop production

While around 54 million of Nigeria's 78 million women live in rural areas and make their living off the land,[19] the fact that men are five times more likely to own land than women significantly limits production among female farmers.[20] Additionally, there is gender and age disparity regarding access to training on crop farming techniques, with women and youth disproportionately affected.[21]

5.1.2. Livestock production

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[7] Nigerian Country Report on Disability: http://www.disabilityrightsfund.org/wp-content/uploads/Country-Report_Nigeria_2018.pdf

[8] Models of Equal Employment Opportunity: https://doi.org/10.1300/J156v02n03_06

[9] UNICEF, Situation of women and children in Nigeria: https://www.unicef.org/nigeria/situation-women-and-children-nigeria

[10] Tanyi, Perpetua, Pelser, Andre, Mbah, Peter 2018/12/03 Care of the elderly in Nigeria: Implications for policy, VL - 4 10.1080/23311886.2018.1555201 Cogent Social Sciences

[11] UNICEF, Situation of women and children in Nigeria: https://www.unicef.org/nigeria/situation-women-and-children-nigeria

[12] World Bank data: https://data.worldbank.org/indicator/SI.POV.NAHC?locations=NG

[13] Statista: https://www.statista.com/statistics/1193506/contribution-of-agriculture-to-gdp-in-nigeria/

[14] World Bank: https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=NG&most_recent_value_desc=false

[15] Nigeria Federal Ministry of Environment, National Action Plan on Gender and Climate Change for Nigeria. Page 28

[16] Nigeria Federal Ministry of Agriculture and Rural Development, Gender Policy in Agriculture. Page 45

[17] Ibid. Page 43

[18] Nigerian Country Report on Disability: http://www.disabilityrightsfund.org/wp-content/uploads/Country-Report_Nigeria_2018.pdf

[19] Ibid. Page 39

[20] Ibid. Page 41

[21] Ibid. Page 43

Cultural norms in Nigeria allow for both women and men to access livestock; however, larger animals such as cows are the responsibility of men, while women control smaller stock such as goats, chickens or rabbits as part of their household duties.[22] This smaller stock is easily disposed of to meet the family's daily food and income requirements. Not having control over the larger stock sidelines women from decision-making regarding animal products, as well as from accessing funds when the livestock is sold. Combined with the disproportionate levels of land ownership mentioned earlier, the lack of control over livestock further contributes to a woman's inability to build up physical assets.[23]

5.1.3. Forestry

While women play a vital role in forest management in Nigeria, there is evidence that the indigenous knowledge that contributes to forest management and the role of Nigerian women as drivers of change and social cohesion have been largely ignored by forest management stakeholders and REDD+ programs.[24] Studies show that a shortage of forest products would particularly affect women's lives and livelihood, increasing their marginalization and poverty.[25]

5.2. Gender-Responsive Approach to the Implementation of Adaptation Technologies

The aim of implementing gender-responsive technology programming is twofold:

- To prevent existing **gender inequalities** from being exacerbated by climate change and
- To prevent the exacerbation of **climate change impact** due to existing gender inequalities.

Key tools to address gender in climate change adaptation programs are gender analyses to identify gaps; gender-responsive budgets; gender targets and indicators; and sex-and age-disaggregated data.

When women and men, regardless of age, disability status, ethnicity, or geographical location, participate in decision-making and have equal access to assets, resources, knowledge, and skills they jointly assist in building the resilience of communities.

6. Assessment of adaptation technologies in the agriculture and land use sector

6.1. Crop production

1. Agricultural biotechnology (cross-cutting)

➢ Introduction

[22] Ibid. Page 43

[23] Ibid. Page 44

[24] UN-REDD. The role of women as local indigenous knowledge holders in sustainable management of forests. Page 3

[25] Ibid. Page 3

Agricultural biotechnology refers to a biological approach that utilizes biotechnological methods and traditional plant breeding to produce crop varieties with enhanced carbon sequestration.[26]

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Agricultural biotechnology can contribute in diversifying crops and introducing new varieties, which can reduce the farmers' dependence on a single crop for income generation and enhance farmers' ability to adapt to climate change. Furthermore, it can introduce crops that are resistant to droughts, pests, and heat stress, which are all challenges faced by the agricultural sector in Nigeria.	2
Potential impact on climate change mitigation/greenhouse gas emissions reduction	According to a study conducted by Brookes and Barfoot (2009), genetically modified crops using agricultural biotechnology conserved over 14,200 million kg of CO_2 in the year 2007, which is equivalent of over 6 million cars.[27] Therefore, it can potentially contribute to the reduction of GHG emissions from the agricultural sector, which accounts for the largest GHG emissions in Nigeria.	2
Alignment with climate change policies and priorities	Although there is no direct reference to agricultural biotechnology in Nigeria's climate change policies, increasing access to drought resistant crops is indicated as one of the strategies for agriculture in the National Adaptation Strategy and Plan of Action for Climate Change Nigeria (NASPA).	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental* Introducing new varieties and diversifying crop portfolio by using agricultural biotechnology can enhance biodiversity. *Social* Agricultural biotechnology has the potential of increasing employment, as the creation of new varieties can provide new job opportunities in the agricultural sector. In addition, through crop diversification, it can help to stabilize famers' income and address food insecurity.	3

[26] UNEP "Technologies for Climate Change Mitigation-Agricultural Sector"
[27] CTCN "Crop varieties with enhanced carbon sequestration"

	Economic Cultivating crops that are resistant to droughts and pests can improve the overall agricultural production in Nigeria.	
Technological constraints	Agricultural biotechnology is implemented in many countries, including in several African countries. Yet, agricultural biotechnology requires several years of testing, especially to observe the impact on carbon sequestration, which makes it difficult for the technology to be available in the short term.[28]	2
Readiness of Nigeria for the technology	Several projects using agricultural biotechnology are under implementation in Nigeria (for example, pod borer resistance cowpeas), however, none of the crops have been commercialized.[29] Furthermore, agricultural biotechnology has been generally accepted by the stakeholders since the technology has multiple benefits, such as carbon sequestration and crop diversification (meeting with stakeholders on July 29th, 2021). There is also a policy framework for agricultural biotechnology in Nigeria, creating a more enabling environment for the technology.	3

2. Cover crop technology (cross-cutting)

- Introduction

Cover crop technology refers to the use of fast-growing crops that can cover the soil surface to protect soil from erosion while reducing emissions and sequester carbon.[30] Examples of cover crops include, but not limited to, winter rye and clovers that are planted between periods of regular crop cultivation and cover the soil surface.

