CLIMATE CHANGE

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EDITOR'S NOTE

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Africa's population is projected to grow to 1.3Billion by 2050 and almost half of that population will be in Nigeria with approximately 450Million people. The growing population requires an increased agricultural production. The 2018 Global Report on Food Crises highlights four conflict-affected areas that are "at risk of famine" including Yemen, South Sudan, Somalia, and northern Nigeria (including northeast Nigeria).

In the face of these challenges, most sub-Sahara countries such as Nigeria are still not producing enough food to feed their populations. Consequently, due to the supply deficit of food, inflation will most likely rise, higher food prices will squeeze consumers' income, increase expenditure on food and reduce the number of people that will be able to afford their basic need of food. Given that the world poorest are projected to live in 10 Sub-Saharan countries with Nigeria and DRC leading with 152Million and 70Million respectively, the governments of African countries have to, individually and collectively, develop mitigating and adaptive strategies to feed their nations.

Several factors are at the hem of the limited supply of food, however, the least apparent in the sector is climate change. There is a disconnect between the climate change efforts and the African Agriculture. This edition of the Sahel Quarterly seeks to raise an alarm on the challenge of climate change on the African agriculture and call the various stakeholders – governments, private organization, INGOS - to action to create awareness and develop mitigating strategies to curb the impact of climate change in the sector.

CLIMATE CHANGE IN AFRICAN AGRICULTURE – A BIGGER ISSUE THAN WE REALIZE?

Of the ten countries considered most threatened by climate change globally, seven are in Africa (Figure 1). Given the recent devastations from flooding, droughts, desertification and conflicts sweeping across the continent, African governments have increasingly expressed concerns about the impact of climate change. There was a large African delegation at the Conference of Parties, 'COP21' in Paris in 2015 where the Paris Agreement was developed.

By April 2016, forty-seven African countries had signed the agreement, committing to take concrete actions to mitigate and adapt to climate change. However, only few African countries are actively working toward meeting their targets. Alarmingly, as of December 2018, the Climate Action Tracker reported that only three African countries; Ethiopia, Morocco and South Africa were taking the lead toward developing policies to meet the objectives of the agreement.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) presents strong evidence that warming in Africa has increased significantly over the past 50 to 100 years, with clear effects on the health, livelihoods and food security of its people. For example, Lagos, Nigeria, experienced heavy rainfall in January 2019, an anomaly, as the event occurred during the dry season, which typically runs from October through March. Similar changes in traditional seasonal patterns have become more frequent in the past few years. This is only one of the many effects of climate change, a long-term change in seasonal patterns due to an increased accumulation of greenhouse gases released in the atmosphere through the burning of fossil fuels[1].

Similar effects are increasingly being noticed around the world, including rising global average temperatures and sea levels, an increased variability in weather patterns and extreme weather events.

Many African countries have experienced severe flood disasters in recent years. The Limpopo Valley floods in the year 2000 were one of the worst flood disasters in Mozambique's history responsible for at least 700 deaths and displacing up to 650,000 people. It was estimated that the

Figure 1: African countries most vulnerable to the impacts of climate change

total cost of the floods in year 2000 alone was equal to ≈20% of the country's GDP, slowing down the country's economic growth rate by 2.1%. Mozambique continues to suffer severe floods till date. In March 2019, Cyclone Idai devastated parts of the country, wiping out ≈715,000 ha of farm lands which accounts for 13% of the country's total agricultural land area and affecting 500,000 farming households. The cyclone also placed 1.85 million people in need of aid and claimed more than 500 lives. Current fund needs in response to the cyclone is estimated at $282 million[2].

Cyclone Idai also affected parts of Malawi and Zimbabwe. About 50% of crops were estimated to be lost in Southern Malawi, which was hardest hit by the floods while 59 deaths have been reported. For Zimbabwe, at least 181 deaths were reported while 270,000 people were affected in total.

The 2019 floods in Malawi, Mozambique and Zimbabwe have led to an increasing outbreak of waterborne, vector borne and skin diseases with reported cases of cholera and acute respiratory tract infections affecting thousands of people[3].

For Africa, with its burgeoning population, high poverty levels, and low economy diversification, the cost of ignoring the effects of climate change will become even more devastating in future if urgent action is not taken. According to The Sustainable Development Goals Report 2018, climate change is a major contributing factor leading to growing hunger, forced displacement of people, limiting universal access to basic water and sanitation, loss of lives, properties and shelters etc. In Sub-Sahara Africa, food security will increasingly become a major challenge due to an increase in severe droughts, floods and storms threatening the health of populations and economies.

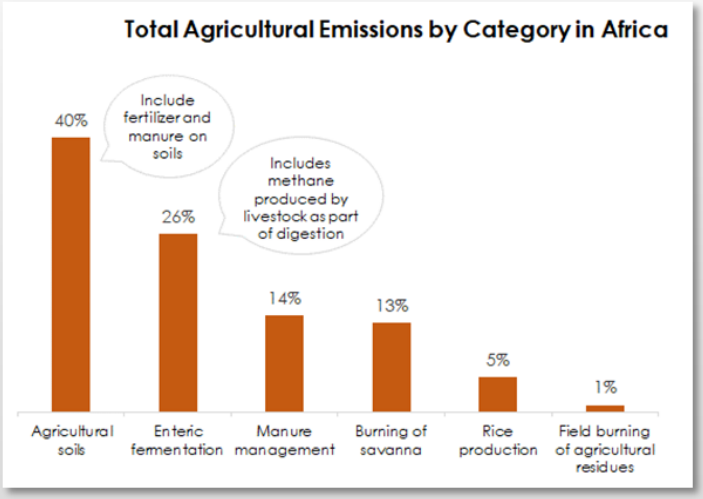
Due to its increasingly devastating effects, African governments need to urgently prioritize climate change in order to minimize the irreversible impact it can have on their economies, population and environment.

