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AFRICAN FOOD SECURITY, AND CLIMATE CHANGE

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Abbreviations

AFD	Agence Francaise de Developpement
AICCRA	Accelerating Impacts of CGIAR Climate Research for Africa
AMIS	Agricultural Market Information Service
CCAP	Climate |Change Action Plan (World Bank)
CGIAR	Consultative Group for International Agriculture Research
EMF	Emerging Market Forum
FAO	Food and Agriculture Organization
GAFSP	Global Agriculture and Food Security Program
GCF	Green Climate Fund
GEF	Global Environment Facility
GRFC	Global Report on Food Crises
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPCC	Inter-Governmental Panel on Climate Change
JICA	Japan International Cooperation Agency
UNFCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Childrens Fund
USAID	United States Agency for International Development
WFP	World Food Program
WHO	World Health Organization

Abstract and Summary[1]

In 2020, about 670 million Africans (or nearly 20% of the population) were moderately or severely food insecure, the highest percentage of the population suffering this situation in the World. By 2023 the numbers are estimated by the FAO and WFP to have increased to 868 million. About 336 million Africans are currently in a situation of acute food insecurity, i.e., requiring food aid. Several factors are contributing to this situation, including civil strife and war, broad economic decline, and severely negative climate impacts. These negative climate impacts include drought, floods, severe storms, saltwater intrusion in coastal agriculture systems, and temperature increases. These climatic effects bring new pests, forest fires, and reduce crop yields, or destroy agriculture altogether. These phenomena are inter-related. African countries in conflict are to a large extent also experiencing negative climate impacts, and negative climate impacts reduce income and increase prices, affecting ability to buy food. While Africa's contribution to climate change is small, the impact of global climate change on the continent is large.

The Intergovernmental Panel on Climate Change (IPCC) and other organizations have documented the increase in frequency and severity of negative climate events in Africa, and its increasingly negative impact on African agriculture, and food security. Modelling has predicted that if global climate change mitigation measures are not successful, the situation will get much worse in the future, with larger negative impacts on food security than witnessed so far.

Measures to help African agriculture to adapt to climate change are well known, and new measures are being progressively identified. The problem is that the scale of implementation of such measures is severely limited, although where undertaken and subsequently evaluated, success is common. The constraints include inadequate government and local knowledge, management capacity, and funding.

The best, though imperfect, estimates are that about US$ 1 billion p.a. is now available for agricultural adaptation to climate change in Africa from external sources, compared to about US$ 15 billion (or more depending on the source) needed. This compares to an estimate of the cost of inaction to be about US$ 200 billion p.a.

Most of this assistance currently comes from multilateral organizations followed by bilateral donors. This assistance is not well coordinated. Most donor institutions have no independent evaluation function which focuses on this type of assistance, so the effectiveness of the

[1] This report is based a review of the literature on food security and climate change in Africa. It was prepared for the Emerging Markets Forum to be held in Marrakech, Morocco in October 2023. It was sponsored by the Japanese International Cooperation Agency (JICA) as a follow-up to the statement of concern in the G7 meeting of 2023 regarding the expanded number of food insecure people in the World. The primary author of this report is Kevin Cleaver. Harinder Kohli of was the project director and Ieva Vilkelyte helped in the preparation and finalization of the report. Peer reviewers include Amnon Golan, Nadim Khouri, Rakesh Nangia, and Alexandra Williams.

assistance in these cases is not known. Some funding for this purpose also comes from African governments, though this is very limited.

Many African governments provide subsidies for chemical fertilizers and pesticides, irrigation water, land clearing, agricultural credit and state-owned marketing enterprises. Some of these subsidies encourage the use of practices that emit substantial greenhouse gases (fertilizer and irrigation water subsidies, and subsidies for land clearing and forest cutting). These subsidies could be repurposed to finance climate adaptation measures such as forest planting, conservation agriculture, drip irrigation, use of organic material as fertilizer and integrated pest management. Some could be repurposed to expand financing for agricultural research, extension and agricultural education, all of which have been neglected.

A first step in addressing these challenges comprehensively would be for African Governments to prepare national plans and projects for agricultural adaptation to climate change. According to a UN report from Nov. 2022 several African countries have revised their national climate plans, which is a good start. The World Bank provides assistance for this purpose in its Climate Smart Agriculture Profiles.

Greatly expanded financing for these plans will be necessary. This could come from existing aid budgets and/or by repurposing a small amount of subsidies provided to domestic agriculture by developed countries. These subsidies are currently estimated at $ 650 billion p.a. globally.

If more international funding is made available, the identification of the most effective existing institutions to intermediate the funding would be helpful. Of course, African governments would manage the programs and projects in their countries. But intermediary organizations will need to channel incremental international funds. In addition, the identification of institutions which can capably coordinate the assistance would be helpful to avoid the overlapping and patchwork project assistance which currently exists. The Global Agriculture and Food Security Program (GAFSP) is a possible coordinating mechanism as is the Green Climate Fund (GCF).

Even if the expansion of funding for agricultural climate change adaptation in Africa is obtained, effective institutions identified to channel the funds, and African governments change policies and subsidies to support these efforts, food security issues will continue to be a problem in Africa, though a lesser one. For this reason, food aid, financial aid, and assistance for the rehabilitation of agriculture sectors which are harmed by climate change or civil strife, will be necessary.

I. Food Security Globally, and in Africa

The generally accepted definition of food insecurity is when people do not have consistent access to sufficient, affordable, and nutritious foods.[2] There are four dimensions to food security: availability of food, accessibility, utilization , and stability. Undernutrition is a related concept, though with different dimensions. Lack of sufficient quantity of food leads to undernutrition, as does the consumption of foods with little or no nutritious value.

The incidence of food insecurity and the incidence of undernutrition are highest in SubSaharan Africa. As shown in table 1, there are more food insecure people outside of Africa, primarily in Asia. However, the prevelance of food insecurity is highest in Africa, which is the focus of this paper.

Table 1: Number of moderately or severely food insecure people (millions)3

	2015	***2019***	***2021***	***2022***
World	1612	1817	2342	2357
Africa	545	695	885	868
Eastern Africa	234	278	308	327
Northern Africa	60	71	87	84
Southern Africa	14	15	17	18
Western Africa	143	206	279	285
Middle Africa	n.a.	n.a.	144	154

The numbers of food insecure people in the World and in Africa are growing. According to the FAO, nearly 2.4 billion of the World's people were moderately to severely food insecure in 2022 compared to 1.6 billion in 2015, with the increase coming primarily in Africa.[4] By 2023, 336 million Africans were in **acute** food insecurity status.[5] Most of those suffering food insecurity and undernutrition in Africa are women, low skilled workers in the informal sector (especially those working in agriculture), and youth.[6]

[2] Global Report on Food Crises, 2023, FSIN and Global Network Against Food Crises. GRFC 2023, Rome, Italy. This report is published by the Food Security Information Network (FSIN) in support of the Global Network against Food Crises (GNAFC). The report is the result of a collaborative effort among sixteen partners to achieve a consensus-based assessment of acute food insecurity in countries with food crises,

[3] Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, | United Nations Children's Fund United Nations, World Food Program, World Health Organization; The State of Food Security and Nutrition in the World, 2023, Rome, Italy; digital version, section 2.1

[4] Ibid. See also same publication for 2022.

[5] Global Report on Food Crises, 2023, op. cit. Note that the number in acute food insecurity is much less than the total number of both moderately and acute food insecurity. This number may include some people that are moderately food insecure. See also FAO, IFAD, UNICEF, WFP and WHO. 2022. The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Data are available on FAOSTAT (https://www.fao.org/faostat/en/#data/FS).

[6] Ibid.