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Nigeria's TNC indicates that cover crops such as potatoes and melons can contribute in addressing climate change adaptation as well as soil erosion, which is catastrophic especially in southern parts of Nigeria. Cover crop technology can also contribute in	3

[28] UNEP "Technologies for Climate Change Mitigation-Agricultural Sector"
[29] USDA "Agricultural biotechnology annual"
[30] UNEP "Technologies for Climate Change Mitigation-Agricultural Sector"

	improving soil quality, water, biodiversity, and pest management.[31]	
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Cover crop technology can assist in reducing GHG emissions from Nigeria's agriculture sector, which accounts for approximately 67 percent of overall GHG emissions in the country.[32] According to a study conducted on an eroded Alfisol in western Nigeria, cover crops can increase soil carbon sequestration with the rates from 0.28 to 2.60 Mg ha-1 yr-1.[33]	3
Alignment with climate change policies and priorities	Cover crop technology has been identified in Nigeria' s climate change policies, specifically in Nigeria's NDC, TNC, as well as NASPA.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	Cover crop technology can contribute in alleviating nutrient deficiencies and reducing the use of artificial fertilizers and pesticides which are harmful to the environment.	
	Social	
	Cover crop technology can improve the overall production and yield of farmers by addressing soil erosion, which can not only help farmers' income, but also food insecurity.	
	Economic	
	Better crop production has the potential to improve Nigeria's agricultural sector, which contributes approximately 27 percent to the GDP between October to December in 2020.[34]	
Technological constraints	Economic costs for planting cover crops can be a burden for farmers, and this fact has hindered the technology's dissemination in many countries.[35] Human capacity development will also be necessary when introducing this technology, as the benefit of cover crops may be limited if the crops are not managed properly.	2
Readiness of Nigeria for the technology	The technology may be available in the short to medium term, given that the production of cover crops such as potatoes and melons is	2

[31] Federal Ministry of Environment "Third National Communication (TNC) of the Federal Republic of Nigeria"
[32] FAO "Nigeria at a glance"
[33] CTCN "Cover crop technology"
[34] Statista "Contribution of agriculture to GDP in Nigeria from the 3rd quarter of 2019 to the 1st quarter of 2021"
[35] Ibid.

	not prevalent compared to other crops such as cassava and maize.[36] The overall policy environment for cover crop technology, however, can be considered favorable, which can facilitate in implementing the technology.	

3. Conservation Tillage (cross-cutting)

➢ Introduction

Conservation tillage is a tillage system that conserves soil, water, and energy resources through the reduction of tillage intensity and retention of crop residue.[37] The aim of this technology is to plant, grow and harvest crops with limited interruption to the soil.

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Conservation tillage can minimize soil erosion and improve nutrients in the soil, which can lead to reduction in water and energy use as well as increase in yields.[38] Improved soil properties and increased soil organic matter as a result of conservation tillage can also enable farmers to maintain its yields in the case of drought and extreme weather.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Conservation tillage can enhance the soil's ability to sequester carbon. Lu's study (2018) suggests that, conservation tillage has the potential of increasing carbon sinks from 0.84t C ha−1 yr−1 to 2.69t C ha−1 yr−1 compared to conventional tillage.[39] Therefore, conservation tillage has the potential to address Nigeria's GHG emissions from crop production, which accounted for 8.1 percent of total sectoral GHG emissions in 2016.[40]	3
Alignment with climate change policies and priorities	In Nigeria's NDC, adopting better soil and water management is referred to as necessary to tackle climate change. In this regard, conservation tillage can be considered as one of the technologies to improve soil and water management.	2

[36] FAO "FAOSTAT: Crops and livestock products"
[37] Ibid.
[38] UNEP "Technologies for Climate Change Mitigation-Agricultural Sector"
[39] Lu (2018) "Conservation tillage increases carbon sequestration of winter wheat-summer maize farmland on Loess Plateau in China"
[40] Federal Ministry of Environment "Third National Communication (TNC) of the Federal Republic of Nigeria"

Consideration of co-benefits (environmental, social, and economic)	*Environmental* Soil conservation is essential not only in terms of climate change, but also in relation to biodiversity and environmental degradation. *Social* Conservation tillage can minimize soil erosion and has a positive effect on crop yields, which can enable farmers to stabilize or increase their income. *Economic* Conservation tillage has the potential to prevent job losses as a result of decreasing yields. This can also improve the overall agricultural production in Nigeria	3
Technological constraints	The technology is relatively a mature technology that is adopted in many parts of the world, including in African countries.	3
Readiness of Nigeria for the technology	The technology may be available in the short to medium term as the technology is also available in Nigeria[41]. The number of cases using the technology is still limited and many parts of the country still relies on conventional methods. Significant amount of investment and training is necessary when transitioning from conventional methods.	1

4. Climate Smart Agriculture (CSA) (cross-cutting)

➢ Introduction

Climate Smart Agriculture refers to an approach to change the agricultural system to tackle the issue of food security while adapting to the changing climate. This approach has three main objectives: (a) enhance agricultural productivity and increase incomes, (b) adapting to climate change, and (c) reduce greenhouse gas emissions.[42]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Another objective of climate smart agriculture is to build resilience and enable the agriculture sector adapt to climate change. This will be achieved, for instance, by diversifying the	3

[41] Senjobi et al (2013) "Effects of Tillage Practices on Soil Properties under Maize Cultivation on Oxic Paloustalf in South Western Nigeria"
[42] FAO, "Climate Smart Agriculture" Available at: Climate-Smart Agriculture | Food and Agriculture Organization of the United Nations (fao.org)

	production system and managing agro-ecosystems. This technology is also identified in Nigeria's NDC as having the potential to build resilience in Nigeria's agricultural and food security systems.	
Potential impact on climate change mitigation/greenhouse gas emissions reduction	One of the objectives of climate smart agriculture is to reduce GHG emissions in the agricultural sector by promoting renewable energy in agricultural practices, encouraging resource use efficiency, and sequestering carbon from agro-ecosystems.[43] To what extent this technology can contribute to climate change mitigation is yet to be determined. According to Nigeria's NDC, however, climate smart agriculture has the potential to reduce GHG emissions by 74 million tons per year in 2030.	2
Alignment with climate change policies and priorities	As mentioned above, climate smart agriculture is indicated in Nigeria's NDC as both climate change mitigation and adaptation measure.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental* Climate smart agriculture is designed to reduce the negative impact of agricultural activities to the environment (for example, reducing the amount of toxic substances, waste). *Social* Climate smart agriculture encourages social protection schemes to increase resilience of farmers, such as cash-for-work and food vouchers. *Economic* The technology also focuses on increasing productivity for sustained economic growth.	3
Technological constraints	Even though the technology is implemented in many countries to a certain extent, it is still considered as an emerging technology.	2
Readiness of Nigeria for the technology	Even though the concept is indicated in Nigeria's NDC, the concept is too broad and there are many technologies that can be associated with climate smart agriculture. Thus, it may be difficult to identify the specific technology that is needed. Even though there are some cases using this technology in Nigeria, for the technology to be mainstream,	2

[43] FAO "Climate-smart agriculture and the Sustainable Development Goals"

	it will require investments that may become a burden in the long-run.	

5. Alternate Wetting and Drying (AWD) in rice production (cross-cutting)

➢ Introduction

An agricultural practice that, before irrigation, allows the farmers to dry their rice paddies until the water table is below the soils surface. This has the potential to reduce water use by 25 percent compared with maintaining rice paddies in a continuously flooded state, as well as minimize energy use for pumping the irrigation water.[44]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	As a result of climate change, water availability will become more challenging in Nigeria.[45] In this regard, AWD technology reduces the use of water which can enable farmers address water scarcity. As mentioned earlier, the technology can reduce of water supply by 25 percent compared with maintaining rice paddies in a continuously flooded state, which is the common practice in rice cultivation.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	AWD technology has the potential to greatly reduce emissions of methane while minimizing energy use. According to a study conducted by International Rice Research Institute (IRRI), AWD technology can reduce the production of methane by 60% to 90%.[46] Thus, AWD technology can address methane emissions from the AFOLU sector in Nigeria, which was about 7% of total emissions (from the AFOLU sector) in 2015.[47] Furthermore, rice cultivation contributed to approximately 26% of total aggregated emissions from land.[48]	3
Alignment with climate change policies and priorities	Even though the technology is not specifically indicated in any of the climate change policies, improved resource management is	2