IMPACT OF CLIMATE CHANGE ON AGRICULTURE

The agriculture sector is both contributes to and is impacted by climate change given its role in the release of greenhouse gas into the atmosphere and vulnerability to climatic conditions. Agriculture contributes 10-12% of total annual Green House Gaz emissions globally. The effects of climate change on the African agricultural sector include biodiversity loss - limited land and water resources - declining agricultural productivity on crops, livestock and fisherie and curtailed economic development.

Climate Change and Economic Development

African countries are disproportionally impacted by climate change given the heavy reliance of their economies on the agriculture sector, which employs 2/3 of their workforce and accounts for on average 1/3 of their GDP. Countries such as Chad, Niger and Zambia could lose their entire farming sector due to climate change by 2100[4]. In addition, according to the Department for International Development (DFID), climate change could cost Nigeria, the 2nd largest economy on the continent, between 6-30% percent of its GDP worth $100billion-$460 billion by 2050[5].



Climate Change on Land, Water Resources and Biodiversity Loss

Land degradation and dependency on rainfed agriculture is limiting crop production and productivity.

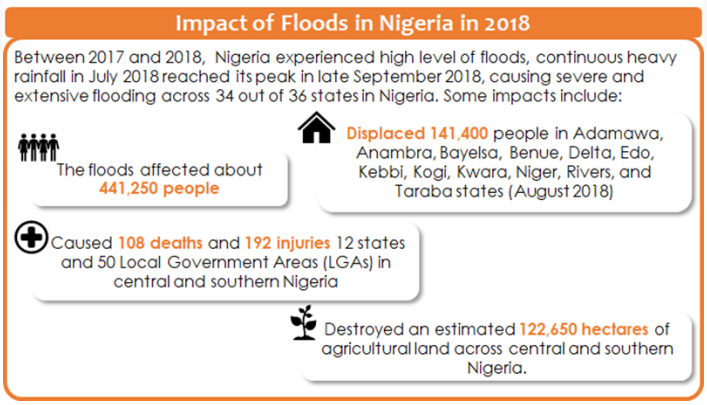
Land degradation: Approximately 35% of the West African country's land is under threat of desertification especially in the north where land degradation and climate change have exacerbated poverty. Northern Nigeria is under severe threat of desert encroachment with sand dunes becoming common Geological features in states like Borno, Jigawa, Katsina, Sokoto and, Yobe, burying large areas of arable lands and grazing rangelands limiting agricultural production.

"Cameroon: loss of ½ of its total forest area (12Million Ha of degraded and deforested land)"

The African wet tropics (West Africa and the Congo Basin) contain the second largest area of tropical rainforest in the world, accounting for roughly 30% of global rainforest cover, a reservoir of biodiversity. However, the countries are losing their forests and land as a result of the climate change. Southern Africa could lose more than 30% of its main crop, maize, by 20306 as a result of the bio-diversity loss. However,

the countries are losing their forests and land as a result of the climate change. Southern Africa could lose more than 30% of its main crop, maize, by 2030[6] as a result of the bio-diversity loss.

Water Resources: African agriculture is largely dependent on rainfall, and there is limited dry season production and minimal use of irrigations system among smallholder farmers. In Nigeria for instance, it is estimated that only 1% of cropland is irrigated. According to the Food and Agriculture Organization (FAO), about a quarter of the world's population will be living in countries with absolute water scarcity by 2025. The United Nations predicted that access to water will be the single biggest cause of conflict and war in Africa in the next 25 years. The loss of 90% of Lake Chad[7] has contributed to the displacement of tens of thousands of people and is causing significant harm to fishing, grazing of livestock and crop lands in the area[8].



Climate Change and Crop production

Agricultural productivity is hinged on several factors including the availability of conducive land, the use of adequate inputs and weather conditions.

Unpredictable Weather Conditions: Nearly 93% of agriculture in sub-Sahara Africa is rainfed, however, the rainy season has become unpredictable in the recent years with early and late rains. This has distorted the current production calendar of smallholder farmers, who have limited access to information to plan and prepare adequately.

Based on the seasons as illustrated above, January is considered a dry season. However, as at January-February 2019, there has been heavy rain downpours in parts of the country.

The start-date and duration of the raining season has become less predictable for crop farmers whose activities are dependent on the above calendar. This raises concerns about the productivity of farms, that the impact that this will have on the availability, quality and price of the produce this year. The Nigerian Meteorological Agency (NiMet) has already predicted 'lower-than-normal rainfall' over most parts of Nigeria in 2019 with expected late start of rains in the north[9]. The unpredictable rains and continuous loss of agricultural produce will strain the output, deepen poverty and malnutrition among smallholder farmer households and lead to a deficit in supply of the food products for the wider population.

> ***"Rice production in Nigeria is majorly rain-fed despite the potential for dry season production. In effect, the total area cultivated for rice farming in Nigeria is estimated at 3.3Million Ha, of which only 25% is used for dry season production while 75% is dedicated to rain-fed production. The current uncertain rains leave the farmers in Nigeria more vulnerable and susceptible to the low production output."***

Agricultural yield performances are susceptible to weather conditions and as the climate becomes ever more extreme, frequent droughts, unpredictable weather patterns and rising temperatures, Africa will face declining crop yields and will struggle to produce enough food for domestic consumption. The table below illustrates the projections of climate change impact on crop production in 2030 as a percentage of 1998 to 2002 yields[10].