II. Hunger Hot Spots in Africa

The causes of food insecurity and malnutrition vary from country to country, so it is useful to identify the current food security hotspots in Africa. These are countries with such severe insecurity in 2023 that food assistance is likely to be needed.[7] The World Food Program (WFP) identifies this situation as one of acute food insecurity.[8]

Table 2: Number of Africans who are in acute food insecurity

Country	Millions of people who are in acute food insecurity
Nigeria	84
Democratic Republic of the Congo	71.7
Sudan	25.4
Ethiopia	24
South Sudan	10.9
Somalia	9.9
Kenya (arid and semi-arid regions)	11.3
Malawi	10.5
Burkina Faso	9.1
Central African Republic	4.9
Mali	5.2
Madagascar	4.7
Cameroon	9.3
Mozambique	16.1
Niger	9.9
Senegal	7.2
Chad	5.3
Zambia	8.6
Tanzania	4.4
Zimbabwe	3.5
TOTAL	335.9

The tools to deal with food insecurity due to local production shortfalls include the release of food from reserves (when there is such a facility), imports, and food aid. But the above countries have exhausted or are rapidly exhausting these avenues. The World Food Program reports a lack of food and financial resources to deal with the problem. Economic decline in each of these countries combined with food price increases limit, and in some cases eliminate, the country's own capacity to deal with the problem.

[7] Global Report on Food Crises, 2023, FSIN and Global Network Against Food Crises. GRFC 2023, Rome, op. cit. See also FAO and WFP; Hunger Hotspots, FAO-WFP; Early Warning on acute food insecurity, January to November 2023 Outlook, Rome, Italy. IFPRI also discussed this situation in its 2023 Report on Food Crises; Joint Analysis for better Decisions,

[8] Acute food insecurity is defined as people in the "Integrated Phase Classification" Phase 3 or above, where populations are classified in five different phases of food insecurity with Phase 1 being the least severe and Phase 5 the most severe, Global Report on Food Crises, 2023, op. cit. Note that some of the people included may be only moderately food insecure.

III. Causes of Food Insecurity in Africa, and the Link to Climate

Food insecurity and undernutrition have afflicted humans for thousands of years. The causes are also not new, and include climate shocks such as drought, floods, severe weather, as well as man-made causes such as war, and negative economic impacts. The FAO/WFP Hotspot analysis and the Global Report on Food Crises, 2023, include a brief description of the causes of the **acute situation** in each African country which is severely affected.[9]

Table 3. Causes of Acute Food Insecurity by Country

Country/Region	Causes of current acute food Insecurity
Nigeria	Multiple natural hazards including below average rainfall in some regions, disruption to humanitarian assistance
Democratic Republic of the Congo	Conflict, population displacement, declining purchasing power, rising food prices
Sudan	Conflict, availability of food, flooding, suspension of assistance
Ethiopia	Conflict, high food prices, consecutive droughts
South Sudan	Drought, flooding, high food prices, persistent conflict, influx of migrants
Somalia	Most severe drought in its history (6 years), conflict
Kenya's arid and semi-arid region	Prolonged drought, deteriorating economy, high food prices
Malawi	Low crop production due to Cyclone Freddy, flooding, and high food prices
Burkina Faso	Conflict limiting movement of goods, high food prices, drought, flooding
Mali, Niger, Chad	Conflict, high food prices, drought, flooding
Mozambique	Low crop production due to Cyclone Freddy, flooding, conflict
Zimbabwe	Rainfall deficit, high temperature, shortage of foreign currency, limiting buyers access to food
Gambia and Senegal	High food prices, macroeconomic challenges, high price of imported food, flooding
Tanzania, Zambia, Namibia, Angola	Drought
Madagascar	Tropical storms

Before assessing the impact of climate and climate change, **it is useful to describe the impact of high food prices and macroeconomic problems on food security**. The FAO food price index jumped from its five-year average of 94.8 pre COVID pandemic, to 159.7 at its height in March 2022. The price index has since fallen to 123.9 in August 2023.[10] After rising rapidly during the worst part of the pandemic in early 2022, the price index has declined steadily, though it is still significantly higher than in the pre pandemic years. This is generally ascribed to the

[9]FAO and WFP; Hunger Hotspots, FAO-WFP; Early Warning on acute food insecurity, January to November, 2023 Outlook, Rome, Italy. Global Report on Food Crises, 2023, FSIN and Global Network Against Food Crises. GRFC 2023, Rome, op. cit.

[10] FAO. 2023. FAO Food Price Index. [Online] https://www.fao.org/worldfoodsituation/ foodpricesindex/en/

disruption in food supplies caused by the war in Ukraine (Ukraine and Russia supply a significant percentage of world trade in grains and fertilizer, especially to countries in Africa and the Middle East), and disruption to supply chains caused by the pandemic itself. Thus, food deficit countries were forced to import food at considerably higher prices. Many were unable to import the quantities required due to shortfalls in foreign exchange, and to global and local economic decline. Economic decline was caused in most of these food deficit countries by agricultural production decline, in part caused by much higher fertilizer and other farm input costs, in part due to conflict, and in part due to climate impact. A negative climate impact on agriculture, caused by drought, flooding, or storms, causes economic decline and local food price increases, all contributing to food insecurity.

Recent analysis finds that the above causes of food insecurity are highly inter-related.[11] **Severely negative climate impacts such as drought, floods, and storms, which reduce food production, also reduce purchasing power of farmers and non-farmers. When combined with soaring prices of imported food, the result is acute food insecurity**. This is often a contributing factor to conflict, as well as to migration.[12] In each country identified above as currently in a situation of acute food insecurity, climatic and conflict impacts were identified by FAO and WFP as principal causes. These two causes were always impacting concurrently, and in each case were causing economic decline. WFP findings indicate that the conflicts between pastoralists and farmers in the Sahel are increasing due to climate crises[13]. It also finds that" high temperature during corn growing seasons in Sub-Saharan Africa reduced yields and led to a rise in civil conflict between 1970 and 2012."[14]

The above material focuses on the causes of acute food insecurity. But as seen in the map of food insecurity presented above, most Africans who are food insecure are in countries categorized as facing moderate food insecurity. This covers nearly every country in Sub-Saharan Africa. The causes of this more generalized situation are like the causes in African countries facing a severe problem but also include agricultural policies and investments which have failed to stimulate agriculture. These include agricultural price policies which effectively tax agriculture, limited public investment in agriculture, and frequent failure of donor financed agriculture projects, among others. As a result, African population growth has exceeded agriculture growth. This was the subject presented in a previous Emerging Markets Forum, and the content of a chapter on Agriculture, Employment and Climate Change in the book Envisioning 2060, Opportunities and Risks for Emerging Markets.[15]

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[11] The Global Report on Food Crises, 2022 and 2023, FSIN and Global Network Against Food Crises. GRFC 2023, Rome, op. cit., observes a food insecurity-conflict feedback loop (p.8). FAO and WFP; Hunger Hotspots, FAO-WFP; Early Warning on acute food insecurity, January to November 2023 Outlook, Rome, Italy found that extreme weather events produce both economic shocks and civil strife. The World Food Program report: Dangerously Hungry, the link between food insecurity and conflict, 2023, found a strong link.

[12] IFPRI; 2023 Report on Food Crisis; Joint Analysis for better Decisions, Food Security Information Network, 2023

[13] Global Report on Food Crises, 2023, FSIN and Global Network Against Food Crises. GRFC, op. cit., p. 13.

[14] Global Report on Food Crises, 2022, FSIN and Global Network Against Food Crises. GRFC 2023, Rome, Italy.2022, op. cit., p. 10.

