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Thank you, Chairman Bass, Ranking Member Smith, and all the subcommittee members, for the humbling opportunity to speak about "The Effects of Climate Change in Africa."

I grew up in a farming community on the Kenyan coast. Back then, the rains were predictable; the soil was healthy, and the heat was mild. As I grew up, I witnessed gradual changes in the weather and seasons and how these changes disrupted the cycles of growing food. I saw how halfway through the growing season insects would come and take away much of our food. What insects had not taken away, the drought would. Other years, after several months of drought and extreme temperatures, the rains would return, and instead of helping plants grow, it would wash them away-which meant we were hungry and poor. In 2016 and 2018, I visited Kenya and saw firsthand the consequences of climate change-failed rains, droughts and extreme temperatures, withered crops, and food insecurity. People were hungry. Last month (March 2021), I had a conversation with my family and farmers in my community at the Kenya Coast who participated in a field day on our farm. The rains had not arrived. Because of extreme heat, all crops had withered. People were hungry. A sense of hopelessness was looming.

The truth is my family and community members are not alone. Because of climate change, millions of African citizens, many of whom depend on agriculture as a source of livelihood, are hungry, poor, food insecure, and displaced. We must work together to address climate change. We must build a global coalition to fight climate change. Climate change is the barometer of leadership right now. We must show ambition and do what we need to mitigate it. We must use scientific evidence to help fight climate change. We can change agricultural practices and change the processes that have resulted in climate change. Scientific advances will allow us to save humanity.

Overview of climate change and the effects of climate change in Africa

Without a doubt, climate change is "the existential threat of our times." It is arguably, the most pressing challenge of our time, the biggest threat to humanity, and an increasing threat to Africa. In the African Continent, climate change has dire and growing impacts, hitting the most vulnerable, including smallholder farmers dependent on agriculture as a source of livelihood, children and women the hardest with consequences for food and water security, human and public health, and socio-economic development. Across Africa, the impacts of climate change have resulted in flooding events, deadly tropical storms, intense cyclones, repetitive droughts, sweltering temperatures, crop failures, degradation of natural resources and ecosystems, displacement of individuals and communities, and waves of invasive transboundary pests. African agriculture, a

significant and critical sector, accounting for over 70 percent of the labor source and over 25 percent of Africa's gross domestic product (GDP), is profoundly impacted by climate change.

The science is precise. Climate change-induced disasters will only keep getting worse, pushing millions into hunger and poverty. In the long-term, Africa could reduce its GDP by up to 30 percent through reduced agricultural and labor productivity, lowered crop yields, and damage to human and ecosystem health, because of climate change. Undoubtedly, climate change presents significant risks to Africa's sustainable development objectives. Without decisive, strategic, comprehensive local and global action on climate change, millions of African citizens will be facing poverty. The impetus to act lies in all countries – developed and developing (African countries alike). It is also clear that African countries, many of which are experiencing challenging fiscal positions and high debt levels, can't afford the costs associated with climate change. They can't do it on their own, which is why the United States and other developed countries must step up their actions. Our world's developed countries must make an effort to help African countries boldly confront the climate crisis. We must urgently act.

Climate change has increased the frequency and intensity of flooding events in Africa. In 2020, for example, floods in East Africa affected close to six million people. According to the United Nations, climate change involving many people in East Africa has continued to increase in recent years, going from 1.1 million in 2016 to six million in 2020. The countries seeing this increase include Kenya, Ethiopia, South Sudan, Burundi, and Uganda. In the same year, Mozambique was affected by the deadly Cyclone Idai. The cyclone and subsequent flooding destroyed 1 million acres of crops, demolished $1 billion worth of infrastructure, destroyed 100,000 homes, and affected over 1.5 million. Subsequently, according to the World Bank, poverty rates in the affected areas rose from 64 percent to 79 percent, and the GDP growth decreased from 4.7 percent to 2.4 percent. Also, the country faces average annual losses of about $440 million due to floods alone. In 2021, flooding continues to impact African countries, killing and displacing millions of people, from Angola to DRC Congo, to Burundi, to South Africa, to Tanzania, to Mauritius and Mozambique.