Production Impact in %	West Africa		Sahel		Central Africa		Eastern Africa		Southern Africa	
	Worst	*Best*	*Worst*	*Best*	*Worst*	*Best*	*Worst*	*Best*	*Worst*	*Best*
Rice	-5.92	0.75	-6.62	-3.70	-6.52	1.23	-3.24	12.27	0.39	12.05
Maize	-9.64	1.09	-6.79	7.42	-4.18	0.70	-5.78	4.42	-46.56	-12.27
Millet	-4.33	6.17	-2.86	12.46	-34.17	0.77	n/a	n/a	n/a	n/a
Sorghum	-5.51	4.65	-15.33	6.18	-16.69	5.56	-7.17	6.23	-16.86	14.66
Cassava	-2.95	4.71	n/a	n/a	-2.89	2.01	-5.63	8.33	-2.91	3.93

"In Malawi for instance, it is estimated that half of the rural population, at 6.7 Million people, are receiving food aid after two consecutive years of drought, and the food prices were at 172% above the 5-year average prices. Furthermore, in Kenya, as at 2017, an estimated 2.6Million people are at risk of food crisis due to the widespread crop failure and falling trading activities affecting farming and agro-pastoral communities in the north-western, north-eastern and coastal strip of the country[1]."

Limited Stress Resistant Crops: Currently, African countries have had a low track record of developing and adopting resilient crops. There is limited research, development and adoption of adequate drought resistant crops by smallholder farmers. Although a few have been released in some countries including maize, beans, potato, through conventional plant breeding techniques or biotechnology and continue to grow and produce even with the uncertain rains. National and International research institutes lead the development stress resistant crops, however, there is still limited investment to breed drought tolerant crops and make them available to farmers. Furthermore, the level of adoption by small holder farmers is low due the knowledge gap and poor agronomic practices such as recycling seeds by farmers.

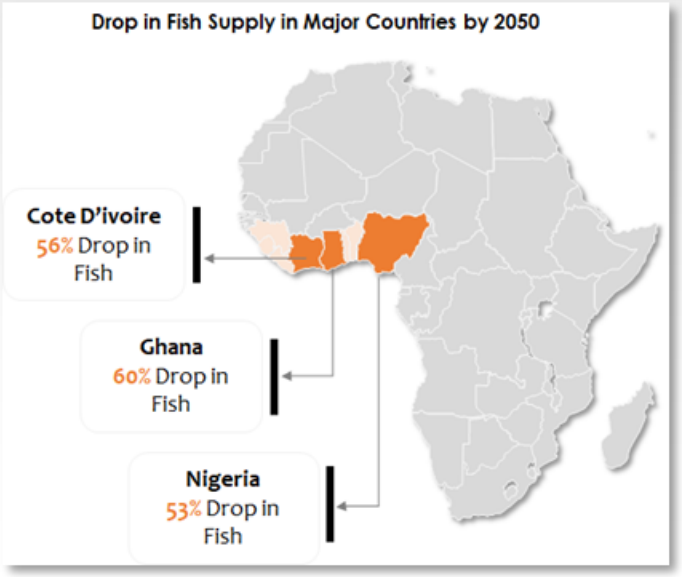
Climate Change and Livestock Production

The dominant livestock production model in Africa is the nomadic and pastoralist system. The increasing land degradation as a result of droughts, limited access to rangeland for grazing is leading to high levels of migrations and mass destructions of crops farms is resulting in social conflicts. Factors that compound challenges of livestock production include rangeland degradation; limited water access; fragmentation of grazing areas; sedentarisation; migrations; lack of opportunities for livelihood diversification.

In several African countries including Nigeria, Niger, Ghana, Mali, Senegal, there have been growing clashes between farmers and herdsmen resulting in death and hampered productivity of the agricultural sector. In Nigeria for instance, Mercy Corps reports that Nigeria could gain up to USD13.7Billion annually[11] in total macroeconomic progress in a scenario of peace between farmers and pastoralists in Benue, Kaduna, Nasarawa, and Plateau alone.

Climate Change and Fisheries

Globally, it is projected that climate change will reduce fish supply by 7.7% and reduce revenues from it by 10.4% by 2050 under a high CO_2 emissions scenario.



In Africa most especially, this decrease in the fish supply may be as high as 60% and 56% in parts of West Africa, Ghana and Cote D'Ivoire respectively, due to the rising sea levels. It is estimated that up to 12Million people are engaged in the fisheries sector in Sub-Sahara Africa and at risk of losing their livelihood.

CLIMATE FINANCE AND INSURANCE FOR AGRICULTURE

Climate finance for agriculture aims to increase investments directed at reducing agriculture greenhouse gas (GHG) emissions and at improving food systems' resilience. Unfortunately, in spite of being among the most vulnerable countries impacted by climate change, most African countries do not have sufficient financial resources to combat its effects. In order for the continent to effectively mitigate and adapt to climate change, funding levels must increase as must smallholder farmers' access to and adoption of adequate climate finance instruments, including insurance.

Increasing African Countries' Climate Finance Funding Levels

Key sources of climate finance include funding for climate mitigation and adaptation, as well as carbon markets.

Most African countries do not have country plans addressing climate change, nor do they have adequate financial resources allocated to it. Instead, they depend for the most part on external funding. For instance, as part of the Conference of Parties (COP)[21] Paris Agreement, Western nations, multilateral development banks and private financial institutions pledged to scale up climate funding to at least $100 billion annually beginning in 2020 to help developing nations build their resilience to climate change. The pledged funds will be managed by the Green Climate Fund (GCF) and the Global Environment Facility (GEF). The GCF for instance finances both climate adaptation and mitigation projects, with African countries representing 42% of its priority countries[12]. Nevertheless, despite the significant funds committed, allocations to Africa's agriculture may not be sufficient to meet the continent's climate change adaptation and mitigation needs. According to the United Nations Environment Programme (UNEP), Sub-Saharan Africa alone is estimated to require $50 billion per year by 2050 for adaptation finance under an optimistic 2oCelsius global warming scenario. UNEP estimated that even if adaptation funding for Africa meets adaptation costs by 2020, annual funding would need to further increase by 7% each year thereafter to meet the adaptation challenge implied by warming levels beyond the 2oCelsius initially forecasted[13].

