Potential for climate-smart agriculture projects in the Great Rift Valley, Kenya

KEY BACKGROUND FACTS

- Agriculture is a key component of Kenya's economy. It directly comprises 26% of the GDP and indirectly another 25%. More than 70% of informal employment in rural areas is in the agricultural sector. Women perform a large percentage of informal work in this sector.
- The *Agricultural Sector Development Strategy 2010-2020* (ASDS) builds on earlier work to place agriculture as a key part of the Kenyan Government's long-term development blueprint '*Kenya vision 2030'.*
- The ***Agricultural Sector Development Strategy 2010-2020*** **(ASDS)** seeks to
  - *increase 'productivity, commercialization and competitiveness of agricultural commodities and enterprises'*
  - *develop and manage 'key factors of production.' (p.xiii, ASDS)*
- Article 69 of the new **Kenyan Constitution (2010)** states that

> Part 2—Environment and Natural Resources
> **69.** (1) The State shall—
> (*a*) ensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;
> (*b*) work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya;
> (*c*) protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities;
> (*d*) encourage public participation in the management, protection and conservation of the environment;
> (*e*) protect genetic resources and biological diversity;
> (*f*) establish systems of environmental impact assessment, environmental audit and monitoring of the environment;
> (*g*) eliminate processes and activities that are likely to endanger the environment; and
> (*h*) utilise the environment and natural resources for the benefit of the people of Kenya.
> (2) Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.

Definition of 'climate-smart' agriculture

The FAO has defined climate-smart agriculture as

> "agriculture that *sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals*."
>
> (FAO, *Climate-Smart Agriculture*, http://www.fao.org/climatechange/climatesmart/en/ (last visited 23 Oct. 2012).

Agriculture in a small area of the Great Rift Valley/ Lake Naivasha region of Kenya

- Sample of 300 households
- Small-scale farmers with private title to land (usually inherited)
- Growing carrots and green beans
- Often washed in roadside ditches, and sold by the road to passing cars on the Naivasha-Nairobi Highway
- Small profits used to pay for school fees, electricity and other needs
- Many farmers are 40+ years of age, with younger members of the household leaving for work in Nairobi or the tourist industry in Naivasha
- In a nearby region, a group of households formed a collective and leased their land to a large European Agribusiness company. Higher yield crops need more irrigation, meaning there is less water available in many wells. These crops are exported.

BACKGROUND PAPER ON CLIMATE-SMART AGRICULTURE IN KENYA

1. WHAT IS CLIMATE-SMART AGRICULTURE?

The global population is predicted to rise to 9 billion by 2050;[1] thus, more people will need to be fed. However, "[t]he world's agricultural sectors, including agriculture, forestry and fisheries, face many challenges in meeting the food requirements of an ever-increasing population – such as intensive competition for land and water resources and a degrading environment."[2] "Agricultural lands (lands used for agricultural production, consisting of cropland, managed grassland and permanent crops including agro-forestry and bio-energy crops) occupy about 40-50% of the Earth's land surface,"[3] but it is consistently being lost through infrastructure, urban development, and land degradation.[4] Additionally, any expansion of agricultural land threatens trade-offs in the form of deforestation, destruction of grasslands and wetlands, and loss of biodiversity.[5] Thus, it is absolutely imperative that we find a way to feed more people whilst sustainably using and managing the natural resources dedicated to agriculture and not causing negative environmental effects to other resources.

One response is sustainable intensification, or producing higher yields per unit of land "without exceeding current resources or reducing the resources needed for the future,"[6] which maximizes short-term benefits *and* ensures long-term productivity. But also, agriculture must adapt to climate change, which will greatly affect its ability to meet increasing food demand. "Increased temperatures and changes in precipitation will stress agricultural and natural systems through: increased water shortages, shorter growing periods in some areas, increased magnitude and frequency of flooding and drought, changes in plant and animal diseases and pest distribution patterns and, more generally, reduced suitability of some areas for agriculture."[7] Finally, despite the fact that food must be grown because people must be fed, agriculture accounted for about "10-12% of total

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[1] UN Dept. of Econ. & Social Affairs, *World Population to 2300*, ST/ESA/SER.A/236, at 4 (2004), http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf.

[2] Katia Medeiros Dubois et al., FAO, *Incorporating Climate Change Considerations into Agricultural Investment Programmes: A Guidance Document*, FAO Investment Centre Division, at 8 (2012).

[3] P. Smith et al., *Agriculture*, *in* CLIMATE CHANGE 2007: MITIGATION, CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, ch. 8, at 499 (B. Metz et al. eds., 2007).