[15] Envisioning 2060, Opportunities and Risks for Emerging Markets, ed by Harinder Kohli, Rajat Nag, Leva Vilkelyte, Penguin Random House, India, 2022, pp.203-222

Research by Von Uerhull, D'Enrico, and Jackson found that **extreme weather events, whether occurring normally or as a result of climate change, produce both economic shocks and resource conflicts**.[16] Farming communities showing higher levels of resilience to climate extremes are less likely to support political violence.[17] The Washington Post, looking at the confluence of violence and climate change in Sub Saharan Africa found the following: "Throughout the Sahel, climate change is raising temperatures, increasing droughts and making rainfall less predictable. These changes are helping fuel Boko Haram, an Islamist extremist movement born in the 2000s in Northern Nigeria, and stoking its violence, according to interviews with former militants, local leaders, military officials, and researchers. Climate change is reducing the economic prospects of young men in this part of Africa and making them more susceptible to recruitment by violent extremists."[18]

IV. Climate Impacts, Climate Change and Food Insecurity in Africa

Since humans began farming, climate impacts on agriculture were well known to farmers throughout the World. **When negative climate impacts are predictable based on past experience, farmers can adopt preventive measures.** The Inca civilization in the South American highlands terraced mountain farms to trap rainwater which was scarce outside of rainy seasons. Some farmers in China adopted the same practice. Where rainfall was scarce in dry seasons, but water was accessible from groundwater or rivers running off mountains, irrigation systems have been built for thousands of years, and are still being built today. In more affluent agricultural societies in Europe and North America, irrigation systems are built in rain-fed areas to supplement rainfall when there is a local rainfall deficit. Other techniques such as planting on the contours of hills to trap rainwater run-off, or water harvesting to trap and train water to move to crops, are commonly used throughout rain deficit agricultural areas. Many African herders practice transhumant livestock raising in which livestock are moved from grasslands fed by rainfall usually at lower altitudes, to highland grassland when the rains stop in the lowlands. This is a major reason collective forms of land tenure rather than individual farms predominated in areas where livestock raising was dependent on a search for rain.

Farmers and herders have adapted to their local climate situation for thousands of years. When adaptation was impossible, farmers migrated, and are still migrating if they cannot survive on their agricultural lands with available technologies. As agricultural populations increased beyond the capacity of local agricultural systems to support it, either investment or technological innovation permitted expanded agriculture production, or people moved, or suffered and sometimes starved. In modern times, food imports from other countries,

[16] See von Uexkull, Nina; Marco d'Errico & Julius Jackson (2020) "Drought, Resilience, and Support for Violence: Household Survey Evidence from DR Congo", *Journal of Conflict Resolution* 64(10): 1994–2021. See also Tackseung Jun, 2017. "**Temperature, maize yield, and civil conflicts in Sub-Saharan Africa**," Climatic Change, Springer, vol. 142(1), pages 183-197.

[17] Von Uexkull et al., op cit.

[18] Washington Post, July 2, 2023, Washington DC

government managed food stocks, and food aid have mitigated the starvation/migration response to some extent, but not fully as seen in the alarming data presented above for African countries facing acute food insecurity.

Two key questions arise: I) Is climate change altering this situation by intensifying negative climate impacts, and II) whether future climate change will continue to make these climate events even more devastating to agriculture and food security. Climate change will also impact other areas of human welfare such as disease, land availability, urban areas; these are beyond the scope of this paper. The following paragraphs summarize a vast literature on this subject.

The most authoritative sources on climate change are from the Intergovernmental Panels on Climate Change (IPCC). The latest report is more definitive than previous reports in documenting both the climate change that has occurred already, the contribution of humans to climate change (anthropogenic climate change), and in predicting further climate change and its effects.[19] **Each IPCC report has predicted dire consequences for agriculture in middle latitudes (most of Africa, Latin America and Asia), but the latest report indicates that the climate extremes witnessed in Africa are more severe than in the past, and are due in part to climate change**.

"Climate Change has reduced food security and affected water security", while "ocean warming, and ocean acidification have affected fisheries in some oceans". [20] It has also caused faster glacier and sea ice melting, raising sea levels. This is impacting coastal agriculture around the world, as sea water intrusion into coastal agriculture increases.[21] Currently, one half the world's population experiences severe water scarcity for part of the year, while water storage in glaciers, which is the basis of irrigation systems in many developing countries, is contracting.[22] These findings provide evidence that as cited above, the severe climate impacts affecting African countries are to a large extent due to climate change. The exact proportion of these impacts due to climate change is unknown; droughts, floods and storms have always occurred and have damaged agriculture. But the severity of these phenomena and their widespread incidence in Africa (as well as elsewhere in the tropics), is due to climate change, which in turn is largely the result of human caused emissions of carbon dioxide and methane.[23]

The IPCC projections for the future, based on a variety of models and simulations, suggest that at current and plausible rates of greenhouse gas (GHG) emission, further global temperature increases are certain. Specifically, the 2023 IPCC report predicts a global temperature increase of between .3 and .7 degrees centigrade in 2016-2035 relative to 1986-2005.[24] **Climate models suggest that much of Africa will be even drier than at present, especially in Southern**

[19] Synthesis Report of the IPCC Sixth Assessment Report (AR6) and its long report (2023)
[20] Ibid, p.6
[21] Ibid p. 5
[22] Ibid p. 7
[23] Ibid, IPCC Synthesis Report and Longer Report
[24] IPCC, op. cit. p. 5 of Synthesis report, op. cit.

Africa, West Africa and the Sahel.[25] The IPCC predicts more intense storms as temperatures rise. Increased temperature will trigger greater evapotranspiration by crops and vegetative cover, and more rapid depletion of soil moisture. This will negatively affect crop yields.[26] Availability of water will be less certain. Surface water will decline in most dry subtropical regions. Droughts will intensify due to more variable precipitation and increased evapotranspiration. The confidence level in these projections has increased because the phenomena is already being observed.

Research sponsored by the International Food Policy Research Institute (IFPRI) in Nigeria found for example that "controlling for other factors, a 15% increase in harmful degree days reduces agricultural productivity by 5.2% on average".[27] The study also found that average annual rainfall has decreased in Nigeria by about 2.8 mm since 1941, the length of the growing season has decreased, and average temperature has risen; as a result, crop yields are declining. **IFPRI found that "rising temperatures will negatively impact agriculture yields, driving up agricultural prices, resulting in increased hunger, especially in Africa."**[28] IFPRI further states that "climate change will have cascading effects on livelihoods thru interconnection with economic, environmental, social and political impacts."[29]

A recent International Monetary Fund (IMF) study states: "In 2022, 12 percent of the [African] population is suffering from high malnutrition and unable to meet basic food consumption needs. The rising frequency and intensity of droughts, floods, cyclones and higher temperatures and sea levels are set to exacerbate this number by hampering agricultural production and food distribution. After each major climate event, people die of hunger and the survivors are less productive. Over the longer term, poor nutrition hurts early childhood development, educational attainment, and earnings potential. Consequently, increased food insecurity could jeopardize the hard-earned improvements in incomes and education and health outcomes across SSA in recent decades. These and other serious humanitarian and economic implications could also fuel conflict and large-scale migration." The study also found that In Ethiopia, Malawi, Mali, Niger, and Tanzania, for example, food insecurity increases by 5 to 20 percentage points with each drought or flood.[30] The IMF study states that In Sub-Saharan Africa, crop yields are projected to decline by 5 to 17 percent by 2050, especially in key staples. "Notably, rising temperatures and rainfall volatility are key contributors to the shrinking of growing seasons and arable land, resulting in reduced productivity from overuse, impeding total factor productivity in agriculture."[31] The book Envisioning 2060, prepared for the 2021 Emerging Markets Forum, had a similar assessment.[32]

FAO finds that climate change is causing diebacks of trees from drought and temperature stress, and increases in water erosion, storm damage, frequency of forest fires, pest and