The ability to unlock additional funding is critical but is only possible if African governments can foster an enabling environment that attracts more private capital and investments in low-emission, climate-resilient development. To that end, African governments can leverage international sources of climate finance to build their internal capacity and involve the private sector. The Green Climate Fund's Readiness and Preparatory Support Programme[14] for instance, aims to improve target countries including African States' ownership and access to funds through grants and technical assistance. Key focus areas include strengthening countries' capacity, engaging stakeholders in consultative processes, providing access to finance, and mobilizing the private sector. Up to $1million per country per year can be accessed through the program.

Carbon markets are another potential source of climate finance available to African countries. The World Bank's Carbon Finance Unit for example, uses contributions from governments and companies in OECD countries to purchase project-based greenhouse gas emission reductions in developing countries. Nevertheless, the lack of robust tracking systems and growing concerns regarding carbon markets' effectiveness at significantly reducing emissions is limiting their relevance.

Increase climate finance support given to smallholder farmers

Smallholder farmers are one of the most vulnerable groups affected by climate change. In addition to attracting additional climate finance funding, African governments need to direct more efforts at improving farmers' access to and adoption of financial instruments aimed at improving farmers' access to and adoption of financial instruments aimed at improving their resilience to climate change and to its effects.

These instruments include:

- **Weather Index Insurance:** is an adaptation measure aimed at protecting smallholder farmers against the impact of climate change by allowing them to use high-risk but higher production crop varieties. Farmers get a pay-out when the index flags a major weather risk such as a drought or flood that the farmer faces. A key challenge in its application in Africa is the availability of accurate local weather data over a reasonable historical period to enable insurance companies to have enough adequate data from previous droughts/floods to analyze probabilities and calculate index insurance prices.
- **Yield Based Agriculture Insurance:** is crop insurance, which covers unavoidable production losses caused by natural disasters such as drought, wind, flood, excessive temperature during pollination, etc. Farmers can get crop-yield insurance where they are covered against a yield guarantee based on their historical production levels. They can also get crop-revenue insurance, which combines crop-yield insurance and decline in prices during the growing season.

Moreover, farmers can be provided with agricultural loans and grants specifically targeted at increasing their ability to procure and use resilient crop input varieties, which are more expensive than regular varieties. They can also be supported to access services such as early warning systems to get more accurate weather forecast to inform farming decisions. IFAD's Adaptation for Smallholder Agriculture Programme (ASAP)[15] for instance, is the largest global finance source dedicated at supporting smallholder farmers' adaptation to climate change. Its scope includes improving farmers' access to and adoption of climate risk management skills, information and technology and innovative approaches to sustainable land and water management. During its first phase (2012 to 2017), the program disbursed $300 million through grants to 43 countries and helped 8 million smallholder farmers build more resilient livelihoods. The second phase, projected at $100 million, seeks to leverage IFAD investments to attract additional co-financing for climate change adaptation. It will enable climate mainstreaming through technical assistance and capacity building in cooperation with governments, research institutes, farmers' organizations and civil society. It aims to benefit 10 million smallholder farmers.

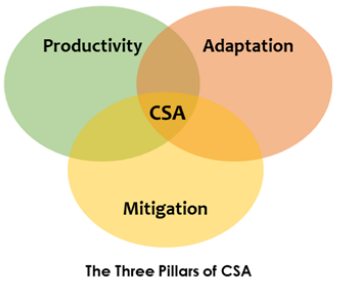
Finally, more cost effective and demand-driven financial instruments are needed to better meet the needs of smallholder farmers, particularly women who are disproportionally affected by climate change. To that end, African governments should foster the development of a strong ecosystem of services needed to support climate mitigation and adaptation strategies for agriculture. These include weather and climate data collection services to capture local weather variations and effectively inform risk models on which to build better agriculture insurance products; fund research around weather resistant crop varieties, land management etc. Financial institutions interested in targeting farmers should also invest to better understand the agriculture sector in order to improve their ability to manage and reasonably price risks. In addition, technology provides an opportunity to reduce transaction costs as a new delivery channel to reach farmers at a larger scale through these instruments.

CLIMATE SMART AGRICULTURAL PRACTICES

Climate change is a threat to food security. It affects the availability of food through a decrease in production caused by extreme weather events, changes in the suitability of farming lands and water for the use of crops and livestock. It can also affect food stability and nutrition caused by fluctuations in food prices and dependency on imports. Climate resilient agricultural practices enhance the achievement of food security through increased adaptation of crops to extreme climatic conditions and higher productivity.

Adaptation is not accomplished in a single intervention. Rather, it is a continuum, requiring an overarching approach that incorporates interventions that range from those that address underlying drivers of vulnerability to those designed exclusively to respond to the impact of climate change .

Climate Smart Agriculture and the World Bank Group



The Three Pillars of CSA

The World Bank is currently scaling up climate-smart agriculture through its Climate Change Agricultural Plan with the objective to increase productivity, enhance resilience and reduce emissions. The Bank is partnering with countries to develop Climate Smart Profiles to bridge the knowledge gap on relevant issues in various countries such as Senegal, Ethiopia in partnership with Climate Change, Agriculture, and Food Security (CCAFS) of CGIAR. In Nigeria, CCAFS is partnering with FAO to develop a climate smart profile of North East Nigeria.

Globally, significant efforts are being channeled towards the development of climate resilient innovations and adaptative strategies to curb the impact of climate change on the agriculture sector.