[44] CCAFS, "Strategies for low-emission cultivation are being explored step-by-step", Available at: Strategies for low-emission cultivation are being explored step-by-step (cgiar.org)
[45] Federal Ministry of Environment "Third National Communication (TNC) of the Federal Republic of Nigeria"
[46] FAO "Climate-smart agriculture and the Sustainable Development Goals"
[47] Government of Nigeria. 2018. "First Biennial Update Report (BUR1) of the Federal Republic of Nigeria"
[48] Ibid.

	considered as one of the strategies for agriculture in NASPA.	
Consideration of co-benefits (environmental, social, and economic)	*Environmental* AWD technology contributes to reducing the use of water resources. *Social* Since AWD technology decreases energy use, it allows farmers to reduce their overall cost in rice production. Furthermore, it can stabilize or increase farmer's income as the technology has the potential to increase yields. *Economic* AWD technology can lead to increase in rice production while reducing energy and water consumption.	3
Technological constraints	The technology is common globally, however, farmers need to be trained as the timing of the irrigation and water depth in the paddies are crucial components for the technology to realize its full potential.	3
Readiness of Nigeria for the technology	Training may be necessary to utilize this technology. Nevertheless, constraints to implement this technology can be considered as minor, as the technology is generally accepted by the stakeholders. Given that this technology is implemented in other African countries (such as Tanzania), it can be inferred that the implementation of the technology in Nigeria will not be that challenging.[49]	3

6. Crop diversification and new varieties

➢ Introduction

Crop diversification refers to enhancing the resilience of agricultural systems to climate change by increasing the variety of crops by introducing new and improved cultivated species. [50]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	This technology reduces farmers' reliance on a single crop for income generation and	3

[49] Mboyerwa et al. (2020) "Evaluation of Growth, Yield, and Water Productivity of Paddy Rice with Water-Saving Irrigation and Optimization of Nitrogen Fertilization"
[50] Climate Technology Centre and Network (CTCN), "Crop diversification and new varieties" Available at: Crop diversification and new varieties | Climate Technology Centre & Network

	enhance farmers' ability to adapt to climate change. Furthermore, a study conducted in Nigeria showed that crop diversification can help farmers resist to climate change impacts, such as droughts, flooding, and pests.[51] Adoption of early maturing crop varieties, for instance, has the potential of addressing water stress and soil deterioration.	
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Crop diversification and new varieties are mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions. However, new varieties that can contribute in sequestering carbon can potentially address Nigeria's GHG emissions from the agricultural sector.	2
Alignment with climate change policies and priorities	This technology has been identified in Nigeria's climate change policies, including Nigeria's NDC and TNC.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental* Crop diversification and new varieties can enhance biodiversity, while minimizing the use of water resources and conserving soil. *Social* Diversifying the crop portfolio and introducing new varieties may create new job opportunities. It can also stabilize or increase income for farmers as it reduces farmers' dependence on a single crop. *Economic* Crop diversification and new varieties can lead to increase in productivity in the agricultural sector.	3
Technological constraints	Crop diversification and new varieties is a mature technology and studies regarding this technology have taken place in West Africa.[52]	3
Readiness of Nigeria for the technology	The policy environment for implementing the technology is favorable and studies regarding this technology have already taken place in Nigeria. Even though introducing new varieties may require initial investments and research to assess whether the new variety is	3

[51] World Bank "Productive Diversification in African Agriculture and its Effects on Resilience and Nutrition"
[52] Kevin (2020) "Impact of Climate Variability on Crop Diversification in West African countries"

	applicable to Nigeria, these barriers can be addressed in the short to medium term.	

7. Drip irrigation

➢ Introduction

Drip irrigation refers to an agricultural system whereby water is delivered directly to plants through a number of emission points called "drippers".[53] This can lead to efficient use of water supply and reduction in water demand, which can help farmers adapt to climate risks such as droughts and extreme heat.

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Drip irrigation can allow farmer adapt to climate change by enhancing efficient use of water supply. In cases of droughts and extreme heat, drip irrigation can provide water directly to the plants which in turn reduces demand for water resources and water evaporation loss.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Drip irrigation is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	2
Alignment with climate change policies and priorities	The technology has been identified in several climate change policies and priorities. In particular, increasing the use of irrigation systems that use low amounts of water is indicated as one of the adaptation strategies for the agricultural sector in Nigeria's NDC.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	Sustainable water management and water conservation is critical for preserving the environment.	
	Social	
	Drip irrigation has the potential to prevent job loss in professions that are dependent on water availability. In addition, it can stabilize or increase farmer's income, as farmers are able to avoid losses due to lack of water resources.	
	Economic	
	Drip irrigation can lead to increase in productivity in the agricultural sector.	

[53] CTCN, "Drip Irrigation" Available at: Drip irrigation | Climate Technology Centre & Network

Technological constraints	This technology is a mature technology and is commercially available in many countries.	3
Readiness of Nigeria for the technology	There has been a number of cases using drip irrigation in Nigeria, but overall, still limited and not mainstream. The technology would also require significant investment initially to mainstream. There are several constraints that need to be considered when implementing this technology in Nigeria. First, due to the quantity of materials that need to be put in place, the initial cost is quite high.[54] Second, the technology needs to be installed properly to work effectively and thus the farmers require training. However, these barriers can be addressed in the short to medium term, and the policy environment can enable the facilitation of the technology in Nigeria.	3

8. Integrated Climate Change Monitoring and Early Warning System

➢ Introduction

An integrated communication system that makes use of forecasting, modelling, and warning systems to allow stakeholders better understand and adapt to climate change impacts and natural hazards. [55]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	This technology warns the possible occurrence of a natural phenomenon that could cause disasters. The technology helps the farmer's ability to prepare and respond to climate related risks and events, such as flooding and droughts. This technology can also enable better agricultural planning, which can lead to improved productivity.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change	Institutionalizing this technology is indicated in	3

[54] Ibid.
[55] CTCN, "Integrated Climate Change Monitoring and Early Warning System" Available at: Integrated Climate Change Monitoring and Early Warning System | Climate Technology Centre & Network

policies and priorities	both Nigeria's NDC and TNC. In the NDC, early warning systems is highlighted as one of the adaptation strategies in the agricultural sector.	
Consideration of co-benefits (environmental, social, and economic)	*Environmental* Has the potential to contribute to sustainable environmental management by providing forecasts and monitoring. *Social* The technology can create new job opportunities, especially by establishing monitoring systems and introducing climate information services. If implemented properly, the technology has also the potential to minimize farmers' losses as a result of floods and droughts. *Economic* Integrated Climate Change Monitoring and Early Warning System can improve agricultural planning, which in turn can lead to increase in agricultural productivity. In addition, the technology has the potential to minimize the damage caused by natural disaster to the economy. According to Nigeria's NDC, total damage caused by natural disasters amounted to $16.9 billion in 2012, which was equivalent to 1.4% of real GDP.	3
Technological constraints	The technology is implemented in many developed countries, However, in the context of Sub-Saharan Africa, it is still considered an emerging technology that is at the planning stage.	1
Readiness of Nigeria for the technology	According to the stakeholders, the technology is still at a planning stage in Nigeria and have not yet received enough support to proceed to the next stage (meeting with stakeholders on July 29th, 2021). Therefore, there is a lack of sufficient environment to implement the technology. Furthermore, the cost of implementing and monitoring the technology is high and the technology requires specialized training to utilize it. Therefore, the technology would require medium to long term waiting period until it is available.	1