[25] Ibid. p. 5 of Synthesis Report
[26] IPCC p. 6 of Synthesis Report, op. cit. p. 6
[27] Mulubrhan, Amare and Bedru Balana, "Climate Change, Income Sources, Crop mix, and input use decisions, Evidence from Nigeria," Ecological Economics, 2023
[28] IFPRI, Global Food Policy Report, 2022, Climate change and Food Systems, 2022, Washington DC
[29] Ibid., p. 8
[30] International Monetary Fund, Climate Change and Chronic Food Insecurity in Sub-Saharan Africa, Departmental Paper, Washington DC., 2022, p. vii
[31] Ibid., p. 3
[32] Envisioning 2060, Opportunities and Risks for Emerging Markets, ed Harinder Kohli, Rajat Nag, Ieva Vilkelyte, Penguin Random House India, 2022. Pp218-222.

disease outbreaks, flood damage, and saltwater intrusion.[33] The FAO found that indirect effects of climate change include impacts on pollinators, pests, crop and livestock diseases, and invasive species.[34] Further, FAO finds that climate change is causing diebacks" and that "climate change will have cascading effects on livelihoods thru interconnection with economic, environmental, social and political impacts."[35]

The World Bank concluded in its Climate Change Action Plan (CCAP) 2021-2025, that droughts, forest fires, hurricanes, floods will become more frequent and severe in the future.[36]

Box 1: Impacts on African Agriculture of 1.5-degree centigrade warming, to 4 degree centigrade warming

It would be desirable to have reasonable predictions of the impact of different warming scenarios on African agriculture. The available literature contains predictions for individual African countries and some crops. The text above includes some of these predictions based on the best guess future increase in temperatures due to climate change, and assuming no agricultural adaptation. These predictions are not very good, because the impact of climate change on agriculture is not largely due to temperature increases, but rather to a combination of increased water deficits, sea water intrusion, change in rainwater patterns, new agricultural pests and diseases, as well as temperature increases. The precise combination of these factors will vary from place to place.

The IPCC Sixth Assessment Report 2023 summarized the literature on projections, with some indicative ones as follows:

Maize yields would decline from 3 to 15% in Western and Central Africa with a 1.6 to 2.4 centigrade temperature increase, but yields would increase by about 3% in Southern Africa. With a 3.3-4.8 degree C temperature increase maize yields in Western and Southern Africa would decline from 10% to 30%. (IPCC, 6th Synthesis Report p. 33)

For vegetables, beans and bananas the impact of a 4 degree C scenario is a decline in yields of 30 %, 30-60%, and 20-40% respectively according to the IPCC 6th Assessment's Special Report on Climate Change and Land (Ibid, p. 455)

Ocean fisheries catches off the African coast would decrease by 10 to 35% in a 0.9 to 2 degree C temperature increase scenario. The decline would be 30 to 35 % in a 3.4 to 5.2 degree C temperature increase scenario.

These scenarios have relatively high confidence levels because declines in crop yields from the temperature related climate change which has already occurred can be measured. Thus, global yields of maize, wheat and soybeans declined by 4.1 %, 1.8 %, and 4.5 % respectively between 1981 and 2010 due to climate change relative to the pre industrial climate (IPCC, Special Report on Climate Change and Land, p. 452).

The Brookings Institution in its Africa Foresight book for 2022 included chapters on climate

[33] Ibid, p. 9
[34] FAO, Climate Change and Food Security, Risks and Responses, 2015, Rome
[35] Ibid., p. 8
[36] World Bank, Climate Change Action Plan, 2021-2025, Supporting Green, Resilient, and Inclusive Development, 2021, Washington

change and food security which found that "under a 3°C warming scenario, Africa is expected to lose up to 30 percent of current growing areas for maize and banana and 60 percent for beans by 2050. Under this extreme scenario," by 2050, the number of Africans who are undernourished is expected to grow to 350 million."[37]

These negative effects will occur at the household level (particularly on farms), and impact farmers in the tropics the most. However, impacts on food availability and food prices will negatively affect food consumers as well. At the national level, declines in agricultural production hurt economies, and increasing food prices hurt everybody. If effects are widespread in a region, regional trade in agriculture will also be hurt.

If climate impacts on agriculture could be reduced, the negative economic impact on populations could be mitigated, food insecurity reduced, and at least some of the cause for conflict reduced as well.[38]

Climate change will be positive for a few countries in Northern latitudes (Canada, Russia, and Scandinavian countries). These countries have seen an increase in the diversity of agricultural crops due to rising temperatures. An example is Iceland which has raised a crop of wheat in the Northern part of the country for the first time. Although these are not countries with food security issues, increased production in those countries helps alleviate world price increases, and permits increased exports to food deficit countries, potentially alleviating food insecurity to some extent. But this positive phenomenon does not come close to offset the negative impact of severe climate conditions in the tropics, as seen by the dramatic increase in food insecurity in the past three years.

Several other OECD countries are managing the negative impacts of climate change on their agricultural sectors and will have additional food for export. But this additional food production for export will need to be purchased by food deficit countries unless it is provided as food aid. And the African countries most affected by climate change will have difficulty purchasing food, hence the importance of continued food and agricultural aid.

v. African Agriculture's contribution to Greenhouse Gas (GHG) Emissions

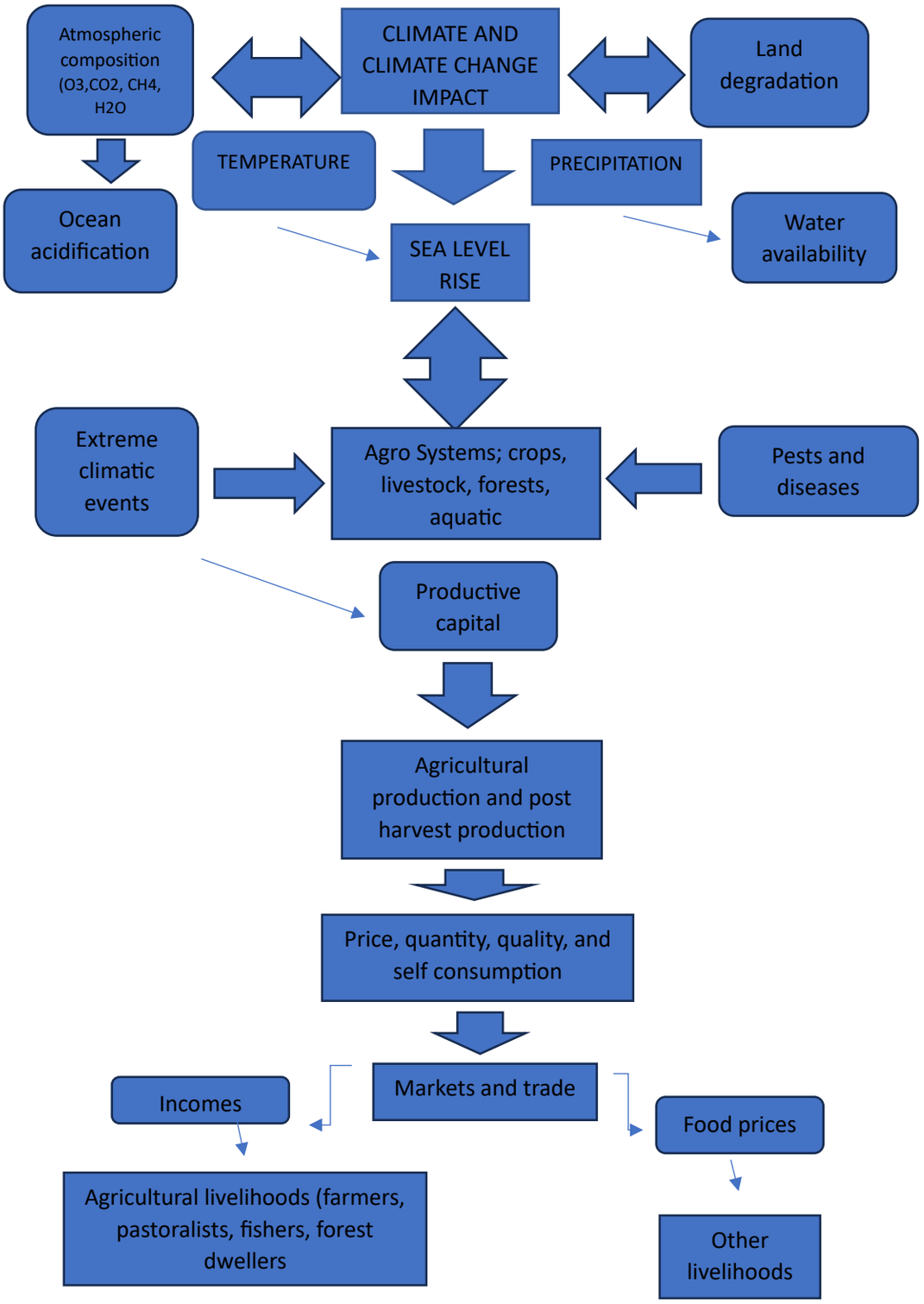
As already noted in previous IPCC reports, **the Sixth IPCC Assessment documents the contribution of agriculture to greenhouse gas emission, and therefore to climate change. The IPCC states that 22 percent of global greenhouse gas emissions are from agriculture,**