However, the adoption rate remains slow due to challenges such as high cost of the innovations and technologies, limited research and development and low capacity building and advocacy. Some of the practices include greenhouses, irrigation systems, development of resilient crops, weather data collection and forecasts etc.

Drought Resilient Crop Varieties

CGIAR research centers and programs are leading the charge towards the development of stress resistant crop varieties that allow smallholder farmers to sustainably produce food despite extreme climate variations. Some interesting initiatives include the following:

- **Drought Tolerant Maize for Africa Project:** Implemented by the consortium of International Maize and Wheat Improvement Center (CIMMYT), and the International Institute of Tropical Agriculture (IITA), over 200 stress tolerant maize varieties were released in 13 countries in Africa between 2010 and 2016 under the project. The stress tolerant maize varieties have the potential to increase productivity and reduce yield variability. Based on on-farm trial results, climate resilient maize varieties produce up to 20 percent increase under drought and stress prone conditions.
- **The "Magic Beans" in Malawi:** Malawi suffered the worst drought in 30 years in 2016, due to climate change. While most of the maize field experienced severe losses due to the effect of drought, a beans variety developed by The International Center for Tropical Agriculture (CIAT) thrived. As a result of its resistance to drought, local farmers dubbed the beans variety the "magic beans". CIAT developed the beans to mature early in 60 days rather than the normal 90 days to ensure that it is ready for harvest before the periods of severe drought commenced. The beans also have longer roots helped the variety reached water deeper in the soil. Trials showed that the bean yielded 1,050 kg per hectares, which is 262.5% higher than the current yield of 400kg per hectares for beans of the country[16].

Greenhouse Systems

Greenhouse farming is a climate smart technology used to improve productivity while reducing greenhouse gaz emissions and impact on climate. Greenhouses are structures with controlled systems used to grow crops with the efficient use of fertilizer, chemicals and minimal soil disturbance, some major contributors to greenhouse gas emission in agriculture. . Some key materials used for greenhouses include polythene, polycarbonate or nets. The role of the structure is to grow

crops indoors protected from unstable atmospheric conditions such as temperature, relative humidity, sunlight and unwanted pests.

Compared with open field crop production, greenhouses generate higher returns per unit production area, eliminate production seasonality and ensure high quality of crops. In greenhouses, farmers control key production variables including temperature, the amount of light, the system of irrigation, fertilizer application and the atmospheric humidity, to get optimum growth and productivity.

Greenhouse are not affordable for most smallholder farmers and are commonly used by commercial farms. A unit of the 192 square meter greenhouse costs about USD5,500 while the 384 square meter greenhouse costs between USD8,000 to USD11,000 to install.

To facilitate access to greenhouses and improved productivity, cost effective and innovative greenhouse systems have been developed for smallholder farmers in Africa.

- **The Children and Youth Empowerment Center (CYEC)**[17]

in Nyeri, Kenya, in partnership with the Humanitarian Engineering and Social Entrepreneurship (HESE) Program at the Pennsylvania State University, developed the "high tunnel or Affordable Greenhouse" technology to support farmers to grow crops all year round at affordable prices. The system is dubbed an affordable greenhouse due to its low material cost of approximately USD200. It is easy to build, and farmers can install drip irrigation systems to reduce crop water requirements by up to 50% compared with production in open fields.

- **PS Nutraceuticals Limited** is a private organization in Nigeria that has developed a low-cost greenhouse made with bamboo due to the prohibitive nature of the cost of greenhouses for smallholder farmers. At about USD850, a 400 square meter bamboo greenhouse is more cost effective than the commercial greenhouse that costs about USD5,500.

Irrigation Systems

Irrigation systems and other forms of agricultural water management systems are critical to building resilience and adaptations to climate variability. However, given the high costs of conventional irrigation systems, and the effect of climate change on the rural populations in Africa, adopting cost effective and convenient irrigation solutions is key to improving livelihoods.

Small-Scale Irrigation Systems: Small-scale irrigation systems are a range of technologies and practices aimed at capturing, storing and distributing water in small farms. Small-scale irrigation is increasingly being used by smallholder farmers in Africa to cultivate their farmlands. There are various innovative types of small-scale irrigation systems including:

- **Manual Water Pumps for Small Scale Irrigation (By KickStart International):** KickStart, a social enterprise, markets the pedal pump, a portable and mobile irrigation technology developed as a modified version of the Asian treadle pump in Bangladesh. Nicknamed the "Moneymaker", the Pedal Pump costs about USD70 and is sold in several villages in Kenya. The pump has the capacity to pull water from a depth of 23 feet (7m) and can be used to expand the current area under irrigation by 50%. Irrigation systems are purchased by the rural poor and has enabled 900,000 people out of poverty and increased farmers' total net-annual farm income by over 400%[18].
- **Bottle Drip Irrigation (Introduced by the Uganda Government):** The bottle drip irrigation is a controlled form of irrigation in which plastic bottles are used to

slowly to the roots of a plant over a long period of time. This system is promoted in Uganda. Agricultural experts acknowledged that this system reduces water loss by up to 60%. This irrigation technique is effective although farmers in Eastern Uganda affirmed that the system is exhausting, especially when water sources are far from the farm plots.

Several programmes and organizations are introducing small-scale irrigation systems:

- **Adapting Irrigation to Climate Change Project (AICCA):** Funded by The International Fund for Agricultural Development (IFAD) and implemented by FAO, the project focuses on improving the sustainability and adaptation of small-scale irrigation systems in West and Central Africa. In 2017, the first phase of the project focused on regional analysis of the implications of climate change on irrigated agriculture in eight countries - Chad, Côte d'Ivoire, Gambia, Mali, Liberia, Mauritania, Niger and Sierra Leone. It also highlighted the irrigation technologies and best practices adapted to climate shocks that are valuable to scale up. The second phase is focusing on four pilot countries - Côte d'Ivoire, Gambia, Mali and Niger. An in-depth analysis is being conducted in each country to assess the impact of climate change on irrigation systems to propose adaptation strategies and cost estimates.