[4] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 16 (2011).

[5] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 16 (2011). These majorly problematic trade-offs must be factored into the interpretation of the data shown in a shocking graph (*Id.* at 17) showing seemingly huge "untapped" resources in places such as Sub-Saharan Africa. Otherwise, one may instantly jump to what appears to be the logical conclusion that we should just start massively shifting cultivation to Africa's land (not an uncommon conclusion when looking at the land grab activities happening on that continent by countries such as China) without considering the negative consequences that may flow from that decision. http://pcfisu.org/wp-content/uploads/pdfs/TPC0632_Resilience_report_WEB11_07_SMALLER.pdf

[6] CGIAR, Research Program on Climate Change, Agriculture and Food Security [CCAFS], *Actions Needed to Halt Deforestation and Promote Climate-Smart Agriculture*, Policy Brief no. 4, June 2011, at 3, http://cgspace.cgiar.org/bitstream/handle/10568/10233/CCAFS_Brief04_web.pdf?sequence=6.

[7] Giacomo Branca et al., FAO, *Identifying Opportunities for Climate-Smart Agriculture Investments in Africa*, at 7 (2012), *available at* http://www.fao.org/docrep/015/an112e/an112e00.pdf.

global anthropogenic emissions of greenhouse gases (GHGs)" in 2005.[8] Mitigation of the sector's contribution to climate change through continually sufficient yields but more sustainable practices must therefore be part of the response as well.

Based upon all of the factors discussed above, the FAO has defined climate-smart agriculture as "agriculture that *sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals*."[9] The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)[10] emphasizes these "triple wins" as the goal of climate-smart agriculture—food security, adaptation, and mitigation.[11] Sustainable and equitable practices achieving these three goals must be promoted in the global food system by governmental policies, laws and regulations prohibiting certain practices with negative environmental effects, donor funding and public/private investment conditioned on meeting certain standards.

2. CLIMATE-SMART AGRICULTURE PRACTICES

Agricultural production is "achieved through a number of production systems which range from smallholder mixed cropping and livestock systems to intensive farming practices such as large monocultures and intensive livestock rearing."[12] Negative effects can result to varying degrees from any of these systems.

2.1 Agricultural practices with negative climate-compatibility

Land Degradation**:** Degradation may occur in the forms of soil fertility loss and soil erosion.[13] Loss of soil fertility happens "through the depletion of nutrients, the loss of soil organic matter, the build-up of salts or toxic chemicals, or changes in soil structure and consistency."[14] Soil erosion is effected by "[o]ver-grazing [which] can strip the land of vegetation and turn semi-arid areas into deserts; deforestation can rob the land of nutrients and protection from erosion; poor irrigation can lead to salinisation and acidification; inappropriate

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[8] P. Smith et al., *Agriculture*, *in* CLIMATE CHANGE 2007: MITIGATION, CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, ch. 8, at 499 (B. Metz et al. eds., 2007).
[9] FAO, *Climate-Smart Agriculture*, http://www.fao.org/climatechange/climatesmart/en/ (last visited 23 Oct. 2012).
[10] Formed as "a strategic partnership of the Consortium for International Agricultural Research Centers (CGIAR) and the Earth System Science Partnership (ESSP)." CCAFS, *Actions Needed to Halt Deforestation and Promote Climate-Smart Agriculture*, Policy Brief no. 4, June 2011, at 12, http://cgspace.cgiar.org/bitstream/handle/10568/10233/CCAFS_Brief04_web.pdf?sequence=6.
[11] CGIAR, Research Program on CCAFS, *Actions Needed to Halt Deforestation and Promote Climate-Smart Agriculture*, Policy Brief no. 4, June 2011, at 4, http://cgspace.cgiar.org/bitstream/handle/10568/10233/CCAFS_Brief04_web.pdf?sequence=6.
[12] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 1 (2010).
[13] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 16 (2011).
[14] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 16 (2011).

farming practices such as excessive tillage, over-use of agro-chemicals, or failure to restore nutrients can lead to a loss of soil fertility. The result can be a decline in yields or forced abandonment of the land."[15]