[37] Brookings Institute, Foresight Africa, 2022, "The urgency and benefits of climate adaptation for Africa's agriculture and food security," by H. Kray, C. Jenane, E. I. Vasquez, and J. Saghir, March 2022, Washington DC. Note that the figure of 350 million Africans undernourished has apparently already been nearly reached. Foresight Africa, 2023 also discussed the impact of climate change on African agriculture.

[38] This is also a conclusion of the FAO State of Food Insecurity 2017 which cited the relation between climate impacts and conflict. Similarly, the Global Report on Food Crises, 2023, FSIN and Global Network Against Food Crises. GRFC 2023, Rome, op. cit. refers to the food insecurity-conflict feedback loop.

forestry and agriculturally related land use.[39] The biggest culprit is deforestation. Deforestation occurs in part to expand land for farming and livestock raising, but also due to logging. Destruction of peatlands, wetlands, rangelands, and mangroves also cause greenhouse gas emissions., as does disposal of food waste. Livestock's contribution is significant, through enteric fermentation (from the digestive process). Rice production is an important emitter. Biomass burning, fuel extraction (biofuels) are also important contributors.[40] However, countries in the tropics, and in particular African countries, contribute only a miniscule share of greenhouse gas emissions. IFPRI estimated that the least developed countries, which includes all of those experiencing acute food insecurity, accounted for only 3.3 percent of global GHG (Greenhouse Gas emissions) in 2019.[41] The small contributions made to such emissions are largely through agriculture and land use changes, including forest and rangelands loss. A schematic representation of the entire systems from climate impact to the livelihoods of farmers and non-farmers is as follows.[42] Note that the arrows represent impact. Thus, climate and climate change impacts land and can lead to land degradation. Increased carbon dioxide in the atmosphere contributes to ocean acidification. Change in precipitation affects water availability. Temperature increase cause sea level rise.

[39] IPCC Synthesis Report 2023, op. cit., p. 3
[40] Agricultural Market Information System (AMIS), FAO AMIS Secretariat, June 2, 2023 Report.
[41] IFPRI, Global Food Policy Report, 2022, op. cit., 2022, p. 10
[42] Adapted from FAO


Atmospheric composition (O3,CO2, CH4, H2O
CLIMATE AND CLIMATE CHANGE IMPACT
Land degradation
TEMPERATURE
PRECIPITATION
Ocean acidification
SEA LEVEL RISE
Water availability
Extreme climatic events
Agro Systems; crops, livestock, forests, aquatic
Pests and diseases
Productive capital
Agricultural production and post harvest production
Price, quantity, quality, and self consumption
Markets and trade
Incomes
Food prices
Agricultural livelihoods (farmers, pastoralists, fishers, forest dwellers
Other livelihoods

VI. Agricultural Adaptation to Climate Change, and Mitigation of GHG Emissions from Agriculture; Technological Solutions for Africa

Based in part on the extensive experience of farmers, and increasingly governments, in adapting agricultural systems to climate impacts (as opposed to climate change), **a great deal is known on how to adapt to extreme climate events**. Adaptation measures introduced by farmers and governments have included irrigation systems to address water shortages. Infrastructure and natural barriers have been introduced to deal with flooding. Improved tillage practices have been introduced to preserve soil moisture (terraces, cultivation along the contour of hills). Farmers have changed crop rotation and introduced agro-forestry to maintain soil moisture. Protective measures have traditionally been used against high winds (tree barriers and hedges for example). Reforestation has improved water retention to help replenish aquifers. Infrastructure and natural barriers (mangroves, wetlands) have helped reduce seawater intrusion in cropped areas.

These traditional methods of dealing with climate impacts are found in the literature dealing with adaptation of agriculture to climate change. In each case, the traditional measures will need to be more effective, more widespread, better managed, and unfortunately more expensive as climate change makes the problems of water shortage, flooding, seawater intrusion, and temperature increase more extreme. Additional adaptation measures outlined in the IPCC Sixth Assessment and from the Consultative Group for International Agricultural Research (CGIAR) include the following[43]:

- Cultivar improvements can increase agricultural productivity using less chemical fertilizer and chemical pesticides and herbicides (which are important contributors to greenhouse gas emissions). This could help reduce food insecurity if developed for the tropics. IFPRI argues that genome editing technology (CRISPR) can and will be used to rapidly develop crop and animal varieties which are adapted to climate change and to reduced emissions.
- Better on-farm water management and storage could help address the widespread water shortages already occurring, and likely to occur more frequently and more severely in the future. Wider application of irrigation will be used, but it needs to come with irrigation techniques such as drip irrigation which lower water use (more crop per drop).
- More extensive application of measures will be needed to conserve soil moisture through crop selection, low or no tillage, cover crops, and plowing back crop residue into the soil.
- Forest replanting, and better landscape management will be part of the solution.[44]
- Solar energy on farms including solar powered pumps for irrigation and water supply.

[43] The CGIAR "Research Program on Climate Change, Agriculture, and Food Security" has proposed many technologies to address adaptation of agriculture to climate change. See https://ccafs.cgiar.org/outcomes
[44] IPPC Sixth Assessment, Long Report, 2023, p. 8 and p. 73

- Improved drying methods to increase food quality and availability and to reduce food waste will be important.
- Digital agriculture to improve data use to make possible precision agriculture, use of robotics, e-logistics and e-commerce will contribute.[45]
- Curbing crop residue burning.
- Better weather forecasting.
- Sustainable livestock production and fish farming.

Other sources of information on appropriate technologies for this task include the FAO, the International Fund for Agricultural Development (IFAD), the World Bank, all of which have publications identifying the same adaptation and mitigation measures.[46] In addition to the CGIAR Research Program on Climate Change, Agriculture and Food Security referenced above, the CGIAR has begun a program entitled "Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA).[47]

The IPCC suggests several actions to reduce greenhouse gas emissions from agriculture, which can be introduced in the tropics. Each of these actions will also help agriculture to adapt to climate change. These include reduced conversion of natural ecosystems to agriculture, greater carbon sequestration in agricultural soils through changed cultivation techniques, and ecosystem restoration. Where possible, IPCC proposes reduced methane and N2O emissions from agriculture by restricting the use of chemical fertilizer, herbicide and pesticide use in favor of measures such as the use of agricultural waste for fertilizer, and integrated pest management. The reduction of food waste from farm to household plate would also contribute to reducing emissions.

