



United Nations Industrial Development Organization
Climate Technology Centre & Network
Federal Ministry of Environment - Department of Climate Change
Federal Ministry of Science, Technology and Innovation – Department of
Environmental Sciences and Technology

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

Technology Fact Sheets – Agriculture and land use

Version 2.0

September 24th, 2022

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1. Introduction

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. After the long-list of mitigation and adaptation technologies that can be applicable to each subsector was prepared, a total of 26 technologies were then prioritized and validated through regional and validation workshops.

This report, therefore, will present technology fact sheets on the prioritized technologies in the agricultural and land use sector. The technology fact sheets summarize mainly the potential of the technology to contribute to climate change mitigation/adaptation, the technology’s impact on development priorities, barriers and opportunities in implementing the technology, as well as the current status of the technology in Nigeria. Furthermore, it will provide an evaluation on the timeframe of implementing the technology, looking at short term (2022 - 2025), medium term (2026 - 2030), and long term (2030 - 2050) outlook. These technology fact sheets will serve as basis in developing the Technology Action Plans, which will provide detailed project ideas on the identified and prioritized technologies.

2. Technology fact sheets – agriculture and land use

2.1 Crop production

2.1.1 Climate smart agriculture

Technology characteristics	Description	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. ¹
	Climate change mitigation/adaptation benefits	This technology is a cross-cutting technology that has the potential to contribute to both climate change

¹ FAO, “Climate Smart Agriculture” Available at: [Climate-Smart Agriculture | Food and Agriculture Organization of the United Nations \(fao.org\)](https://www.fao.org/climate-smart-agriculture/)

		<p>mitigation and adaptation.</p> <p>In regard to climate change mitigation, 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.² To what extent this technology can contribute to climate change mitigation is still a debate, with different figures among various studies.³ According to Nigeria’s NDC, however, climate smart agriculture has the potential to reduce GHG emissions by 74 million tons per year in 2030.</p> <p>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 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.</p>
Potential co-benefits	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.
Applicability and potential in Nigeria		Even though the concept is indicated in

² FAO “Climate-smart agriculture and the Sustainable Development Goals”

³ Zaman et al. (2021) “Climate-smart Agriculture practices for mitigating greenhouse gas emissions”

	<p>Nigeria’s NDC, the concept is too broad and there are many techniques and facilities that can be associated with climate smart agriculture. Thus, it will be important to initially identify the specific practice and facilities that is needed by designing and implementing a pilot project and assessing the pilot project. Even though there are some cases using this technology in Nigeria (such as conservation agriculture and crop diversification), for the technology to be mainstream, it will require investments that may become a burden in the long run. Yet, the enabling environment for implementing the technology is favorable in Nigeria.</p>
<p>Enabling environment for the technology</p>	<p>Climate smart agriculture is clearly indicated in Nigeria’s NDC and other climate change policies as both climate change mitigation and adaptation measure, which ensures that the technology will be supported by the Nigerian government moving forward.</p>
<p>Status of the technology in Nigeria</p>	<p>Several climate smart agriculture practices and technologies, such as conservation agriculture, soil fertility management, improved seeds varieties, have been implemented in some states.⁴</p>
<p>Opportunities and barriers</p>	<p>Climate smart agriculture has the potential of improving agricultural productivity while enhancing climate resilience of farmers. However, as mentioned earlier, identifying the specific practice and facilities that would meet the needs of the country will be necessary for the deployment of the technology to be successful. Conservation agriculture and soil moisture conservation technologies are likely to be available and scaled-up in the short to medium term (until 2030) as there are pilot projects for these practices</p>

⁴ FAO “Climate Smart Agriculture in Yobe State of Nigeria”

	in several states in Nigeria. However, practices such as climate smart irrigation, which includes water harvesting and water pumps, may be available in long term (2030 - 2050) as these practices have not been tested in Nigeria.
Costs and financial requirements	Depending on the technology identified, the initial cost can be significant in deploying the technology. For instance, large scale conservation tillage can cost at least USD 203/ha while water harvesting techniques can cost at least USD 383/ha for initial investment. ⁵ Another common climate smart agriculture practice, drip irrigation can initially cost approximately USD 279/ha. ⁶
Time frame	An initial assessment may be necessary to identify the needs of the country as well as the appropriate practice. Suggested steps include but not limited to stakeholders' consultations, interview, field observation, technical capacity building workshop, designing and implementing technical needs assessment and/or pilot project, and assessment of the pilot project. After these initial steps, it is suggested to identify good practices and guidelines to disseminate the technology to different communities and regions in Nigeria. Similarly, it is equally important to secure finance to address the initial investment costs. Nevertheless, given that the enabling environment is favorable, the technology may be available in the short to medium term (up to 2030).