***Water Degradation and Shortage*:** Agriculture puts an enormous amount of pressure on the surrounding water resources due to the global necessity for irrigation.[16] River systems have been exploited to the point that pumping groundwater is now required, but that usage is similarly unsustainable as seen through rapidly falling water tables.[17] Shortage met by continuing growth in demand threatens riparian ecosystems, since "One-third of the world's population, mostly in developing countries, will live in basins where this deficit is larger than 50%."[18] Agriculture can also have a negative impact on natural watershed regulation "[t]hrough deforestation, clearing of vegetation, draining of wetlands and over-tilling," which increases the risk of droughts and floods.[19] Run-off of synthetic fertilizers contributes to water pollution as well, leading to eutrophication (dead zones, e.g. the Gulf of Mexico).[20]

***Pests and Disease*:** Agricultural practices can either help or harm agro-ecosystems' natural resilience to pests and diseases,[21] the distribution, incidence and intensity (including the presence of invasive and alien species) of which are being altered by climate change.[22] The homogenous planting of crops or growing of livestock and less genetic biodiversity is a problem. Selective breeding has contributed to production successes from developed high-yield varieties, but the more crops that have the same genetic makeup the faster a disease to

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[15] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 16 (2011). These practices not only cause emissions (deforestation and excessive tillage), but degrading the land to the point that yields decrease or the soil will not support production anymore leads to expansion onto other lands and resulting emissions. "The major degrading areas are in Africa, Southern China, North-Central Australia and the pampas of South America, home to about 1-1.5 billion people. There is no evidence that the rate of degradation is slowing. Indeed, with pressure on food supplies growing in some of the worst affected areas, it is likely that the problem will increase if current practices continue." The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 16-17 (2011) (citing Bai et al. (2008) *Global assessment of land degradation and improvement: 1: identification by remote sensing*. Rome, FAO/ISRIC; UNEP, 2008).

[16] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 17 (2011). "[O]nly 17% of the world's land is irrigated but this land produces around 40% of the world's food, as yields tend to be two or three times higher than on rainfed land." *Id.*

[17] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 17 (2011). South and West Asia and northern China are heavily pumping groundwater from aquifers for agriculture, and "In India, water tables are falling so much that well-drillers now have to use modified oil-drilling technology to find water, sometimes drilling a whole kilometre underground." *Id.*

[18] Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 17-18 (2011) (citing Water Resources Group. (2009) *Charting our water future: Economic Frameworks to inform decision-making.* London, Water Resources Group). "[T]he World Health Organization that water scarcity will affect over 1.8 billion people by 2025. Water scarcity is one of the greatest threats to food production in some of the most populous parts of the world. In many of these areas this threat will be further magnified by climate change." *Id.* at 18 (citing UNEP, 2008).

[19] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 17 (2011).

[20] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 17 (2011). "[A] study by the European Commission found that eutrophication accounted for almost 60% of all the environmental costs associated with the food supply chain in the European Union." *Id.*

[21] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 18 (2011). "The application of modern science to agriculture has brought huge advances in our ability to manage the threat of pests and diseases. However, despite these advances, 40% of the world's potential agricultural production is still lost to pests and disease, and agriculture remains vulnerable to outbreaks that threaten increasingly large proportions of global production." *Id.* (citing Pretty, J. (2006) *Agroecological approaches to agricultural development*).

[22] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 2 (2010).

which they are not resistant can wipe them out and causewidespread loss.[23] Confined Animal Feeding Operations (CAFOs), wherein thousands of animals are raised, also create the perfect atmosphere for diseases to spread quickly.[24]

Biodiversity and Ecosystem Dysfunction**:** Agriculture functions within an ecosystem—not natural since agriculture is man-made interference with nature, but an agro-ecosystem that is still reliant on wild species and biodiversity.[25] Agriculture's role in deforestation of the Amazon is showing major negative unintended consequences due to the interplay between less water evaporation by the forest and less rainfall for the related agricultural systems.[26] Pollinators are an essential part of agricultural production, but their decline over the past half century has been partly attributed to "the use of intensive modern agricultural techniques (monocultures and pesticides) along with disease and habitat fragmentation.[27] This monoculture cropping also inhibits the genetic variability and natural evolution that traditional varieties developed over the course of time under changing local conditions.[28] Aquaculture's effect on the marine ecosystem is incredibly reckless at this point as well, with fish stocks being exploited to their utmost capacity and sometimes over-exploited to near

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[23] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 18 (2011). *See, e.g.*, *id*. ("The reduction of wheat varieties is a particular cause of concern. A new variant of wheat rust (Ug99) has spread from Africa to the Middle East and now threatens crops in densely populated South Asia, including India and Pakistan.") (citing Singh et al. (2008) *Will stem rust destroy the world's wheat crop?*, ADVANCES IN AGRONOMY, 98, 271-309).