Are there innovative technologies in the research pipeline which will expand the menu of climate adaptation and mitigation possibilities for agriculture? The principal climate related problems in African agriculture are expected to be drought, flooding, temperature increase and saltwater intrusion. Developing crop and livestock varieties which are more resistant to heat, water scarcity and salt, will be key solutions. Technologies developed in more advanced agricultural countries such as hydroponics (production under greenhouses with drip irrigation, controlled fertilization, and controlled pest/disease measures) are effective and applicable to much of Africa except for one major constraint: expense and technical skill requirements. These technologies will be more applicable as African countries grow economically and with expanded skills. Another longer-term prospect is the production of plant-based meat and dairy substitutes. These products substitute for meat and are more climate and environmentally friendly. However, the slow uptake in more advanced economies suggests that this is only a potential long-term contributor in Africa. Eventually, with more technologically and financially vibrant agriculture sectors, and with slowly changing dietary

[45] IFPRI, op cit. p. 9 and p. 11

[46] FAO, African Union, United Nations Economic Commission for Africa, Regional Overview of Food Security and Nutrition Statistics and Trends in Africa. FAO, Climate Change and Food Security, Risks and Responses, 2015, Rome.

[47] See AICCRA's website: https://aiccra.cgiar.org/. It has focused thus far on Senegal, Mali, Ghana, Ethiopia, Kenya, and Zambia.

preferences, Africa will also be able to apply these agricultural technologies which are good for farmer incomes, mitigate climate impacts and are more resilient in the face of climate change. National and international agricultural research institutes are key actors in this transition, as is the private sector, but this is a medium to long-term prospect for most of Africa.

All the measures described above to adapt to climate change by reducing the impact of extreme climate effects on agriculture as well as to reduce greenhouse gases emitted from agriculture, have been successfully tested and applied in some places. They work. T**he challenge is to significantly expand and mainstream the application of these measures. To do this requires tailoring the measures to the specific situation of each country and each region within each country**. This in turn will require funding, and expertise. But even if this were done on a more significant scale than is currently the case, the positive impacts on food security will only manifest themselves over several years. **Few of these measures will solve the problems of countries presently in the situation of acute food insecurity. These countries will continue to need a combination of food aid, financial aid to offset the negative economic effects of agricultural decline, and developmental actions to revive agricultural sectors**. These actions will include the distribution of agricultural inputs such as seeds and fertilizer, farm tools and equipment, and technical advice to farmers. In some places it will require rehabilitation of rural infrastructure such as food storage and rural roads. Some of these rehabilitations can be undertaken quickly (farm inputs) and some will require several years (infrastructure rehabilitation). The latter can be undertaken in combination with investments in climate adaptation technologies such as those listed above.[48]

VII. Toward a Vigorous Global Response

In 2009, an international agreement was reached to provide US$ 100 billion p.a. from 2020 to 2050 for climate change adaptation (in all sectors, not solely agriculture) in developing countries. Subsequently the UN Framework Convention on Climate Change (UNFCC) COP 26 held in November 2021 witnessed 137 countries pledge to halt and reverse forest and land degradation by 2030. One hundred countries pledged to reduce methane emissions including from agriculture. None of these agreements and pledges have been fully implemented. Are there ideas for accelerating implementation of the kinds of adaptation and mitigation measures described above, and thereby to improve food security in developing countries?

IFPRI estimates that US$ 350 billion is needed annually to meet climate related goals (adaptation and mitigation) in global food systems (agriculture production, marketing, processing including input supply).[49] IFPRI calculates that actual funding for climate change in agriculture, forestry and the land use sector is about US$ 20 billion per annum, or about 4 percent of existing climate finance.[50] So the gap between the US$ 20 billion p.a. available

[48] See also World Food Program

[49] IFPRI, Global Food Policy Report, 2022, op. cit., p. 14

[50] Ibid., p. 46. IFPRI estimates that most climate funding goes to renewable energy, energy efficiency, and sustainable transportation.

globally (not just for Africa), and what is needed (US$ 350 billion p.a.) is enormous. More specific figures for Africa are difficult to come by. However, staff in the World Bank and the Brookings Institute found that **climate finance provided by multilateral development banks to the agriculture sector (which encompasses more than the food sector) in Africa increased from US$ 433 million in 2015 to US$2 billion in 2018, and then declined to just over US$1 billion in 2020.**[51] **Given the magnitude of the problem in Africa, this amount is miniscule. World Bank staff estimated that about US$ 15 billion p.a. was needed for climate adaptation of African agriculture, compared to the US$ 1 billion p.a. available**.[52] This compares to estimates of the cost of inaction at around US$ 200 billion p.a.[53]

Development aid for all sectors globally currently totals about $ 250 billion p.a.[54] One way to fill the gap in climate finance for Africa is to allocate more of this aid to agricultural adaptation to climate change in Africa. But this would come at the cost of aid supporting other needy sectors and to needy countries outside of Africa.

Box 2: Information issues regarding donor financing of adaptation of agriculture to climate change

The data on financing of adaptation is poor. Some donors count as a contribution the total commitments to projects which contain climate adaptation elements. Some more accurately count only the part of total project financing which is directed at adaptation measures. Some count only actual disbursements for projects which contain adaptation measures, and some more accurately count only the disbursements for actual adaptation measures. Some donors, such as the Japan International Cooperation Agency finance agricultural projects which have a positive impact on adaptation of agriculture to climate change but are not classified as such. The result of these problems is that the data on financing of adaptation is poor. The best estimate is that of World Bank staff quoted in the text above.

IFPRI proposes that much of the gap could be filled by repurposing agricultural subsidies. Total agricultural subsidies are about US$ 620 billion p.a. worldwide.[55] IFPRI estimates that about US$ 540 billion of these subsidies are targeted to price support mostly for staple crops (rather than nutritious foods) and to subsidize farmers in developed countries. Support measures requiring fiscal expenditures by governments (as opposed to price supports for example) totaled about US$ 450 billion. Repurposing those developed country subsidies which exacerbate climate change or inhibit farmer adaptation to climate change in developed countries would help. Examples of these kinds of subsidies include subsidizing irrigation water (which reduces the incentive to use irrigation water efficiently), ethanol subsidies (which reduces maize available for human consumption), lower than market prices for use of grazing

[51] Brookings Institute, Foresight 2022, Kray and al., op cit. Note that determining the amount of funds used in Africa to help its agriculture adapt to climate change is only poorly recorded. These estimates are subject to error.
[52] Ibid.
[53] blogs.worldbank.org/africacan/adapting-africas-food-system-climate-change-imperative-its-time-action
[54] IFPRI, op cit., p.50
[55] Ibid., p. 15-17

land and for logging companies to use public forests. Some developed countries subsidize chemical fertilizers and pest control, which reduces the incentive to use crop residues as fertilizer and integrated pest management. Repurposing these subsidies to conservation agriculture in developed countries would provide incentives for their farmers to invest in more sustainable and climate resilient practices such as those described above. It would be desirable from the perspective of global agriculture adaptation and mitigation of climate change, for some part of these subsidies to be reallocated to African agriculture, and specifically to incentivize the adoption of the climate adaptation practices indicated above.

If expanded aid is forthcoming, how would it be distributed and managed? Currently, the Green Climate Fund (GCF) is the largest single funding source dedicated entirely to climate finance. Its web site indicates that it has financed 216 ongoing projects involved with climate change adaptation and mitigation in all sectors world-wide, for a portfolio valued at over US$ 12 billion. It approved US$ 1.4 billion in new projects in 2022. This Fund was created as the financing mechanism for the UN Convention on Climate Change and the Paris Agreement referred to above. Adding funds to the Green Climate Fund and increasing its capacity to work on food and agriculture related issues would be a legitimate solution. However, since most of its funds go to sectors outside the food sector, and much goes outside of Africa, this would not be a very targeted solution. The Green Climate Fund does not appear to have a significant food sector capacity.