9. Rainwater harvesting

➢ Introduction

Rainwater harvesting is defined as "a method of inducing, collecting, storing, and conserving local surface runoff (rain or surface water flow that occurs when soil is infiltrated to full capacity) for agriculture in arid and semi-arid regions". [56]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Rainwater harvesting gives farmers an alternative way of supplying water and address the demand for fresh water, which is crucial given the fact that climate change may lead to the reduction of water resources available in Nigeria.[57] Similarly, it can enhance people's access to clean and fresh water especially in drought prone areas in south Nigeria.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change policies and priorities	Nigeria's climate change policies indicate the use of rainwater harvesting as an adaptation measure, especially in the NDC.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental* Sustainable water management and water conservation is critical for preserving the environment. *Social* The technology has the potential to prevent job loss in professions that are dependent on water availability. In addition, it can stabilize or increase farmer's income, as farmers are able to avoid losses due to lack of water resources. *Economic* Rainwater harvesting can lead to increase in productivity in the agricultural sector.	3
Technological constraints	Rainwater harvesting is common in many countries and thus can be considered a mature technology.	3
Readiness of Nigeria for the technology	Given the number of cases in implementing the technology and the alignment with Nigeria's climate change policies, the enabling	3

[56] CTCN, "Rainwater harvesting" Available at: Rainwater harvesting | Climate Technology Centre & Network
[57] Federal Ministry of Environment "Third National Communication (TNC) of the Federal Republic of Nigeria"

	environment for implementing rainwater harvesting in Nigeria is favorable. There has also been studies on rainwater harvesting in Nigeria.[58] Cost of installing and maintaining the system can be considered as barriers (the cost varies depending on the size of the system), however, these barriers can be considered as minor and studies indicate that the technology is beneficial in building resilience against climate change.	

10. Integrated pest management (cross-cutting)

- Introduction

Integrated Pest Management refers to managing the development of pest population by considering all pest management techniques so that disruptions to the agricultural system are minimized. [59]

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Pests is considered as a significant threat in Nigeria and attacks by pests may become more severe as a result of climate change.[60] In this regard, integrated pest management aims to reduce risk of crop damage associated with pests and enhance crop yield and food security.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	A study indicates that integrated pest management can contribute in reducing GHG emissions by 30%, as the method requires less energy use.[61] This can therefore address GHG emissions from Nigeria's agriculture sector, which accounts for approximately 67 percent of overall GHG emissions in the country.	2
Alignment with climate change policies and priorities	Controlling pests is indicated as one of the adaptation strategies in Nigeria's TNC.	3

[58] Lade and Oloke (2013) "Assessment of rainwater harvesting potential in Ibadan, Nigeria"
[59] FAO, "Climate Smart Agriculture Sourcebook" Available at: B1 - 2 Climate-smart crop production practices and technologies | Climate Smart Agriculture Sourcebook | Food and Agriculture Organization of the United Nations (fao.org)
[60] Federal Ministry of Environment "Third National Communication (TNC) of the Federal Republic of Nigeria"
[61] CTCN "Integrated Pest Management (IPM)"

Consideration of co-benefits (environmental, social, and economic)	*Environmental* Integrated pest management is associated with better soil management which can be beneficial for the environment and biodiversity. *Social* The technology can stabilize or increase farmer's income, as farmers are able to reduce risk of crop damage. *Economic* Integrated pest management can lead to increase in agricultural production.	3
Technological constraints	Despite being implemented in many countries, integrated pest management can be challenging to implement as it requires significant amount of training to understand the methodology.	2
Readiness of Nigeria for the technology	Even though there are a number of cases of applying integrated pest management in Nigeria, it is still not mainstream. In addition, the technology itself is complex and therefore, requires a significant amount of training for the famers. As such, it is possible that the technology will not be accepted by the farmers.	1

11. Soil Moisture Monitoring (SMM) devices

➢ Introduction

Soil moisture monitoring devices provide farmers the information on the water status of soil.[62] It can assist better irrigation management which can lead to development of better crops with fewer inputs.

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	SMM devices allow farmers adapt to climate change by enhancing efficient use of water supply. SMM devices can lead to better irrigation management and reduce demand for water while minimizing overall water use. This is crucial given the fact that climate change may lead to the reduction of water resources	3

[62] CTCN, "Soil moisture monitoring" Available at: Soil moisture monitoring | Climate Technology Centre & Network\

	available in Nigeria.[63]	
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change policies and priorities	There is no direct reference to the technology in any of the climate change policies. However, enhanced use of irrigation systems that minimizes the amount of water being used is recognized as an adaptation measure in Nigeria's NDC.	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	Sustainable water management and water conservation is critical for preserving the environment.	
	Social	
	The technology has the potential to prevent job loss in professions that are dependent on water availability. In addition, it can stabilize or increase farmer's income, as farmers are able to avoid losses due to poor irrigation management.	
	Economic	
	SMM devices can lead to increase in productivity in the agricultural sector.	
Technological constraints	This technology is common in many countries. The cost and its availability will depend on the type of device that the country implements. The technology is also more effective and suitable for small-scale farmers.[64]	2
Readiness of Nigeria for the technology	Given the size of the agricultural sector in Nigeria, it may require significant initial investment in implementing the technology. The policy environment, however, could be favorable in facilitating the technology. Furthermore, even though the technology is still not mainstream, there are several cases in Nigeria using the technology.	3

12. Soil moisture conservation techniques

- Introduction

The purpose of soil moisture conservation techniques is to "minimize the amount of water lost

[63] Federal Ministry of Environment "Third National Communication (TNC) of the Federal Republic of Nigeria"
[64] CTCN, "Soil moisture monitoring" Available at: Soil moisture monitoring | Climate Technology Centre & Network

from the soils through evaporation (water loss directly from the soil) and transpiration (water loss occurring through the plants) – or combined, the evapotranspiration".[65]

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	This technology allows farmers adapt to climate change by enhancing efficient use of water supply. It can lead to sustainable resource management and reduce demand for water while minimizing overall water use. This is crucial given the fact that climate change may lead to the reduction of water resources available in Nigeria.[66]	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change policies and priorities	There is no specific indication of the technology in any of the climate change policies and priorities. However, it can be considered as part of improved resource management, which is considered as one of the adaptation strategies in Nigeria's NDC.	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	Sustainable water management and water conservation is critical for preserving the environment.	
	Social	
	The technology has the potential to prevent job loss in professions that are dependent on water availability. In addition, it can stabilize or increase farmer's income, as farmers are able to avoid losses due to poor water management.	
	Economic	
	Soil moisture conservation techniques can lead to increase in productivity in the agricultural sector.	
Technological constraints	The technology is fully mature and widely implemented in many countries. Depending on the location, the technology may require	3

[65] CTCN, "Soil moisture conservation techniques" Available at: Soil moisture conservation techniques | Climate Technology Centre & Network

[66] Federal Ministry of Environment "Third National Communication (TNC) of the Federal Republic of Nigeria"

	additional costs for it to work effectively.[67] The technology can be available in the short to medium term, but may require some testing since the technology is not suitable for every location.	
Readiness of Nigeria for the technology	The number of cases implementing this technology is limited in Nigeria. It will require significant amount of investment and data collection initially for the technology to reach its potential.	1