CLIMATE CHANGE ADAPTATION PROGRAMS IN AFRICAN COUNTRIES

There is an urgent call for action to strengthen the continents adaptation and resilience to climate change as it threatens to impoverish millions of Africans by 2030 and undo the development gains of the continent. Programs focused on agroforestry, climate smart agriculture, food production diversification, social protection mechanisms, and agriculture technology have the potential to build the resilience of smallholder farmers and rural populations to climate extremes and shocks[19].

The international community has been active in developing solutions to mitigate the challenges of climate change in Africa through the UNFCCC and the Paris Agreement.

International Committee Agreement

Paris Agreement: The Paris agreement is built under the UNFCCC to combat and adopt to climate change effects through targeted strategies to keep global temperature rise to below 2 degrees Celsius and limit increasing temperature to 1.5 degree Celsius. However, as at December 2018, the Climate Action Tracker reports that only three African countries, with Ethiopia and Morocco taking the lead, have made progress toward developing and implementing policies to meet the objectives of the Agreement. South Africa is the third country with slower progress but higher than every other African country.

United Nations Framework Convention on Climate Change (UNFCCC): Is a global environmental treaty adopted in 1992 and kicked-off in 1994 after ratification by 197 countries. The convention's objective is to achieve the stabilization of greenhouse gas concentrations in the atmosphere to a level that prevents interference with the climate system. As of 2015, all United Nations member states are parties to the UNFCCC and is supplemented by the Kyoto protocol and Paris Agreement.

Furthermore, there are key initiatives on climate adaptation policies and mitigation measures in Africa led by key actors in the landscape.

The World Bank Climate-Smart Agriculture (CSA) Country Profile Series

CSA Country Profile Series is a collaborative effort by the International Center for Tropical Agriculture (CIAT), the CGIAR Research Program on Climate Change Agriculture and Food Security (CCAFS), the World Bank and the UK Government's Department for International Development (DFID). The initiative analyses the challenges and solutions of climate change in agriculture in 33 countries across, Africa, Asia, Latin America and Caribbean (LAC). CSA creates country profiles to inform strategies that will improve livelihoods, reduce emissions and increase resilience of the agriculture value chains, providing a detailed guide for large-scale agricultural investments.

CSA has assessed and profiled over 16 countries in Africa, 7 in Asia and 10 in LAC. African countries profiled to date include Benin, Cote D'Ivoire, Ethiopia, Ghana, Kenya, Lesotho, Malawi, Mali, Mozambique, Niger, Rwanda, Senegal, Tanzania, The Gambia, Uganda, Zambia and Zimbabwe. Figure 1 highlights the insights from the country profiles on climate smart technologies, the strength and weaknesses of farming

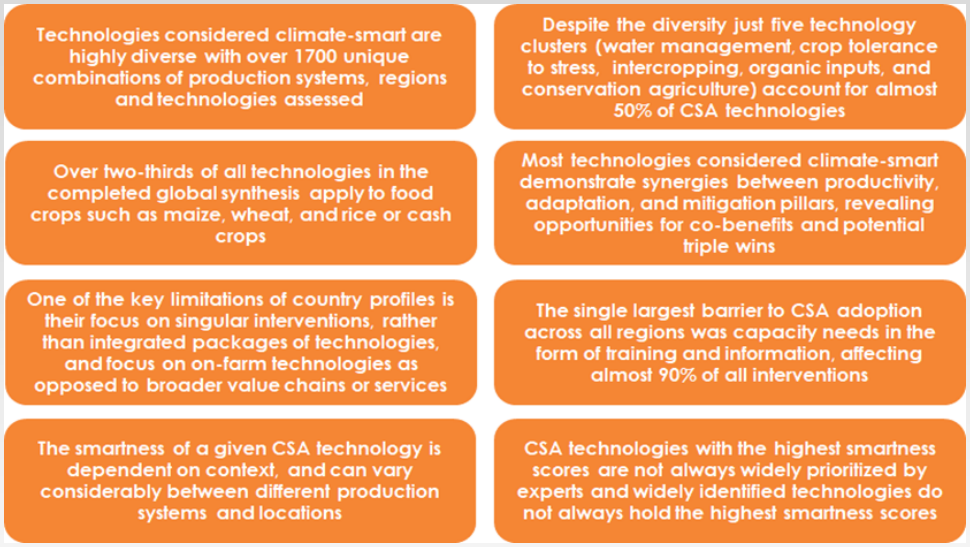


Figure 1: Insights from CSA Country Profiles across Africa, Asia and Latin America

CCAFS research activities on Climate Smart Agriculture has resulted in additional funding for climate smart programmes across different regions. The World Bank is financing a program inspired by the Climate Smart Village Model in Niger with the objective to 'increase agricultural productivity and enhance drought resilience of agro-pastoral system in 60 targeted communes in Niger'. The project also focuses on delivering 'the triple win of climate-smart agriculture: improving productivity, building resilience and reducing emission in selected locations in Niger'. The project worth USD 111 million is led by 3N (Nigeriens Nourish Nigeriens) High Commission of Niger and will be implemented for seven years (from 2016 to 2023)[20].

In addition, the world Bank, in January 2019, launched the Action Plan on Climate Change Adaptation and Resilience to increase climate finance for direct adaptation to $50 billion over FY21-25.

Country Spotlight: International Best Practices

Some countries around the world are at the forefront of developing and adapting innovations and strategies to mitigate the impacts of climate change. Some notable countries including Israel, Netherlands and Ethiopia have developed policies to mitigate climate change effect.