The World Bank manages several environment and climate change related funds, including the Forest Carbon Partnership Facility, the Biocarbon Fund Initiative for Sustainable Forest Landscapes, and the Global Environment Fund (GEF). It also targets an increasing share of its own funds to climate change. The projects that the World Bank finances from the climate and environmental funds that it manages, include climate adaptation and mitigation measures in African agriculture such as those described above.[56] Of note are the World Bank's Climate Smart Agriculture Profiles. Thirty have been released covering developing countries in Africa and elsewhere.[57] A brief summary of the Profile developed for Zambia is described in Box 2.[58]

Box 3: Zambia's Climate Smart Agriculture Profile

With the objective of informing Zambia's national Investment plans, this profile focuses on crop diversification, commercial horticulture, agro forestry and infrastructure to reduce post-harvest loss. Similar climate smart agriculture profiles are available for Cote d'Ivoire and Mali, and many are in preparation.

[56] World Bank Climate Change Action Plan 2021-2025, 2021, Washington, op. cit.

[57] https://www.worldbank.org/en/topic/agriculture/publication/climate-smart-agriculture-investment-plans-bringing-climate-smart-agriculture-to-life

[58] "World Bank. 2019. Zambia Climate-Smart Agriculture Investment Plan: Analyses to Support the Climate-Smart Development of Zambia's Agriculture Sector. © World Bank, Washington, DC. http://hdl.handle.net/10986/31383 License: CC BY 3.0 IGO

The World Bank has significant agriculture and food sector capacity, with a substantial presence and work in Africa. Because the World Bank has considerable experience and knowledge with respect to African agriculture and climate finance, it would be a legitimate intermediary for such funds. A possible objection is that allocating incremental funds for climate adaptation and mitigation in African agriculture to the World Bank may be considered problematic as the funds that they manage are not targeted to this purpose. Secondly, the World Bank already has the largest single amount of climate funding available for developing countries, and its absorptive capacity may have been reached.

The International Fund for Agricultural Development (IFAD) also manages a fund to assist developing countries adapt their agriculture sectors to climate change.[59] Its menu of actions mirrors the areas indicated above as effective. The climate adaptation projects it funds are independently evaluated and are found to have an astonishing success rate of 90%.[60] The FAO undertakes small scale climate adaptation projects which serve as pilots for governments and other donors to finance. Allocating more funds to IFAD and the FAO, working together would be a legitimate approach.

Several bilateral donors provide assistance for climate change adaptation in agriculture, as do the regional development banks. For this paper a brief review of the climate change related activities of major bilateral donors was undertaken. This did not include an assessment of the quality or impact of this work, which would be a major study in itself.

The Japanese Government has been active in advocating reforms to the global food system. It hosted a Food Summit in December 2021 (the Tokyo Nutrition for Growth Summit) which had as its ultimate objective the transformation of health and food systems to deliver better health, nutrition, and diets, and to end malnutrition. Japan has argued for agriculture to have a lower environmental burden, and for decarbonization of the agriculture, forestry, and fisheries industries.

The Japan International Cooperation Agency (JICA), which is the sponsor for this report, is one of the three biggest bilateral donor agencies with a total scale of operations in 2021 of JPY 192 billion (roughly US$ 1.36 billion) in technical assistance, JPY 1275 billion in loans (about US$90 billion), and JPY 70 billion in grants.[61] JICA has announced a priority effort to support both adaptation to climate change and mitigation. Because of the types of experience and expertise that JICA has, it sees opportunities to do this in energy, transport, forest conservation, disaster risk reduction, and in association with the Green Climate Fund. JICA now requires that climate risks in the projects it finances be evaluated and mitigated. It has promised to provide up to JPY 6.5 trillion in climate finance over the period 2021-2025.

A brief review of JICA's ongoing projects suggests that few deal with African agriculture, and none specifically deal with agricultural adaptation to climate change in Africa. However, its

[59] https://www.ifad.org/en/asap. See also: https://www.ifad.org/documents/38714170/42288233/IFAD2RP_pillar_1.pdf/fe841122-0247-3832-96a4-1c9dfc663e86?t=1676642287697

[60] International Fund for Agriculture Development, Independent Office of Evaluation, ARIE report 2022.

[61] JICA Sustainability Report 2022. This report is available on the JICA web site.

forest management in the Congo, sustainable irrigation in Djibouti, rural water supply and irrigation and rural resilience in Ethiopia include agricultural adaptation and mitigation measures in response to climate impacts. The review also suggested that there are ample opportunities for reformulation of some JICA African agriculture projects to include adaptation. Places to look are in ongoing rice projects in Nigeria, Senegal and Zambia; and irrigation rehabilitation in Uganda, Zimbabwe, Madagascar, Malawi, Rwanda and Tanzania. This may be a finding relevant to all donors. Many existing donor-financed agricultural projects in Africa might to modified to address climate adaptation and mitigation more directly. This is likely to be a faster way to have an impact than designing new projects from scratch.

The largest bilateral donor is USAID, which has a Climate Strategy 2022-2030.[62] The strategy targets 500 million people to be assisted to adapt to and manage the impacts of climate change by 2030. In addition to USAID projects which will fund many of the technological improvements discussed above, USAID will endeavor to catalyze private investment in adaptation. It also focuses on disaster risk finance, and creation of more weather resistant water, sanitation, and hygiene investments. Achievements thus far include the conservation of 60 million hectares of carbon rich lands such as tropical forests, and US$ 340 million in public and private funds to help adaptation to climate change. It also underlines the USAID-NASA partnership to harness satellite capacity to inform climate and development decisions. This example points to bilateral donor capacity to harness other domestic agencies that have relevant experience (NASA), and access to their domestic private sector.

China has become a major bilateral donor in recent years, and China's government has expressed concern about the impact of climate change on agriculture. Data and information available on Chinese assistance for African agriculture's adaptation to climate change is not available, so no analysis could be undertaken.

The final bilateral studied is France's Agence Francaise de Developpement (AFD). AFD began its program entitled ADAPTACTION in 2017. "Since 2017, ADAPTACTION supports countries and regional organizations particularly vulnerable to climate change in the implementation of their adaptation strategies."[63] The budget for the first phase 2017-2022 was small, including Euro 30 million. Seventy-Five studies were undertaken, and funds leveraged totaling Euro 580 million financed by AFD itself or co-financed, particularly from the Green Climate Fund and the European Commission. The second phase is now underway (2022-2025) with a budget of Euro 15 million to "understudy, plan, and invest"[64]. Projects have indeed focused on climate adaptation, including, in African agriculture. Activities financed in this regard have focused on the French speaking countries of Sub-Saharan Africa, but also including Nigeria and Ghana. Activities include disaster risk reduction, biodiversity conservation, forest management and conservation, education and training, climate governance, coastal zone management, water

[62] See USAID's website which includes considerable documentation on climate change.
[63] See website for the Agence Francaise de Developpement, and its program "ADAPTACTION".
[64] Ibid.

management and livestock. The lesson here is the bilateral donor's advantage in similar language environments and in places where the bilateral donor has accumulated knowledge.

The Consultative Group for International Agricultural Research (CGIAR) has a large-scale research program directed toward adaptation of agriculture to climate change. The World Food Program (WFP) provides food aid and immediate agricultural inputs to people in developing countries suffering from acute food insecurity, due at least in part to climate impact.

Several non-government organizations provide aid to agriculture as well as food aid. These organizations are potential recipients for increased aid since they are already engaged and experienced in climate change adaptation/mitigation.