2.1.2 Agricultural biotechnology

Technology characteristics	Description
	Agricultural biotechnology refers to a biological approach that utilizes

⁵ USAID "Land Tenure & Climate Smart Agriculture"

⁶ Sain et al. "Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala"

		biotechnological methods and traditional plant breeding to produce crop varieties with enhanced carbon sequestration. ⁷
	Climate change mitigation/adaptation benefits	<p>This technology is a cross-cutting technology that has the potential to contribute to both climate change mitigation and adaptation.</p> <p>According to a study conducted by Brookes and Barfoot (2009), genetically modified crops using agricultural biotechnology conserved over 14,200 million kg of CO₂ in the year 2007, which is equivalent of over 6 million cars.⁸ Therefore, it can potentially contribute to the reduction of GHG emissions from the agricultural sector, which accounts for the largest GHG emissions in Nigeria.</p> <p>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.</p>
Potential co-benefits	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 farmers' income and address food insecurity.
	Economic	Cultivating crops that are resistant to

⁷ UNEP "Technologies for Climate Change Mitigation-Agricultural Sector"

⁸ CTCN "Crop varieties with enhanced carbon sequestration"

		droughts and pests can improve the overall agricultural production in Nigeria.
Applicability and potential in Nigeria		There is also a policy framework for agricultural biotechnology in Nigeria, creating a more enabling environment for the technology.
Status of the technology in Nigeria		Several projects using agricultural biotechnology are under implementation in Nigeria (for example, pod borer resistance cowpeas), however, none of the crops have been commercialized. ⁹ 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).
Enabling environment for the technology		A framework for agricultural biotechnology has already been established in Nigeria, identifying the responsibilities of key institutions. However, specific regulations and guidelines on agricultural biotechnology has not been formulated.
Opportunities and barriers		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 (2022 - 2025). ¹⁰
Costs and financial requirements		Significant investment is needed in establishing facilities and deploying technologies associated with agricultural biotechnology. In particular, the technology requires specialized equipment which can range from USD 5,000 – 220,000 per equipment. Moreover, specific laboratories are needed for this technology, which can cost up to USD 115 million from

⁹ USDA “Agricultural biotechnology annual”

¹⁰ UNEP “Technologies for Climate Change Mitigation-Agricultural Sector”

Time frame	<p>construction to regulation.¹¹</p> <p>As mentioned earlier, since several years of testing is required to observe the benefits of the technology, it will be difficult to deploy the technology in the short-term (2022 - 2025). Furthermore, even though there is a policy framework for agricultural biotechnology in Nigeria, appropriate regulations are yet to be implemented and capacity building of relevant institutions is still required. Therefore, the technology may be available in mid to long term (2030 - 2050).</p>
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2.1.3 Integrated climate change monitoring and early warning system

Technology characteristics	Description	<p>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.¹² This technology warns the possible occurrence of a natural phenomenon that could cause disasters to enhance the farmer's ability to prepare and respond to climate related risks and events, especially flooding and droughts. It has a flood forecasting platform, four fundamental elements; 1) knowledge of the risks; 2) monitoring, analysis and forecasting of the hazards; 3) communication or dissemination of alerts and warnings; 4) and local capabilities to respond to the warnings received.¹³</p>
	Climate change mitigation/adaptation benefits	<p>This is a technology mainly aimed at adapting to the impact of climate change and do not aim at reducing GHG</p>

¹¹ Crop Life International "Cost and Time Required for the Discovery, Development and Authorisation of a New Plant Biotechnology-Derived Genetic Trait"