Climate change is happening through several pathways, among which invasive and transboundary plant-eating insect pests are a leading cause. In December 2019, the Horn of Africa was it by a plague of locusts – the most extensive and worst outbreak the region had seen in generations, decimating the crops that feed tens of millions of people. Kenya had not faced a plague this severe in over 70 years, and Ethiopia and Somalia not in a quarter of a century. Before the desert locust, African countries got infested by the fall armyworm which affected more than 44 African countries. In general, invasive insect pests costs the African continent U.S. $1.1billion every year. Ongoing and anticipated challenges posed by transitory and invasive insect pests will worsen by global warming, thereby promoting insect pest population growth. Frequent insect pest outbreaks facilitate many species' geographic expansion, leading to more significant economic losses and reductions in food security. The projected increase in insect-pest populations is particularly worrying. Countries like the United States **must** ensure that African countries can securely and effectively deal with transboundary insects.

Beyond food insecurity, climate change causes displacement of communities and disenfranchisement of the youth. In Countries like the Republic of Chad, millions have been displaced. With no hope for the future, citizens become hopeless. Climate change has contributed to fragility and the risk of conflict and disaster. Climate-fueled disasters were the number one driver of internal displacement over the last decade –forcing an estimated 20 million people a year from their homes. Hunger is already increasing due to climate change. People are forced from their livelihoods, homes, and communities due to climate shocks and persistent climate stress – indigenous peoples being among those at the most significant risk of displacement. Clearly, climate change has increased the need for life-saving assistance and protection for those facing humanitarian disasters.

Climate change has caused common and repetitive vicious cycles of drought and famines in Africa, sending millions of citizens into cycles of poverty. Many countries have been destabilized. Currently, the South Western Provinces of Angola are experiencing their worst episodes of drought in four decades. In Kenyan North Provinces, 1.4 million face hunger, in part due to food shortages. In 2018-2019, Southern Africa countries, mainly Zambia and Zimbabwe, suffered through their worst droughts in several decades and perhaps a century. Ethiopia, for example, has faced annual repetitive drought cycles. Food shortages further trigger declines in crop yields and as a result, food prices and the number of hungry people increase. At the moment, according to the UN WFP, over 31 million African citizens from West and Central Africa are hungry in part because of skyrocketing food prices and droughts. Drought can further lead to displacement of individuals and communities. e.g. more than 1.3 million Somalis moved in 2020, and 112,000 have already been uprooted from their communities in the first three months of 2021. It is disheartening that vulnerable women and girls bear all the brunt and lose access to essential health care services. Along the migration paths, women and girls are often raped, living lifelong scars that can never get erased.

Together, climate flood events, extreme temperatures, droughts lead to food insecurity by affecting the four pillars of food security (availability, access, utilization, and stability). In terms of production, climate change and the extremities associated with a changing climate result in reduced yields in crops and livestock systems because of plant pests and diseases, drought stress, flooding stress, increased food spoilage, and disruptions to food storage and transport networks. Without large-scale adaptation to climate change, food shortages will become more common and food prices more volatile, with the potential to exacerbate significantly conflict over scarce resources, hunger, and malnutrition, and fuel tidal waves of climate refugees. Moreover, food insecurity is likely going to result in social unrest as has been in the past.

Clearly, climate change continues to impact agriculture, a sector that is very critical to Africa's growth and development. The agricultural sector employs more than 50 percent of Africa's workforce and is the primary source of livelihood for millions of Africans. In West Africa, agriculture accounts for 35% of the region's GDP. Overall, African agriculture's vulnerability to climate change lies in the fact that its agricultural system remains mainly rain-fed and underdeveloped. Most of Africa's farmers are small-scale with few financial resources, limited access to infrastructure, and limited access to current agricultural knowledge. Besides, agriculture is dependent on biophysical characteristics such as soil type, fertility, water, and temperature. The

changing climate is profoundly impacting temperature and precipitation, two critical variables for crop growth. Changes in rainfall patterns and high temperatures have already reduced crop productivity in the African Continent. The science is precise. Climate change will continue to impact many African crops, and this will put pressure on already fragile African food systems.