A more targeted approach would be to use an independent evaluation of each of these organizations to determine the effectiveness of their aid to climate adaptation and mitigation in Africa. Based on the findings, a greater portion of incremental funds could be channeled through the most effective of them.

The G7 summit's declaration on May 20, 2023 noted the increased incidence of acute food insecurity, and listed a number of actions to deal with this problem. The G7 called for more humanitarian assistance, expanded development funding, rules-based trade in agriculture products, scaling up sustainable food production, better data collection, preparation of food security preparedness plans, and **better coordination of donors**. All these actions are sensible, and much of the expanded development funding could go to adaptation and mitigation in agriculture. **Improved donor coordination would be desirable, but difficult**.

Existing coordination mechanisms for agricultural aid include the CGIAR (the Consultative Group for International Agricultural Research) for agriculture research, the World Bank and/or the Green Climate Fund as a coordinator and manager for climate and related environmental funds, the FAO for agricultural policy, and the World Food Program for food aid. The effectiveness of these coordination mechanisms varies and needs an independent evaluation in the same vein as for the effectiveness of existing climate adaptation and mitigation programs. The coordination mechanisms to be encouraged could then be chosen based on their effectiveness.

One coordination possibility is to expand the remit of the Global Agriculture and Food Security Program (GAFSP) to include support for agricultural climate adaptation and mitigation, given the connection to food security. The GAFSP membership includes all the International Finance Institutions (World Bank and Regional IFIs), IFAD, the FAO, and several important bilateral donors. The International Finance Corporation is a member, which is important given the potential role of the private sector. The GAFSP's steering committee also includes civil society representatives. It could call for the preparation of agricultural climate adaptation and mitigation plans for each willing country. The plans would be developed by the potential recipient counties themselves, assisted by groups of donor agencies which are members of the GAFSP. The plans, once evaluated, could be financed by GAFSP members, and the GAFSP itself. GAFSP could be a recipient of incremental agricultural climate funds.

VIII. African Agricultural and Climate Policy Implications

The above proposals for dealing with the issue of climate change and food security in Africa have focused on technological solutions, financing, financial and technological intermediation, and coordination. They have touched on policy issues such as repurposing developed country agricultural subsidies and aid to focus on the adaptation of African agriculture to climate change, and to mitigating African agriculture's contribution to greenhouse gas emissions. But there is more that policy in Africa can do to address the problem.

Many African countries subsidize their agricultural sectors with the same kinds of subsidies found in industrial countries, though at a much lower level. African subsidies for farmer purchase of chemical fertilizers, pesticides, herbicides, agricultural credit and irrigation water are common according to studies by the World Bank, IFPRI and FAO. Often these subsidies are supported by donor agriculture projects because most African governments have only limited financial resources for such purposes. Although less common today, state owned agricultural marketing enterprises nearly always require government subsidies to stay in business. There is a long-standing debate over the question of the effectiveness of these subsidies on stimulating agricultural production. Some argue that encouraging chemical fertilizer use through subsidies is key to expanding agricultural production, while other research contests this.

None of the above types of subsidies have positive impacts on agricultural adaptation to climate change, mitigation of agriculture's contribution to climate change, or to the natural environment generally. On the contrary, irrigation water subsidies encourage excessive use of irrigation water and discourage the use of water saving technology. Often subsidies encourage the clearing of forest land for agriculture use. Subsidies for chemical fertilizer give a distorted incentive to use chemical fertilizer and pesticides compared to natural fertilizer (from organic matter) and integrated pest control. The reform of these subsidy policies is therefore the major area of policy change by African governments needed to address the issue of adaptation of agriculture to climate change in Africa. **Repurposing some of these subsidies to encourage and support the application of climate adaptation and mitigation technologies** is recommended, as was recommended above for more advanced agricultural economies. This is different from simply eliminating the subsidies altogether, a politically and economically impossible objective. The fact that donors support most existing African agricultural subsidy schemes should make such repurposing easier if the donors insist on it.

Repurposed African agricultural subsidies could be used for forest conservation and replanting, subsidizing measures to conserve soil moisture through crop selection, low or no tillage, cover crops, and plowing back crop residue into the soil. The use of organic matter as fertilizer could be subsidized. Other possibilities include integrated pest management, subsidized seed which is heat resistant or requiring less water, drip irrigation, and rainwater harvesting. Solar powered water and irrigation pumps, tree planting, sustainable livestock

production, and improved drying methods to increase food quality and availability, would all be good candidates for repurposed subsidies.

Another area of African policy change is to **expand finance of national agricultural research, extension, and education facilities**. These have been generally neglected throughout Africa. Such institutions will be needed to cooperate with international agriculture research institutes and institutes of higher learning which have programs in Africa. African institutions will need to collaborate more effectively with these foreign actors, and to do this they will need more resources. Increased African government funding for these purposes could come in part from repurposed subsidies.

Support for **weather monitoring and reporting** would be helpful; there is a surprising lack of weather data for Africa.

A problem with the above expanded areas for African government investment to deal with climate adaptation is that limited resources can mean cuts to other well- meaning food security programs. The report recently published by FAO, IFAD, UNICEF, WFP, and WHO (World Health Organization) described a long list of measures for African governments (and donors) to take to deal with food insecurity.[65] These were all reasonable and included among other things: disincentives for consumers to buy processed foods, nutrition education in schools and homes, investment in domestic food processing and marketing, rural roads and communications, electrification, and building local capacity. None of these are focused on climate change, but they are all valuable in dealing with food insecurity. **There are trade-offs.**

IX. Conclusion and Next Steps

There is a lengthy list of next steps that the international community and African governments should take to better assure that countries with food security issues can adapt their agriculture sectors to climate impacts, and to contribute to mitigation efforts. Since **the G7** has announced the importance of food security and has listed climate change as an important factor affecting food security, it **can follow up with its own plan for implementing those actions that it has committed to undertake on this subject**. That plan could consider many of the elements presented in this paper. Responsibilities for implementation could be identified, including most importantly G7 governments, as well as suggested additional actions by International Financial Institutions, the United Nations, Bilateral donors, and Non-Government Organizations. The potential role of private sector partners could be identified. The G7 could recommend a coordinating body, such as the GAFSP, or an alternative.

Funding is a major issue, and the G7 needs to identify how its call to action can be financed.

An assessment needs to be made of **the effectiveness of various donor efforts** to assist countries adapt their agricultural and food systems to climate change, and of efforts to mitigate the contribution of agriculture to climate change. The results need to be made

[65] FAO et al., State of Food Security and Nutrition in the World 2023, op cit.

public. There are some good practices in this regard, including by the International Fund for Agricultural Development and the World Bank.

Governments in Africa, and those in other Regions having agricultural sectors negatively impacted by climate change, need to prepare adaptation action plans. There are some resources currently available to finance parts of these plans, and some planning has occurred providing examples of how to go about this. The World Bank's initiative to develop Climate Smart Agriculture Profiles is a good place to start. **The governments themselves are likely to find that providing their own funds to begin implementing these plans has value in preserving their agricultural economies**. As more funds become available, these plans will form the bedrock for efforts to adapt agriculture sectors to climate change.

African government plans to deal with this issue need to begin to **repurpose agricultural subsidies to focus more on agricultural adaptation** to climate change, and more generally to environmental protection. A great deal more focus in these plans on national agricultural research, extension, and education is also required. Donors have been, and will be, supportive of such efforts so there will be some external funding available. More would of course be desirable.

Food aid will continue to be needed as the impact of climate change becomes more pronounced, and given the likely time needed to fully adapt to the climate change which is coming. The World Food Program is best placed to coordinate this aid. Cash transfers to Africans who are acutely food insecure will also help, when there is food to be purchased.

International research on climate change adaptation is important, and the CGIAR has started an important multi center research program in this regard. This needs additional funding, and additional partners.

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