13. Nutrient management: nitrogenous fertilizers (cross-cutting)

- Introduction

The efficient use of nitrogenous fertilizers can reduce nitrous oxide from agricultural fields while contribute to the reduction of carbon dioxide emissions by minimizing the quantity of synthetic fertilizers.[68]

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	The technology can preserve ground water quality by preventing nitrate leaching, which can be essential when the availability of quality water reduces.	2
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Using nitrogenous fertilizers can contribute in reducing nitrous oxide from the agricultural sector. For instance, nitrogenous fertilizers like SBT butanoate and SBT fluroate reduced nitrous oxide by 4-5%, which is equivalent to reducing global warming potential by 8.9 to 19.5%.[69] Since the use of nitrogenous fertilizers reduce the quantity of synthetic fertilizers, this technology also has the potential to reduce carbon dioxide emissions.	3
Alignment with climate change policies and priorities	The technology is not indicated in any of the climate change policies and priorities. It can be, however, considered as part of adopting	2

[67] CTCN, "Soil moisture conservation techniques" Available at: Soil moisture conservation techniques | Climate Technology Centre & Network
[68] CTCN, "Nutrient management: nitrogenous fertilizers" Available at: Nutrient management: nitrogenous fertilisers | Climate Technology Centre & Network
[69] Ibid.

	better soil management, which is indicated in the NDC.	
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	As mentioned above, the technology prevents nitrate leaching which can help preserve ground water quality.	
	Social	
	It has the potential to stabilize or increase farmer's income, as farmers are able to avoid losses due to poor ground water quality.	
	Economic	
	The technology can lead to increase in productivity in the agricultural sector.	
Technological constraints	The technology is common in many countries, however, it requires significant input cost and is relatively expensive. Furthermore, the technology needs to be tested to assess whether the technology is suitable for the location. In addition, capacity building is needed to ensure that the technology is used appropriately.	2
Readiness of Nigeria for the technology	Despite having some cases implementing the technology in Nigeria, the overall cost and the need for testing and training can hinder the process of mainstreaming the technology in Nigeria. As such, it is possible that the technology will not be accepted by the farmers.	2

14. Seed and grain storage

- Introduction

Improved seed and grain storage can allow farmers to increase their resilience to climate-related impacts and rapidly recover from shocks.[70]

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Improving seed and grain storage can enable farmers to reduce their vulnerability from climate change impacts, such as pests and floods. The technology will also allow farmers to quickly recover in the case of disasters.	3
Potential impact on climate	This is a technology mainly aimed at adapting	0

[70] FAO, "Appropriate Seed and Grain Storage Systems for Small-scale Farmers"

change mitigation/greenhouse gas emissions reduction	to the impact of climate change and do not aim at reducing GHG emissions.	
Alignment with climate change policies and priorities	Increasing and upgrading crop storage facilities is identified as an adaptation strategy in Nigeria's TNC.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental* Improving seed and grain storage has the potential for better resource management as it minimizes the amount of waste. *Social* It has the potential to stabilize or increase farmer's income, as farmers are able to minimize food loss. *Economic* The technology can lead to increase in the amount of production.	3
Technological constraints	Seed and grain storage are available in many countries. However, for the technology to be effective, it requires to keep low levels of temperature, certain amount of moisture and humidity, which can be challenging in terms of maintenance and costs.	2
Readiness of Nigeria for the technology	The policy environment for implementing the technology is favorable and there are already cases in Nigeria in which the technology has been implemented. Yet, significant initial investment is necessary as installation and maintenance costs can be a burden for farmers.	2

15. Seasonal to Interannual Prediction

- Introduction

Seasonal to interannual prediction is a technology that presents forecast of weather conditions for a period of 3 to 6 months ahead[71]. Weather conditions are forecasted based on existing climate data such as sea surface temperatures, and then developed by using mathematical models.

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Understanding the forecast of weather conditions for a period 3 to 6 months ahead	3

[71] CTCN, "Seasonal to interannual prediction" Available at: Seasonal to interannual prediction | Climate Technology Centre & Network

	can enable farmers to have better resource management, especially reducing the use of water resources. This technology also helps the farmer's ability to prepare and respond to climate related risks and events, such as flooding and droughts.	
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change policies and priorities	Even though the technology is not clearly indicated in any of the documents, providing meteorological forecasts are considered as one of the strategies for agriculture in NASPA.	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	Has the potential to contribute to sustainable environmental management by providing forecasts and monitoring.	
	Social	
	The technology can create new job opportunities, especially by establishing monitoring systems and introducing climate information services. If implemented properly, the technology has also the potential to minimize farmers' losses as a result of floods and droughts.	
	Economic	
	Seasonal to interannual prediction can improve agricultural planning, which in turn can lead to increase in agricultural productivity. In addition, the technology has the potential to minimize the damage caused by natural disaster to the economy.	
Technological constraints	The technology is well known and has been adopted in many countries.	3
Readiness of Nigeria for the technology	The main constraint of implementing this technology is the initial investment. Furthermore, a significant amount of training is required, especially in relation to forecasting and climate modelling.	1

16. Index-based Climate Insurance

- Introduction

Index-based climate insurance assesses compensation for agricultural, livestock, or fishery production losses caused by extreme weather events using an index that is closely connected

to output losses[72]. The insurance payment is made when the index surpasses a particular threshold without an onsite inspection.

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	The technology has the potential of protecting farmers' livelihoods and income by providing compensations for productions losses as a result of climate change. Since it is not directed mainly at adapting production to climate change, its long-lasting impact on resilience remains limited to some extent.	2
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change policies and priorities	Increasing support for insurance schemes is considered as an adaptation strategy in Nigeria's TNC.	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	2
	No significant co-benefits in terms of environment	
	Social	
	The technology can enable affected farmers sustain their livelihoods and income through indemnities paid by insurance companies.	
	Economic	
	The technology can prevent loss in production in the agricultural sector as the technology can allow farmers to continue his/her activities.	
Technological constraints	The technology is adopted in various countries.	3
Readiness of Nigeria for the technology	There is no known case of this technology in Nigeria. This technology requires other technologies like remote sensing and GIS to obtain real-time weather data for it to function, which in turns needs significant amount of initial investment and training,	0

17. Hydroponics/Soilless Agriculture

[72] CTCN "Index-based climate insurance", Available at: Index-based climate insurance | Climate Technology Centre & Network

➢ Introduction

Hydroponics refers to a form of growing plants in a water-based, nutrient-rich solution without soil. An inert medium such as perlite, rockwool, clay pellets, peat moss, or vermiculite supports the root system. It allows farmers with limited access to land and water to do farming, contributing to water and land use savings. [73]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	The adoption of the technology can enable farmers to use water resources and nutrients more efficiently while avoiding uncertainties in the water and nutrient status of the soil. Furthermore, it assists farmers in overcoming issues concerning sanity and pests/diseases.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change policies and priorities	There is no specific indication of the technology in any of the climate change policies and priorities. However, it can be considered as part of improved resource management, which is considered as one of the adaptation strategies in Nigeria's NDC.	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental* The technology can contribute to sustainable water management and reduce soil degradation, which is critical to preserving the environment. *Social* Can provide job opportunities in the creation and maintenance of hydroponics systems. *Economic* Hydroponics system can lead to increase in agricultural production.	3
Technological constraints	Hydroponics is still considered an emerging technology and requires testing to figure out which crop can be produced through the technology.	1
Readiness of Nigeria for the technology	There is no known application of this technology in Nigeria. High investment is initially required to put in place the necessary modern equipment to function properly.	0

[73] FAO "Home Gardens/Vertical Farming, Hydroponics and Aquaponics" Available at: http://www.fao.org/land-water/overview/covid19/homegardens/en/

	Training for farmers is also needed, and thus the technology may be available in the medium to long term.	