¹² CTCN, "Integrated Climate Change Monitoring and Early Warning System" Available at: [Integrated Climate Change Monitoring and Early Warning System | Climate Technology Centre & Network](#)

¹³ United Nations International Strategy for Disaster Reduction (UNISDR) (2009). [UNISDR Terminology on Disaster Risk Reduction \(2009\)](#).

		emissions. 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.
Potential co-benefits	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.
Applicability and potential in Nigeria		However, institutionalizing this technology is indicated in both Nigeria's NDC and TNC. In the NDC, early warning systems is highlighted as one of the adaptation strategies in the agricultural sector. If deployed, the technology can contribute to reducing damages in the agricultural sectors caused by natural disasters.
Status of the technology in Nigeria		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, awareness building activities and capacity building activities are required as immediate steps to establish support for the technology as well as its dissemination.
Enabling environment for the technology	As mentioned above, institutionalizing this technology is indicated in both Nigeria's NDC and TNC. In the NDC, early warning systems is highlighted as one of the adaptation strategies in the agricultural sector. Therefore, it is likely that the dissemination of this technology would be supported by the Nigerian government.
Opportunities and barriers	Significant amount of investment and training is required for the technology to be utilized effectively.
Costs and financial requirements	High investment costs in building and maintaining the necessary facilities and equipment. Equipment such as automatic water level measuring system (approx. USD 10,000 per item), meteorological system (approx. USD 22,000 per item), upper air sounding system (approx. USD 254,000), mobile discharge meters (approx. USD 40,000), high performance computers (approx. USD 1,125,000), modernized telecommunication system (approx. USD 425,000), along with radar (approx. USD 1,300,000) are necessary equipment in installing this technology. Therefore, a minimum of USD 3,136,000 is required as initial investment, and investment is further needed for human resource development.
Time frame	Given the fact that the technology is at a planning stage in Nigeria, with appropriate financial support, the technology may be available in the short term (2022 - 2025).

2.2 Livestock production

2.2.1 Selective breeding via controlled mating

Technology characteristics	Description	A systematic form of breeding in order to improve productivity and breed animals that are more resilient to climate change impacts. ¹⁴
	Climate change mitigation/adaptation benefits	<p>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.</p> <p>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.</p>
Potential co-benefits	Environmental	This technology can contribute to enhancing and maintaining biodiversity.
	Social	Farmers are able to stabilize or increase their income as the technology reduces animal loss.
	Economic	It can potentially lead to increase in agricultural productivity.
Applicability and potential in Nigeria		This technology aligns with Nigeria's climate 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.
Status of the technology in Nigeria		There are small number of cases in implementing this technology in Nigeria. However, the technology is still not mainstream.

¹⁴ CTCN, "Selective breeding via controlled mating" Available at: [Selective breeding via controlled mating | Climate Technology Centre & Network](#)

Enabling environment for the technology	Developing improved livestock breeds is indicated in the NDC and increasing access to drought resilient livestock is identified as NASPA sectoral strategies.
Opportunities and barriers	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 (USD 15,000 – 30,000 per cycle for in-vitro fertilization; USD 200,000 per year for genetic engineering). Training of farmers is also required for the technology to reach its full potential.
Costs and financial requirements	As mentioned earlier, the cost will depend on the type of methodology that is used. Establishing facilities to conduct related research may also require high investment. In the case of advanced selective breeding methodologies, such as in-vitro fertilization or genetic engineering, have relatively higher costs while conventional methods (for ex: inbreeding) can be implemented with an average investment of USD 200 per livestock.
Time frame	Significant amount of initial investment and training may be required if the method is high-tech. Therefore, depending on the methodology, the technology may be available in mid to long term (2030 - 2050).