Israel

The Israeli government prioritised climate resilience through effective climate information management, technology and policies. In a bid to build a climate resilient economy, the Israeli Climate Change Information Center (ICCIC) was set up by the country's Ministry of Environmental Protection in 2011 to implement the national climate change adaptation programme[21].

A key policy direction of the Israeli government on agricultural irrigation targeted at making the country climate resilient is to heavily subsidize the consumption of water for farming. An estimated 50% of Israeli's agricultural land is irrigated[22]. Given the lack of natural water resources and dry climate, Israel leveraged on the use of desalination plants, reuse of treated sewage for agriculture, computerised early warning systems for leaks and computerised drip irrigation and micro sprinklers. Israel ranks 20th among 113 countries on the global food security index due to the climate adaptation initiatives currently implemented[23].

Netherlands

The Dutch Government has successfully built sustainable partnerships with the private sector and research institutes to tackle climate change challenges. The cooperation formed the building block for the Dutch Agriculture and Enterprise Policy. A specific feature of the policy is the established linkage between adaptation and mitigation interventions for optimal results[24]. The government launched the Delta Programme focusing on three issues:

- Setting new water safety standards.
- Consistent supply of fresh water for agriculture and nature.
- More climate-proof and water-robust spatial planning.

The Delta programme has significantly reduced flooding and increased the volume of water available for agricultural purposes[25].

Ethiopia

The existence of diverse agro-ecological conditions enables Ethiopia to grow a large variety of crops. The country is adopting a wholistic approach to mitigate and adapt to climate change vulnerabilities through the following climate-smart agricultural practices:

- **Conservation Agriculture:** This is implemented through reduced tillage and crop residue management to help reduce emissions from farm machinery and increase resilience to dry and hot spells. The conservation agriculture techniques including crop residue retention, minimum soil disturbance and intercropping (or rotation) of maize and legumes have been reported to improve both crop yields and soil health by increasing moisture levels and reducing soil degradation[26]. This approach has increased the productivity of over 21,000 farmers in Ethiopia[27].
- **The Climate Resilient Green Economy Strategy (CRGE):** The CRGE Strategy was developed in 2011 based on four pillars, of which two are mainly focused on Climate Smart Agriculture. The pillars include: 1) adoption of agricultural and land use efficiency measures and 2) increased greenhouse gas sequestration in forestry, including protecting and re-establishing forests for their economic and ecosystem services, including carbon stocks[28]. Specifically, Ethiopia prioritised improved inputs and better residue management to reduce demand for additional agricultural land that would primarily be taken from forests[29]. CRGE is targeted at creating new agricultural land in degraded areas through small-, medium-, and large-scale irrigation to reduce the pressure on forests as agricultural production expands.
- **The Ethiopian Programme of Adaptation to Climate Change (EPACC):** The EPACC was targeted at building a climate-resilient economy through adaptation initiatives implemented at sectoral, regional and local community levels. The programme was targeted at climate resilient considerations in government policies[30]. EPACC was designed to address issues around diseases and pest, low agricultural productivity that emanates from climate change through effective research and development.

Ghana[31]

Ghana Climate Innovation Centre (GCIC) is funded by the Government of Denmark and the Netherlands through the World Bank. The Centre is focused on supporting the growth of sectors relevant to climate change through the provision of business advisory services, trainings, market development services, technical facilities, policy support and funding etc. GCIC is also a pioneering business incubator focused on developing SMEs and entrepreneurs in Ghana's Green Economy. GCIC leverages partnership with key industry players in five key sectors including energy efficiency, domestic waste management, water management and purification, solar energy and climate smart agriculture to promote climate smart initiatives.

Energy Efficiency

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AAE ALCHEMY ALTERNATIVE ENERGY

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Solar Energy

GREEN POWER

Black Star Energy

As part of the centre's efforts to fund and support climate smart agriculture initiatives, GCIC partnered with Crop Research Institute- Savannah Agricultural Research Institute (CRI-SARI) in 2019 to support the adoption of the aeroponics technology for seed yam production under the **Yam Improvement for Income and Food Security in West Africa Project II (YIIFSWA II).** CRI-SARI will use the funds to construct irrigation, greenhouse and storage facilities to cultivate foundation seed yam produced from the aeroponics system technology. This initiative will increase the availability of high-quality seed yam to smallholder farmers.

In 2018, Neat Eco-Feeds established a 175 X 175 substrate tank capacity maggot farm in Bawku West District Ghana with a Proof of Concept Grant worth $18,000 from GCIC. This intervention by Neat Eco-Feeds recycles waste from abattoirs to produce maggot which are processed and sold as feeds for poultry and animal production. The production of feeds from maggot will reduce the global issues caused by deforestation and overfishing to produce fish meal.

African countries must device innovative initiatives and collaborate on major initiatives to curb the national and global impact of climate changes.

Private Sector Spotlight

Interview with Ignitia

- **Can you briefly discuss what Ignitia is doing?** Ignitia AB is a high-technology company and social enterprise that has developed a highly accurate weather model to help small-scale farmers in West Africa manage their daily activities by predicting the weather to improve their yields .

  Rain forecasts are sent daily via SMS directly to the farmers phones, in partnership with mobile operators. The location specific weather predictions include the timing, intensity and likelihood of rain for the next two days. In addition, farmers receive both monthly and seasonal forecasts on a monthly basis.

- **How are you changing the farming experience in Africa?** 96% of all agriculture in tropics uses rain as the only source of water. Climate change is already causing changing rain patterns in the tropics, in some cases cutting down the days a farmer can grow by 70%. In fact, it is estimated that 20- 80% of yield loss is due to weather alone (Gommes et al, 2011). Ignitia's forecasts are changing the farming experience by equipping farmers with highly accurate and reliable weather information which inform 12 critical farming decisions for farmers including, when to plant, apply fertilizer, dry crops and harvest. It also helps to make them more resilient to climate change as they are able to predict and adapt to the changing weather. The African farming experience is now more predictable, and farmers are better able to deal with the evolving patterns in weather.