18. Aquaponics

➢ Introduction

Aquaponics is a system that combines hydroponics with conventional aquaculture. It can lead to better water management as the fish water is used as fertilizer for the plants, while the plants clean the water for the fish[74].

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	This technology allows farmers adapt to climate change by enhancing efficient use of water supply. It can lead to sustainable resource management and reduce demand for water while minimizing overall water use.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change policies and priorities	There is no specific indication of the technology in any of the climate change policies and priorities. However, it can be considered as part of improved resource management, which is considered as one of the adaptation strategies in Nigeria's NDC.	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	The technology can lead to soil conservation, which is critical for sustaining the environment.	
	Social	
	Can provide job opportunities in the creation and maintenance of aquaponics systems.	
	Economic	
	The technology can lead to increase in agricultural production.	
Technological constraints	Even though there are some commercial applications, similar to hydroponics, this technology is still considered as an emerging technology.	1
Readiness of Nigeria for the technology	There is no known application of this technology in Nigeria. High initial costs may	0

[74] CTCN "Soilless agriculture", Available at: Soilless agriculture | Climate Technology Centre & Network

	be a barrier in mainstreaming the technology.	

6.2. Livestock production

1. Straw ammoniation and silage (cross-cutting)

➢ Introduction

Straw ammoniation refers to the process of adding ammonia sources such as liquid ammonia, urea, or ammonium bicarbonate to low-value forage (examples: corn stalks, rice straw, wheat straw, and straw of other crops). Straw silage is "forage that is prepared through the fermentation of chopped fresh green fodder, forage grass, and all kinds of vines and other materials by lactobacillus in the anaerobic conditions of an airproof silage container (tower or silo)."[75]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	The technology allows straws to be stored in large quantities for a long period of time, which enhances farmer's ability to withstand climate change impacts.	2
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Straw ammoniation and silage can contribute in improving feed quality and animal productivity, which in turn leads to the reduction of methane emissions. For instance, a study suggests that feeding the straw treated with ammoniation reduced methane emissions by 16% to 30% compared to that of dry straw.[76]	3
Alignment with climate change policies and priorities	There is no reference to the technology in any of the climate change policies.	1
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	The technology can contribute to sustainable resource management.	
	Social	
	Straw ammoniation and silage can reduce feeding costs and increase productivity, which can stabilize or increase income for farmers.	
	Economic	
	The technology can lead to increase in the	

[75] CTCN, "Straw ammoniation and silage" Available at: **Straw ammoniation and silage | Climate Technology Centre & Network**

[76] Ibid.

	amount of production in the agricultural sector.	
Technological constraints	The technology is implemented in many countries. However, the procedure in using the technology is complex and may cause environmental degradation if it not used appropriately. Therefore, it requires a significant amount of training. In addition, some materials can be relatively expensive.	2
Readiness of Nigeria for the technology	Significant amount of training and investment cost can be a hindrance in implementing the technology in Nigeria. In addition, there is no known application of this technology in Nigeria. This technology, therefore, can only be available in the medium to long term.	0

2. Shifting human dietary needs (cross-cutting)

➢ Introduction

Changing human dietary needs by moving away from meat consumption and diversify sources of food.

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Diversifying the food system can contribute to increasing the resilience of agricultural ecosystems.	1
Potential impact on climate change mitigation/greenhouse gas emissions reduction	According to a study conducted by WWF, shifting human dietary needs has the potential to reduce GHG emissions by 30% by 2030.[77] Reliance on carbon intensive meat production and large-scale industrial agriculture can be decreased as well.	2
Alignment with climate change policies and priorities	The technology is not indicated in any of the climate change policies.	0
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	Transitioning to diets that have lower environmental impact can have a positive effect on biodiversity and the overall environment.	
	Social	
	Potential of new job opportunities in sectors	

[77] Carbon Brief "Experts: How do diets need to change to meet climate targets". Available at: Experts: How do diets need to change to meet climate targets? (carbonbrief.org)

	that does not handle meat. It can also enable farmers to stabilize or increase income as it reduces the reliance on a single crop.	
	Economic	
	The technology has the potential improve agricultural productivity.	
Technological constraints	The technology has not been widely implemented. Moreover, the food supply chain consists of many stakeholders and thus may be difficult to reach an agreement on how to implement the technology.	1
Readiness of Nigeria for the technology	It is questionable whether shifting dietary needs is possible in Nigeria since the acceptability for this technology may be low.	0

3. Enhance farmers' access to micro-credits

➢ Introduction

Improving access to micro-credits to support famers to gain the necessary tools and resources to tackle climate change

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	This technology has the potential to increase farmers' resilience to climate change impacts. Through micro-credits, farmers can install adaptation measures such as water conservation and diversification of livestock that can help them better adapt to climate change.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This technology is mainly considered an adaptation strategy. However, enhancing farmers' access to micro-credits can enable farmers to install technology that contribute to reducing GHG emissions.	1
Alignment with climate change policies and priorities	There is no specific indication of the technology in any of the climate change policies. However, it can be considered as part of assisting low income farmers, which is mentioned in Nigeria's NDC.	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	The technology can support implementing technologies that are less harmful to the environment.	
	Social	

	Depending on how the technology is used, it has the potential to increase or stabilize farmers' income as well as create new job opportunities.	
	Economic	
	It can potentially lead to increase in agricultural productivity.	
Technological constraints	There are several cases of implementing this technology, but still limited. If this technology is implemented by domestic financial institutions, it usually requires capacity building and international support.	2
Readiness of Nigeria for the technology	There is no known application of this technology in Nigeria and may need international support, in terms of finance and capacity building.	1

4. Selective breeding via controlled mating

➢ Introduction

A systematic form of breeding in order to improve productivity and breed animals that are more resilient to climate change impacts.[78]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Selective breeding via controlled mating can enhance an animal's tolerance to climate change impacts, such as heat stress, droughts, pests, and diseases. Furthermore, it can increase fertility rates and decrease mortality rates, as well as improve livestock products (such as milk and fiber), which lowers the risk of farmers losing animals due to climate change impacts.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Despite being considered mainly as an adaptation measure, this technology can contribute to cutting GHG emissions by improving the animals' resilience to diseases, which can reduce animal loss and improve the efficiency of the farm.	1
Alignment with climate change	This technology aligns with Nigeria's climate	3

[78] CTCN, "Selective breeding via controlled mating" Available at: Selective breeding via controlled mating | Climate Technology Centre & Network

policies and priorities	change policies and priorities. Developing improved livestock breeds is indicated in the NDC and increasing access to drought resilient livestock is identified as NASPA sectoral strategies.	
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	This technology can contribute to enhancing and maintaining biodiversity.	
	Social	
	Famers are able to stabilize or increase their income as the technology reduces animal loss.	
	Economic	
	It can potentially lead to increase in agricultural productivity.	
Technological constraints	This technology is a mature technology that has been implemented in many countries. Depending on the methodology, the cost for the technology can be significant. For instance, methods such as in-vitro fertilization or genetic engineering are high-tech and relatively high cost. Training of farmers is also required for the technology to reach its full potential.	2
Readiness of Nigeria for the technology	Even though there are a number of cases in Nigeria implementing the technology, it is still not mainstream. Significant amount of initial investment and training may be required if the method is high-tech.	1