Climate change has unmeasurable impacts on millions of African children. According to a very recent report by Save the Children, around 490 million children under the age of 18 in 35 African countries are at the highest risk of suffering the impact of climate change. UNICEF estimates that almost 160 million children live in high drought-severity zones, and another 500 million live in high flood occurrence zones. In 2017, according to UNICEF, 175,000 children were not attending primary and pre-primary school. With no food to feed families because of climate change, African parents marry off young girls as young as 13 to ease the pressure. We are unsure where our future scientists, doctors, educators, accountants, politicians, and doctors will come from if we condemn our African children to a life of poverty because they never got an education or were married early due to climate change. I know several peers who dropped out of school. Some were married off. Today, they live in abject poverty. We must ACT on climate change and protect our children.

Climate change substantially impacts African women who work in the agricultural sector and produce as much as 90% of the food supply in African countries. Women are responsible for providing water and fuel for their families which makes them exceptionally vulnerable to the effects of climate change. Equally impacted by climate change are the youth. Left unchecked, the impacts of climate change could push the young population into arms of organized crimes and terrorists.

Additionally, climate change profoundly continues to impact soil microorganisms. Unseen to the naked eye, soil microorganisms, including bacteria and fungi that are hard at work and have been our allies for millions of years, helping us deal with the consequences of a changing climate and are impacted dramatically by the environment. These microorganisms aid in keeping our soils healthy, allowing us to produce more food. They help plants to tolerate extreme temperatures and fight off insect pests that come with a changing climate. They indeed could be critical allies in revolutionizing agriculture under changing weather conditions. I know from my research, at Auburn University, and now, at the University of Illinois at Urbana Champaign, that not caring about climate change will significantly impact the many unappreciated microbial workers who live beneath our feet. Global warming resulting from environmental changes and an increase in temperatures would threaten and kill these essential members of our society. Soils that lack these microorganisms lose their ability to carry out the many vital processes, including recycling water and nutrients. In the end, soil is mined of its life, further resulting in soil degradation. Consequently, ailing African soils result in low crop yields and low household capital, further pushing millions of African citizens into hunger and the poverty, further thwarting Africa's hope for a food secure future.

Because of the ever-changing climate change, many of Africa's freshwater bodies and lakes have shrunk. As an example, one of Africa's largest freshwater body, the Lake Chad, in the Sahel region, has shrunk by 90 percent. Consequently, over 30 million people in the region who have relied on the lake for irrigation, provision of drinking water, fishing, livestock, and other ecosystem services are unable to meet their food security needs. This has resulted into a humanitarian crisis across

Lake Chad. Furthermore, countries surrounding Lake Chad, including Cameroon, Niger and Nigeria have been confronted with terrorism and violent extremism, in addition to religious, ethnic, and farmer-herder conflicts. In West Africa, a similar crisis is occurring. Africa's third largest river and the main water source for over 100 million African citizens, livestock and crops in the Sahel region has also been shrinking. Without water, there is no food. Without food, communities dependent on rivers and lakes are pushed into conflicts and terrorism.

African Governments and Climate Change.

While African countries have contributed negligibly to climate change, they have suffered the worst climate change impacts. We all applaud African countries for boldly stepping up to cut greenhouse gas emissions and address the climate change crisis. African countries have ratified environmental treaties. They have launched several awareness campaigns such as the African Union's Agenda 2063, preservation funds such as the Blue Fund, the African Development Bank's Desert to Power project, or the Great Green Wall initiative to grow trees and plants across the Sahel. From Burkina Faso, home to West Africa's largest solar power plant, to President Macky Sall's Green Emerging Senegal Plan, to Ethiopia, which draws 93 percent of its electricity from renewable sources, governments are taking action. Nigeria, for its part, aims to achieve 30 percent clean energy within ten years.