2.2.2 Manure management

Technology characteristics	<p>Description</p> <p>According to the FAO, manure management is practice to “ensure the recovery and recycling of nutrients and energy contained in manure and improvements in energy use efficiency along supply chains” for climate change</p>
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		mitigation. ¹⁵
	Climate change mitigation/adaptation benefits	<p>According to the TNC and BUR1, poor manure management was responsible for approximately 10% of total emissions from livestock in 2016. In this regard, manure management has the potential to reduce carbon dioxide emissions by 4.2% and methane emissions by 9.2%.¹⁶</p> <p>Manure management mainly addresses climate change mitigation and has limited adaptation impact. However, the outputs of manure management (biogas, compost) may have considerable adaptation impact, such as improved access to energy and food security.</p>
Potential co-benefits	Environmental	Improving manure management can lead to sustainable resource management.
	Social	Manure management has the potential of reducing farmers' costs, which can enable farmers to stabilize or increase income.
	Economic	The technology has the potential improve the amount of production.
Applicability and potential in Nigeria		The TNC and BUR1 indicates that poor manure management is one of the challenges in the livestock sector. In this regard, improving manure management can be considered as a technology that aligns with Nigeria's climate change priorities.
Status of the technology in Nigeria		There are few cases of applying manure management, however, the technology is still not mainstream in Nigeria.
Enabling environment for the technology		As mentioned earlier, since the TNC and BUR1 indicates this technology, it is likely that the Nigerian government will support this technology's dissemination.
Opportunities and barriers		Assessing the technology in local conditions will be critical as some

¹⁵ FAO, "Tackling Climate Change through Livestock: A Global Assessment of Emissions and Mitigation Opportunities"

¹⁶ Ibid.

	approaches are not suited for certain locations and time (for example, if the manure is applied at the wrong time, it might release nitrous oxide). ¹⁷ For Nigeria, northern regions are more suited for applying manure management. ¹⁸ Furthermore, training will also be necessary for the technology to be effective.
Costs and financial requirements	The costs and financial requirements depend on the methodology used. For instance, earthen holding pond using drag-line direct injection can cost up to USD 6,500 without construction costs while tack pad using a conventional spreader can cost up to USD 5,000 without construction costs. Construction costs and operations costs depend on the size of the manure handling system (total of approximately USD 300 per cubic meter).
Time frame	Although the policy environment seems favorable, a certain amount of experiments and trainings may be required for deploying the technology. Therefore, this technology may be available in the mid to long term (2030 - 2050).

2.2.3 Livestock disease management

Technology characteristics	Description	Livestock disease management has two key components: prevention measures (biosecurity) measures in susceptible herds and control measures taken once infection is observed. ¹⁹
	Climate change mitigation/adaptation benefits	Climate change impacts such as increasing frequency of heat stress, drought and flooding events can lead to increased spread of existing vector-borne

¹⁷ CTCN “Manure management” Available at: [Manure management | Climate Technology Centre & Network | Wed, 04/05/2017 \(ctc-n.org\)](http://Manure%20management%20|%20Climate%20Technology%20Centre%20&%20Network%20|%20Wed,%2004/05/2017%20(ctc-n.org))

¹⁸ Harris and Yusuf. “Manure management by smallholder farmers in Kano close-settled zone, Nigeria”

¹⁹ CTCN, “Livestock disease management” Available at: [Livestock disease management | Climate Technology Centre & Network](http://Livestock%20disease%20management%20|%20Climate%20Technology%20Centre%20&%20Network)

		<p>diseases and macro-parasites, along with the emergence of new diseases. In this regard, livestock disease management can increase the animals' resistance to these threats.</p> <p>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.</p>
Potential co-benefits	Environmental	Livestock disease management reduces the transfer of diseases to other wildlife species surrounding the farm, which can help maintaining biodiversity.
	Social	Farmers are able to stabilize or increase their income as the technology reduces animal loss.
	Economic	It can potentially lead to increase in agricultural productivity.
Applicability and potential in Nigeria		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.
Status of the technology in Nigeria		There is not known application of this technology in Nigeria.
Enabling environment for the technology		This technology is identified in Nigeria's key climate policies as an adaptation strategy.
Opportunities and barriers		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 (such as advanced options using IoA (Internet of Animals) tools), it might need a long waiting period until the technology becomes available.
Costs and financial requirements		As mentioned above, the costs

	associated with this technology can be high as antibiotics and vaccines need to be developed continuously. The total cost for deploying vaccines can range from USD 11 to 15 per animal, which can be heavy burden especially for large-scale farmers.
Time frame	The technology may be available in the mid to long term (2030 - 2050).