5. Livestock Disease Management

➢ Introduction

Livestock disease management has two key components: prevention measures (biosecurity) measures in susceptible herds and control measures taken once inflection is observed.[79]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Climate change impacts such as increasing frequency of heat stress, drought and flooding events can lead to increased spread of existing vector-borne diseases and macro-	3

[79] CTCN, "Livestock disease management" Available at: Livestock disease management | Climate Technology Centre & Network

	parasites, along with the emergence of new diseases. In this regard, livestock disease management can increase the animals' resistance to these threats.	
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Despite being considered mainly as an adaptation measure, this technology can contribute to cutting GHG emissions by improving the animals' resilience to diseases, which can reduce animal loss and improve the efficiency of the farm.	1
Alignment with climate change policies and priorities	This technology aligns with Nigeria's climate change policy and priorities as vaccination of livestock is identified as an adaptation strategy in Nigeria's NDC.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	Livestock disease management reduces the transfer of diseases to other wildlife species surrounding the farm, which can help maintaining biodiversity.	
	Social	
	Famers are able to stabilize or increase their income as the technology reduces animal loss.	
	Economic	
	It can potentially lead to increase in agricultural productivity.	
Technological constraints	The technology is still an emerging technology, which is either at a planning or testing stage. Strategies such as antibiotics and vaccines are not biologically sustainable as viruses keep transforming over time. Therefore, the cost of the technology can be high for a long period of time. Depending on the strategy, it might need a long waiting period until the technology becomes available.	2
Readiness of Nigeria for the technology	Initial and maintenance costs associated with the technology can be significant, which can be a burden for implementing the technology in Nigeria. There is also not known application of this technology in Nigeria.	1

6. Diversification of livestock

- Introduction

Diversifying the livestock portfolio to enhance the agricultural system's ability to adapt to climate change. Strategies include adopting breeds that are more tolerant to climate change impacts or

diversifying into different breeds of the same livestock species.

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	This technology reduces farmers' reliance on a single livestock species for income generation and enhance farmers' ability to adapt to climate change. Livestock diversification can help farmers resist to climate change impacts, such as droughts, flooding, and pests.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Livestock diversification is mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG emissions.	0
Alignment with climate change policies and priorities	Diversification of livestock is indicated in Nigeria's NDC as well as other documents as an adaptation measure.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	This technology has the potential to enhance biodiversity.	
	Social	
	Diversifying livestock may create new job opportunities. It can also stabilize or increase income for farmers as it reduces farmers' dependence on a single livestock species.	
	Economic	
	This technology can lead to increase in productivity in the agricultural sector.	
Technological constraints	This technology is implemented in many countries. However, implementing this technology in a large scale can be costly.	2
Readiness of Nigeria for the technology	The policy environment for this technology is favorable. There are also some use cases of this technology in Nigeria. Yet, the technology would require significant investment to mainstream.	2

6.3. Forestry

1. Agroforestry (cross-cutting)

- Introduction

According to the World Agro-forestry Centre, Agroforestry is "a dynamic, ecologically based, natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic, and

environmental benefits for land users at all levels".[80]

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Agroforestry can provide a number of ecosystem services that can enhance resilience to climate change. It can improve water security by improving infiltration to soils and ground water, while trees can act as a buffer against floods, erosion, pests, and storms.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	The forestry sub-sector is the highest emitter of GHGs in the agriculture and land use sector in Nigeria, accounting for 84 percent of total emissions.[81] In this regard, agroforestry practices can reduce GHG emissions by increasing carbon storage in biomass (both above-ground and below-ground) and in soil organic carbon. According to Nigeria's NDC, agroforestry can contribute to total (lifetime) emissions reductions ranging from 158 million to 712 million tonnes.	3
Alignment with climate change policies and priorities	The technology is identified in many of the climate change policies and priorities of Nigeria.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	Agroforestry can support tree-related ecosystem services, such as regulating sediment and water flows, improving nutrient and carbon cycle in soils and creating habitat for biodiversity. This in turn can also reduce soil erosion.	
	Social	
	It can reduce the use of external inputs such as conventional fertilizers and chemicals for pest management, which can stabilize or increase farmers' income. May provide new job opportunities in the forest-related industry.	
	Economic	
	Agroforestry has the potential to increase farm	

[80] CTCN, "Agroforestry" Available at: Agroforestry | Climate Technology Centre & Network
[81] Federal Republic of Nigeria. 2020. TNC.

	productivity and develop forest-related industry.	
Technological constraints	Agroforestry is practiced in many countries to some extent.. The process of realizing the potential of the technology may be slow and careful maintenance is needed. The location needs to be considered thoroughly as studies indicate that agroforestry has led to lower crop yield in drier lands due to tree-crop competition for water.[82]	2
Readiness of Nigeria for the technology	The policy environment is favorable, and the technology is available in Nigeria to a certain extent. Issues regarding land rights and lack of knowledge may be a potential barrier in scaling up the technology.	2

2. Forest management techniques for mitigation (REDD+) (cross-cutting)

➢ Introduction

Managing forests by either promoting afforestation or reducing deforestation to increase stand-level forest carbon stocks.[83]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Activities under REDD+ has the potential to improve water security by improving infiltration to soils and ground water, while trees can act as a buffer against floods, erosion, pests, and storms.	2
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This technology can contribute in reducing GHG emissions from the atmosphere by slowing and halting forest loss (deforestation and forest degradation) while also enhance and conserve forest-carbon stocks. As mentioned earlier, the forest subsector is the highest emitter of GHGs in the agriculture and land use sector in Nigeria.	3
Alignment with climate change policies and priorities	This technology aligns with Nigeria's climate change policies and priorities as the technology is clearly indicated in Nigeria's	3

[82] CTCN, "Agroforestry" Available at: Agroforestry | Climate Technology Centre & Network
[83] CTCN, "Forest management techniques for mitigation (REDD+)" Available at: Forest management techniques for mitigation (REDD+) | Climate Technology Centre & Network

	TNC.	
Consideration of co-benefits (environmental, social, and economic)	*Environmental*	3
	This technology can support tree-related ecosystem services, such as regulating sediment and water flows, improving nutrient and carbon cycle in soils and creating habitat for biodiversity. This in turn can also reduce soil erosion.	
	Social	
	It can reduce the use of external inputs such as conventional fertilizers and chemicals for pest management, which can stabilize or increase farmers' income. May provide new job opportunities in the forest-related industry.	
	Economic	
	REDD+ has the potential to increase farm productivity and develop forest-related industry.	
Technological constraints	Even though the technology is implemented in many countries, the technology requires time for it to reach its potential and have an impact on climate change mitigation and adaptation. The technology also requires sufficient financial support as well as capacity building of institutions.	2
Readiness of Nigeria for the technology	The policy environment for this technology is favorable and several REDD+ programs has been implemented in Nigeria. However, a significant amount of investment and capacity building is necessary for this technology.	2

3. Sustainable Forest Management (cross-cutting)

➢ Introduction

Managing forests in accordance to sustainable development and community development principles.[84] This includes the protection, restoration, afforestation, and reforestation of forests while preventing forest degradation.