As evidenced above, African countries take the climate crisis seriously. Many African countries, including Benin, Burkina Faso, Cameroon, Chad, Ethiopia, Gambia, Gabon, Ghana, Kenya, Nigeria, Somalia, Tunisia, Uganda, Zambia, and Zimbabwe, are members of international climate agreements, including the 2016 Paris Climate Accord. Many have fulfilled the critical requirements of the Paris Agreement-to formulate Nationally Determined Contributions (NDCs), which provide roadmaps and clearly outline the plans and efforts African countries have to achieve climate change goals. Encouragingly, many African countries have indicated plans to prioritize climate-proofing and mitigation development activities in critical sectors like agriculture and energy.

In December 2020, I participated in a virtual Climate Ambition Summit 2020, co-convened by the United Nations, the United Kingdom, and France, in partnership with Chile and Italy. This summit brought together world leaders, including several African Presidents and Prime Ministers, who made new, bold, and ambitious commitments to tackle climate change under the three pillars of the Paris Agreement: mitigation, adaptation, and financial obligations. It was clear that the African countries are considering the climate crisis as a serious threat. Many African countries continue to make serious efforts to transition to climate-resilient economies.

Kenya, for example, reported that it was on track to cut its greenhouse emissions. Also, Kenyan Government has already adopted the Climate Change Act that provides a framework on how the government will promote climate-resilient low carbon economic development. Kenya's Ministry of Agriculture has also formulated a Climate Smart Agriculture Strategy, which serves as a guiding tool to implement mitigation actions in the agricultural sector. Kenya continues to be a leader in the fight against climate change, and it is evident that Kenya Government Leadership is committed to tackling climate change. Additionally, the Kenyan Government launched a $34 million project aimed at easing climate change impacts. This project will restore 500,000 hectares of rangeland,

all while assisting 620,000 people living in dryland areas. President Uhuru Kenyatta also recently participated in the U.S. climate change virtual summit organized by the current Biden-Harris Administration.

Ethiopia has taken bold leadership in tackling climate change. In the 2020 summit, the President highlighted several of Ethiopia's initiatives, including building a Climate-resilient green economy strategy that aspires to create a carbon-neutral and resilient economy by 2030. It is also encouraging to see that Ethiopia is focusing on climate change vulnerable sectors that include agriculture, forestry, health, and transport. Ethiopia launched the Green Legacy National Flagship initiative to plant 20 billion tree seedlings for the next four years. Already 9 billion are produced. Nigeria is also doing its part to tackle climate change. Speaking at the recently virtual climate summit hosted by President Biden, Nigeria shared its plans it is implementing, including providing accurate and timely weather forecasting to farmers and providing other climate-smart agricultural inputs. Malawi reported some of the initiatives it has committed to undertake, including restoring 4 million hectares of degraded land by 2030, replace diesel-powered power plants with solar, all while moving towards carbon neutrality by 2050.

It is further encouraging to see the participation of various stakeholders, including the business community, NGOs, and the African Development Bank. The African Development Bank continues to finance climate adaptation and mitigation change initiatives around Africa. As a result, efforts such as heat and drought-resistant crops to insurance are helping African countries to adapt to climate change.

African countries are also making headways in making the rural sector resilient by adopting climate-smart agricultural practices. Climate-smart practices (CSA), as defined by the U.N. Food and Agriculture Organization are approaches that help to transform and reorient agricultural and food systems to effectively support the development and ensure food security in a changing climate. These approaches aim to tackle three objectives: sustainably increasing agricultural productivity, adapting and building resilience to climate change, and reducing greenhouse gas emissions. CSA initiatives employ and encourage several strategies, including planting improved and drought-tolerant crop varieties, delivering timely seasonal and current weather information to farmers, and sharing agricultural innovations. Several CSA initiatives are rolling out in many African countries, including Kenya, Niger, Tanzania, and Uganda. Agencies and international research centers such as the UN FAO, the World Bank, USAID, and the CGIAR, are implementing these initiatives.