2.3 Forestry

2.3.1 Agroforestry

Technology characteristics	Description	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”. ²⁰
	Climate change mitigation/adaptation benefits	<p>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. 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 tons.</p> <p>Furthermore, 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.</p>

²⁰ CTCN, “Agroforestry” Available at: [Agroforestry | Climate Technology Centre & Network](#)

Potential co-benefits	Environmental	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 productivity and develop forest-related industry.
Applicability and potential in Nigeria		The technology is identified in many of the climate change policies and priorities of Nigeria. Therefore, the enabling environment for implementing the technology is favorable.
Status of the technology in Nigeria		Several practices of agroforestry is already implemented in Nigeria.
Enabling environment for the technology		AS mentioned earlier, hte technology is identified in many of the climate change policies and priorities of Nigeria, including NDC. Therefore, there will be support from the Nigerian government in implementing this technology.
Opportunities and barriers		Issues regarding land rights and lack of knowledge may be a potential barrier in scaling up the technology. 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. In addition, the process of realizing the potential of the technology may be slow and careful maintenance is needed.
Costs and financial requirements		The costs and financial requirements are highly dependent on the methodology utilized. For instance, agroforestry methodology that emphasizes soil management can cost up to USD 380/ha

	while crop diversification techniques can be limited to USD 38/ha.
Time frame	Given the need to assess the effectiveness of the technology, as well as the need to monitor the process, the technology may be available in mid to long term.

2.3.2 Forest management techniques for mitigation (REDD+)

Technology characteristics	Description	Managing forests by either promoting afforestation or reducing deforestation to increase stand-level forest carbon stocks.
	Climate change mitigation/adaptation benefits	<p>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.</p> <p>Furthermore, 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.</p>
Potential co-benefits	Environmental	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.
Applicability and potential in Nigeria		This technology aligns with Nigeria's climate change policies and priorities as the technology is clearly indicated in Nigeria's TNC. However, for the technology to be mainstream, significant amount of investment and capacity building is required.
Status of the technology in Nigeria		Several initiatives related to REDD+ has already been implemented in Nigeria.
Enabling environment for the technology		The technology is clearly indicated in Nigeria's TNC. The Nigerian government has also launched the National REDD+ Strategy.
Opportunities and barriers		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.
Costs and financial requirements		Costs are dependent on policy instruments, but generally high investment is required. According to other countries' experiences, total cost for implementing this technology can range from USD 70,000,000 to 460,000,000 per year. ²¹
Time frame		The technology may be available in mid to long term (2030 - 2050) even though the enabling environment is favorable in Nigeria.

2.3.3 Ecosystem-based adaptation

Technology characteristics	Description	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,
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²¹ IUCN "Financial costs of REDD: Evidence from Brazil and Indonesia"

		sustainable forest management, integrated water resource management etc. ²²
	Climate change mitigation/adaptation benefits	<p>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.</p> <p>Even though primarily an adaptation approach, ecosystem-based adaptation has the potential to reduce GHG emissions by halting habitat loss and ecosystem degradation.</p>
Potential co-benefits	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.
Applicability and potential in Nigeria		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. Since ecosystem degradation is one of the issues in Nigeria, adopting ecosystem-based adaptation may be necessary in the long run
Status of the technology in Nigeria		There is also no known application of this technology in Nigeria.

²² IUCN, "Ecosystem-based approaches to climate change adaptation" Available at: [Ecosystem-based Approaches to Climate Change Adaptation | IUCN](#)

Enabling environment for the technology	As mentioned above, there is no indication of the technology in any of Nigeria's climate change policies.
Opportunities and barriers	If successfully deployed, the technology can contribute to environmental conservation while enhance climate resilience of the agricultural sector and rural communities.
Costs and financial requirements	Depending on the activity, the initial and maintenance costs can be relatively high.
Time frame	Detailed research and assessment of the technology is needed to understand its potential for climate change mitigation and adaptation. Thus, this technology may be available in the mid to long term (2030 - 2050).

3. Next Steps

These technology fact sheets will be used as reference in developing the Technology Action Plans, which presents the implementation plans for the prioritized technologies. Once the technology action plans for the prioritized technologies are prepared by the consulting team in coordination with the local experts, the technology action plans will be validated by the stakeholders through the subsequent validation workshop.