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Sustainable forest management has the potential to improve water security by	2

[84] CTCN, "Sustainable forest management" Available at: Sustainable forest management | Climate Technology Centre & Network

	improving infiltration to soils and ground water, while trees can act as a buffer against floods, erosion, pests, and storms.	
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This technology can contribute in reducing GHG emissions from the atmosphere by slowing and halting forest loss (deforestation and forest degradation) while also enhance and conserve forest-carbon stocks. This technology can address GHG emissions in the forest subsector, which is the highest emitter of GHGs in the agriculture and land use sector in Nigeria.	3
Alignment with climate change policies and priorities	Incentivizing sustainable forest management is indicated as a measure to reduce GHG emissions from AFOLU sector and thus, the technology aligns with Nigeria's climate change policies and priorities.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental* The technology can contribute in conserving and enhancing biodiversity. *Social* It can reduce the use of external inputs such as conventional fertilizers and chemicals for pest management, which can stabilize or increase farmers' income. May provide new job opportunities in the forest-related industry. *Economic* Sustainable forest management has the potential to increase farm productivity and develop forest-related industry.	3
Technological constraints	This technology is implemented in many countries to some extent. The technology requires the development of regulatory, institutional, technical and information capacity to reach its potential. Management and maintenance cost can be relatively high.	2
Readiness of Nigeria for the technology	There is an enabling environment to facilitate the technology in Nigeria. There are also some cases of sustainable forest management in Nigeria. However, a significant amount of investment and capacity building is necessary for this technology.	2

4. Ecosystem-based adaptation

- Introduction

According to the Convention on Biological Diversity, Ecosystem-based adaptation (EbA) refers to "the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change." Examples include livelihood diversification, sustainable forest management, integrated water resource management etc.[85]

- Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	There are several ways in which ecosystem-based adaptation can contribute in increasing resilience to climate change impacts. Examples include, but not limited to, maintaining, and restoring mangroves to reduce coastal flooding and erosion, managing upland wetlands to improve water flow and quality, restoring forests to prevent flooding and landslides, and establishing agroforestry systems to provide flexible livelihood options.	3
Potential impact on climate change mitigation/greenhouse gas emissions reduction	Though primarily an adaptation approach, ecosystem-based adaptation has the potential to reduce GHG emissions by halting habitat loss and ecosystem degradation.	1
Alignment with climate change policies and priorities	There is no indication of the technology in any of Nigeria's climate change policies. Nevertheless, it can be considered as part of restoring ecosystems, which is indicated in Nigeria's TNC.	2
Consideration of co-benefits (environmental, social, and economic)	*Environmental* The technology can contribute in conserving the environment and enhancing biodiversity. *Social* May provide an additional source of income especially for people living in rural areas. *Economic* Has the potential to minimize the impact of natural disasters to the economy and increase agricultural production.	3
Technological constraints	Even though there are some projects under implementation in several countries, it is still considered as an emerging technology, Depending on the activity, the initial and	2

[85] IUCN, "Ecosystem-based approaches to climate change adaptation" Available at: Ecosystem-based Approaches to Climate Change Adaptation | IUCN

	maintenance costs can be relatively high. Starting to be implemented in many countries, but further research and assessment is needed to understand its potential for climate change mitigation and adaptation.	
Readiness of Nigeria for the technology	Since ecosystem degradation is one of the issues in Nigeria, adopting ecosystem-based adaptation may be necessary in the long run. However, the concept is too broad and sufficient investment is necessary. There is also no known application of this technology in Nigeria.	1

5. Afforestation (cross-cutting)

➢ Introduction

According to the IPCC, afforestation is "the direct human-induced conversion of non-forest to forest land through planting, seeding, and/or the human-induced promotion of natural seed sources". [86]

➢ Evaluation of the technologies against criteria

Criteria	Evaluation	Scoring
Potential impact on climate change adaptation	Afforestation has the potential to improve water security by improving infiltration to soils and ground water, while trees can act as a buffer against floods, erosion, pests, and storms.	2
Potential impact on climate change mitigation/greenhouse gas emissions reduction	This technology can address GHG emissions in the forest subsector, which is the highest emitter of GHGs in the agriculture and land use sector in Nigeria, by enhancing stand-level forest carbon stocks (1 to 1.5tCO2/yr).[87]	2
Alignment with climate change policies and priorities	Afforesting with suitable species is indicated as an adaptation measure in Nigeria's TNC.	3
Consideration of co-benefits (environmental, social, and economic)	*Environmental* The technology can contribute in conserving the environment and enhancing biodiversity. *Social* May provide new job opportunities in forest-related industry. It can also be an additional	3

[86] IPCC, "9.4.2.2 Maintaining or increasing forest area: afforestation/reforestation" Available at: 9.4.2.2 Maintaining or increasing forest area: afforestation/reforestation - AR4 WGIII Chapter 9: Forestry (ipcc.ch)
[87] Ibid.

	source of income especially for people living in rural areas. *Economic* Has the potential to develop the forest-related industry in Nigeria.	
Technological constraints	The technology requires the development of regulatory, institutional, technical and information capacity to reach its potential. Management and maintenance cost can be relatively high.	2
Readiness of Nigeria for the technology	There is an enabling environment to facilitate the technology in Nigeria and some use cases has been identified. However, a significant amount of investment and capacity building is necessary for this technology.	2

7. Summary of list of adaptation technologies

Technology	(a) Potential impact on climate change adaptation	(b) Potential impact on climate change mitigation/ greenhouse gas emissions reduction	(c) Alignment with climate change policies and priorities	(d) Consideration of co-benefits	(e) Technological constraints	(f) Readiness of Nigeria for the technology	Total
Agriculture and Land Use: Crop Production							
Agricultural biotechnology	2	2	2	3	2	3	14
Cover crop technology	3	3	3	3	2	2	16
Conservation tillage	3	3	2	3	3	1	15
Climate Smart Agriculture	3	2	3	3	2	2	15
Alternate Wetting and Drying in Rice Production	3	3	2	3	3	3	17
Crop diversification and new varieties	3	2	3	3	3	3	17
Drip Irrigation	3	2	3	3	3	3	17
Integrated Climate Change Monitoring and Early Warning System	3	0	3	3	1	1	11

Rainwater harvesting	3	0	3	3	3	3	15
Integrated Pest Management	3	2	3	3	2	1	14
Soil Moisture Monitoring (SMM) devices	3	0	2	3	2	3	13
Soil moisture conservation techniques	3	0	2	3	3	1	12
Nutrient management: nitrogenous fertilizers	2	3	2	3	2	2	14
Seed and grain storage	3	0	3	3	2	2	13
Seasonal to Interannual Prediction	3	0	2	3	3	1	12
Index-based climate insurance	2	0	2	2	3	0	9
Hydroponics/Soil less Agriculture	3	0	2	3	1	0	9
Aquaponics	3	0	2	3	1	0	9
Agriculture and Land Use: Livestock Production							
Straw ammoniation and silage	2	3	1	3	2	0	11
Shifting human dietary needs	1	2	0	3	1	0	7
Enhance farmers' access	3	1	2	3	2	1	12

to micro-credits							
Selective breeding via controlled mating	3	1	3	3	2	1	13
Livestock disease management	3	1	3	3	2	1	13
Diversification of livestock	3	0	3	3	2	2	13
Agriculture and Land Use: Forestry							
Agroforestry	3	3	3	3	2	2	16
Forest management techniques for mitigation (REDD+)	2	3	3	3	2	2	15
Sustainable forest management	2	3	3	3	2	2	15
Ecosystem-based adaptation	3	1	2	3	2	1	12
Afforestation	2	2	3	3	2	2	14