- **What has been the most evident impact of Ignitia's operations across Africa since your commercial launch in 2015?** Based on interviews of farmers who are receiving our weather forecasts, we have uncovered encouraging results that suggest our forecasts are truly impacting farming activities and creating improved outcomes. Overall, 87.8% of farmers receiving the forecasts have indicated using the rain forecasts to directly change their sowing, fertilizer or chemical application, and/or harvesting practices. Moreover, these farmers who have integrated the forecasts into their farming practices were 1.2 times more likely to report any increase in yield and 1.9 times more likely to report any increase in income than the farmers receiving weather forecasts but not directly integrating the forecasts into their farming practices. In total, farmers reported a 60.0% yield increase by mass and 78.9% of farmers reported increases in income after receiving the rain forecasts. As we have just begun operating in Nigeria, the largest market in West Africa with nearly 200 million people, there is a substantial subscriber base that stands to see these same benefits by integrating our weather forecasts into their farming practices.

- **What has been the adoption rate of your products by farmers in Africa?** Since 2015 we have had over 740,000 farmers subscribe to our service. Through interviews with these customers we have seen that the adoption rate (those who most effectively use the forecasts in their farming practices) has been 87.8%. For example, nearly 90% of our farmers have indicated that they trust the forecast, and will alter their behaviour based on our messages, such as changing the timing of sowing, changing the variety of seeds depending on the seasonal outlook, changing timing of fertilizer, pesticide, or herbicide application to aid in absorption/avoid it being washed away, changing timing of harvesting to reduce post-harvest loss.

- **How affordable is your weather forecasts and other products to smallholder farmers and how do they pay?** Ignitia forecasts are as low as GHc12p per message. Farmers pay through their mobile credit and have the option to opt out of receiving the forecasts when their finances do not allow them.

- **What are the biggest challenges you face penetrating into the African market?** One of the biggest challenges has been raising awareness of our service with small scale farmers. Partnering with Mobile Network Operators

(MNOs), helps with this as mobile penetration in the region is over 100% and it allows us a direct channel to our potential customers, but MNOs can be slow moving and difficult to partner with.

The second has been overcoming the language barrier. Africa has over 300 languages and dialects and being able to deliver the forecasts in all the relevant languages is a challenge we're hoping to overcome with the introduction of the voice forecasts through IVR.

- **What other support do you need to require to foster climate change resilient agriculture in Africa?** Partnerships are key to scaling our operations and reaching more farmers. We work with telecommunications providers to offer our SMS subscription service through national mobile networks. We partner with NGOs and agri-input companies to provide our forecasts as a service bundled with other supports and products provided to farmers in their networks.

We are actively seeking more partners working across the agricultural value chain, allowing us to pilot with farmers who might otherwise not hear of or be able to afford our services. We can act as a value added to other industries including agribusinesses, corporates, insurance providers, and transportation and logistics companies, to help build climate resilience and increase productivity by improving access to highly accurate and localized weather forecasts.

SAHEL CONSULTING SPEAKS

NPA Annual Summit 2019

Ndidi Nwuneli, Managing Partners spoke on "Positioning for Post Oil Economy " at the NPA Annual Summit in Nigeria in January 2019

Unboxed Conference

Ndidi Nwuneli spoke on "Minding the gap between excellence & mediocrity " at the Unboxed conference in January 2019.

Ausso Leadership Academy Mentorship Masterclass

Ndidi Nwuneli attended Ausso Leadership Academy Mentorship Masterclass in January 2019.

Future Leaders Conference

Ndidi Nwuneli spoke on "Opportunities for Youths in Agribusiness" at Future Leaders Conference in February 2019.

FBN Quest Women Interactive Network

Ndidi Nwuneli spoke on "Balance for Better" at FBN Quest Women Interactive Network in March 2019.

Airtel International Women's Day Celebration

Ndidi Nwuneli spoke on at Airtel International Women's Day Celebration in March 2019.

Food and Land use Coalition conference

Ndidi Nwuneli spoke on " The Impact of Climate Change on Agriculture'' at the Food and Land use Coalition conference during the Africa Climate Week in March 2019.

Havard Business School Alumni International Women's Day Celebration

Ndidi Nwuneli attended Havard Business School Alumni International Women's Day Celebration in March 2019.

British High Commission International Women's Day Celebration

Ndidi Nwuneli attended the British High Commission International Women's Day Celebration in March 2019.

Nigerian Breweries International Women's Day Celebration

Ndidi Nwuneli spoke at the Nigerian Breweries International Women's Day Celebration in March 2019.

Aluko & Oyebode's International Women's Day Celebration

Ndidi Nwuneli attended the Aluko & Oyebode's International Women's Day Celebration in March 2019.

SAHEL CAPITAL SPEAKS

Private Equity and Venture Capital Association (PEVCA), Nigeria

Mezuo Nwuneli moderated a panel on "Private Equity in Africa" at the Private Equity and Venture Capital Association (PEVCA), Nigeria, Breakfast Forum hosted at Radisson Blu, Victoria Island, Lagos on November 30, 2018.

10th Annual Retreat of the Central Bank of Nigeria's Bankers' Committee, Lagos, Nigeria

Mezuo Nwuneli spoke on a panel discussing Financing Export and Trade Development at Radisson Blu, Ikeja, Lagos on December 9, 2018.

Agribusiness Private Investments in Africa, Paris

Mezuo Nwuneli spoke on a panel at the "Agribusiness Private Investments in Africa" workshop in Paris. It was hosted by MEDEF International, the African Development Bank, and the African Agricultural Council on March 20, 2019.

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