It is encouraging to see several success stories where climate-smart agriculture is applied. Kenya's climate-smart villages have helped farmers transform their previously unproductive land into productive high-yielding farms to Tanzania, where improved irrigation systems have increased rice productivity for more than 228,000 farmers. The increased farm productivity and Ethiopia, where farm productivity has increased, soil health improved, and average annual farm household incomes increased by over 260 percent because farmers were provided with accurate analysis of their soil health, allowing them to apply the needed fertilizers. In Rwanda, these success stories clearly show that climate-smart agricultural practices are a viable option that can sustainably transform the agriculture sector under a changing climate.

While African countries are taking bold actions, it is also clear, African countries can't do it alone. The costs of dealing with the climate crisis are enormous. African countries need the support of developed countries like the United States. Without finances to meet the bold climate action agendas African Governments have set forth, African countries face a bleak future. Extreme weather, droughts, floods, food shortages, and climate-driven displacement and migration further threaten to reverse the decades of progress made in lifting people out of poverty. COVID-19 and soaring debts that African Countries have accrued additionally make a compelling case that it would be impossible for African countries to respond to the climate crisis without the support effectively.

How can the U.S. help support a more stable climate?

The threats presented by climate change necessitate that all countries work together, call for developed countries to boldly step up to help African countries, who, despite emitting lesser carbon, bear the brunt of a rapidly changing climate. While climate change affects many sectors, its effect on African agriculture is enormous. The United States can help African countries to build a climate-resilient and vaccinated agricultural industry. The farm sector is a source of livelihood in Africa. As we have seen, unless African agriculture is resilient, even the most ambitious climate mitigation and action initiatives will bear minimal returns. Climate-resilient agriculture will pave the way for the attainment of African food security, self-sustainability and will secure and facilitate a more stable and prosperous African continent.

The frameworks that have propelled the U.S. to become food secure encompass a multitude of several interlinked targeted strategies and initiatives. It includes prioritizing the agricultural sector, investing in innovative farming initiatives that are resilient and responsive to new challenges such as climate change, and building safety nets that can be tapped upon by citizens who need help. Further, many of the initiatives have clear goals, targets, benchmarks, and indicators of success. These initiatives have built-in monitoring and evaluation systems to ensure they achieve the intended outcomes.

Take California, for example, also referred to as the agricultural powerhouse of the U.S. Despite facing drought, one of the extremities that come with a changing climate, recent Agricultural Statistics Review and report shows that investing in innovative agricultural initiatives has allowed the State to maintain sustainable agricultural crop production and become food secure. The State of Illinois ranks nationally and internationally in maize and soybean output and has maintained these rankings despite the many challenges' farmers face, including a changing climate. By using all the available and recent agricultural technologies and tools such as improved seed varieties, farmers have maintained crop yields, translating into food security. Furthermore, the United States Department of Agriculture continuously supports all states and provides detailed reports and resources that farmers can consult.

Notably, the frameworks that have allowed the U.S. to be food secure have a common backbone — the land-grant university system . Through the U.S Land-Grant University system that has a very functional extension service, university institutions have been vital in helping the U.S. communities and citizens to deal head-on with the challenges –including those brought by climate

change. The U.S.-could help African countries build thriving research and higher institutions of learning.

How can the U.S. Government assist?

There is a need to modernize African agriculture and support technology-led but science-informed farming practices such as precision agriculture, GIS, and climate-smart farming. It will demand significant investments in irrigation (for farmers to maintain yields even when the weather is unfavorable). Investments in better roads can help connect markets (for farmers to sell their crops timely and at fair prices). Improvements in our seed systems ensure farmers get new varieties of climate-resilient seeds. Investments in post-harvesting systems – Building more crop storage facilities and upgrades will reduce food shortage.

- Developed countries can help through exchange programs, climate-specific sponsorships, funding African research, and even friendly climate-conscious bilateral diplomacy, etc.

Energy - Most developed countries including the United States are going green. They have green/environmental audits to assess environmental impact, and Africa can benchmark on this. Africa can learn more about these energy audits to understand best practices on cutting energy consumption at commercial levels. These programs can also compensate individuals who reduce emissions at household levels (can be through planting tree species that maximize the absorption of CO_2 from the atmosphere). Africa suffers high rates of deforestation primarily driven by absent or inappropriate policies, which are reducing our forest cover. If Africa removes these cheap policies, it will have achieved its environmental sustainability. Costa Rica is a model country with a national environmental program that bundles together carbon sequestration, biodiversity protection, water regulation, and landscape beauty. The responsible agencies make direct cash transfers to citizens for different ecological efforts to cut our carbon emissions. The U.S. has such programs, and we can learn these programs and know-how as well.

- Developed countries should focus and invest in African waste management/recycling systems - We face poor waste management as a continent. As we slowly build capacity as a continent, we need to produce biodegradable products for our markets. The products we consume are primarily in developed countries, like the U.S.
- They can also invest in our renewable energy sources (Photovoltaic, Geothermal, Solar, and Wind) - Africa has great potential in producing photovoltaic and wind power. However, we need the resources, technology, and expertise required to meet the escalating continent's energy demand. Apart from Turkana, who wouldn't want electric cars in Nairobi?

Education - Partner and invest with grassroots organizations to tackle climatic change, funding startups, social innovations, incubation hubs, etc. We also have good energy policies - and implementation is the problem. We (developed and developing countries) can collectively agree to climate-conscious decisions and programs and develop a disciplined, adherent framework to ensure the working of the established policies.

Other ways U.S. Government can help African countries

Just like every other developed country, the US government has the resources to assist African countries in strengthening and developing comprehensive plans on preventing and dealing with all climate-linked extremities including drought, flooding, tropical cyclones and insect invasions. These can be achieved through supporting the African countries in building capacity to undertake robust research on climate change and tapping on evidence-based and science-driven solutions. As a scientist, I know that science and research can provide sustainable solutions for Africa's pressing challenges brought about by the changing climate. To leverage science effectively also requires the translation of scientific solutions into packages that farmers can adopt at scale, both at the farm and landscape levels. Achieving all of this loosely translates to:

- Finance rescue to African farmers.
- Committing to sharing resources, expertise, and capabilities with the African countries
- Helping African countries' abilities to tap on big data - Data, and access to good reliable data, is becoming an increasingly important tool for dealing with climate change. It can help guide and support decisions in agriculture. These include how food is produced, how it moves along the food chain, and how it's stored to avoid food wastage and losses. The U.S. has access to satellites such as NASA satellites. Data generated from NASA satellites includes digital imagery of vegetation, soil and water cover, sea and land surface temperature, and weather patterns. All of this information can help African countries tremendously. With the correct data and careful analysis, the continent can address its declining soil health and the threats of climate change and invasive insect pests such as the fall armyworm.
- Bringing onboard young people, from African Countries, in climate adaptations and resilience conversations and all initiatives being launched by the United States Government. They will continue to bear the brunt of climate change
- Increasing foreign aid help to African countries
- Increasing the funding through US Feed the Future Initiatives. The United States longstanding commitment and comprehensive support to African countries must be applauded. The escalating climate crisis demands for more support and funding, especially funding that allows for more collaborative research between African universities and U.S Universities.

Indeed, climate change is the most urgent crisis of our times. Helping African countries to address the escalating climate change crisis is the right thing to do for the United States. African Governments cannot do it alone, and nor should they. The United States must take action to help Africa to attain all its climate mitigation and adaptation goals. Lives, African lives are at stake. Now is the time to ACT.