[24] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 18 (2011). Note the response to this is to provide sub-therapeutic levels of antibiotics in animal feed, which "can also increase the selection pressure for antibiotic resistant pathogenic bacteria." *Id.* (citing WHO . (2004) *Report of the WHO/FAO/OIE joint consultation on emerging zoonotic diseases*. Geneva, WHO). This can also occur in aquaculture with the huge rise in fish farms. *See, e.g.*, *id.* at 19 ("[T]he Chilean salmon farming industry, which had grown to become the world's second largest supplier, collapsed in 2007-08 due to the oubreak of the Infectious Salmon Anemia (ISA) virus. Globally, cultivated shrimp production has levelled off since the early 1990s because of viral outbreaks.") (citing UPI. (2010) *Disease decimates salmon farms in Chile*. Online from http://www.upi.com/Science_News/2010/08/17; Coelen, R. J. (1997) Viral diseases in aquaculture. *World Journal of Microbiology and Biotechnology*, at 1).

[25] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 19 (2011).

[26] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 19 (2011). "One example is the interaction between the Amazon rainforest and food production in South America. The Amazon forest evaporates some eight trillion tonnes of water into the atmosphere each year. A large proportion of this is deflected south by the Andes, producing the rain that underpins a multi-billion agricultural complex in Brazil, Argentina and Uruguay. Some scientists believe that widespread clearing of the rainforest could produce a tipping point and lead to a dramatic die-off of the forest, changing rainfall patterns and causing more droughts thousands of miles away. 2005 brought a glimpse of what might happen if the rainforest disappeared:
drought in the Amazon led to crop failures in southern Brazil and the Pampas region of Argentina." *Id.* (citing Werth, D. & Avisar, R. (2005) The local and global effects of African deforestation. Geophysical Research Letters, 32; Global Canopy Program (2007). *Forests first in the fight against climate change*).

[27] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 19 (2011). "About 40-50% of food comes from crops that rely on wild pollinators or domestic honey bees. But over the latter half of the twentieth century populations of many pollinators have declined. For example,
feral honey bee populations in many parts of the US have dropped by 90% in the past 50 years. Managed honey bee colonies have dropped by about two-thirds, in what has become known as Colony Collapse Disorder. Although the exact cause of decline is unknown, it is thought to stem from habitat fragmentation, the use of intensive modern agricultural techniques (monocultures and pesticides) and other factors including disease. One study estimates that the complete loss of such pollinators would reduce global food production by 3-8%." *Id.* (citing Aizen et al. (2009) *How much does agriculture depend on pollinators? Lessons from long-term trends in crop production*. ANNALS OF BOTANY, 103, 1579-1588).

[28] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 19 (2011).

collapse.[29] Alarmingly obvious from this example is the fact that there is poor understanding of the "tipping points" of agriculture's interactions with the natural ecosystems—the point "at which ecosystem services break down and begin to impact on food production."[30]

Post-Harvest Losses from Inefficient Systems: Growing the crops is the first step in the equation—getting them to people's plates takes much more coordination, which if done poorly can waste a large amount of potential food. Lack of storage facilities, transport equipment, infrastructure allowing for efficient transport, and processing facilities to utilize perishable food before loss all contribute to post-harvest losses, food insecurity, risks to health and nutrition, and lost income.[31]

2.2 Climate-smart changes to agricultural production systems

Climate-smart agriculture practices maintain or increase yields in the face of climate change whilst decreasing their climate and environmental impacts. Generally, these practices can be applied within production systems to enhance their "overall efficiency, resilience, adaptive capacity and mitigation potential."[32] In response to the categories of problems outlined above, there are specific practices that can help prevent or reverse the negative effects.

***Soil and Nutrient Management*:** Land degradation results from soil nutrient depletion, so making nitrogen and other nutrients available in the soil builds healthy soil and increases yields.[33] "This can be done through composting manure and crop residues, more precise matching of nutrients with plant needs, controlled release and deep placement technologies or using legumes for natural nitrogen fixation."[34] This will reduce the need for synthetic fertilizer inputs,[35] which results in positive spillover effects in farmer income through lower costs of production and better water quality from reduced runoff. Reducing tillage, sustainably managing livestock grazing, incorporating agroforestry, and planting cover crops all focus on improved soil nutrient content, as well as reducing soil erosion and increasing above and below-ground stored carbon in the soil and biomass.[36]

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[29] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 19 (2011).
[30] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 20 (2011).
[31] FAO, *Climate-Smart Agriculture: Food Production System Elements*, no. 6, http://www.fao.org/climatechange/climatesmartpub/66303/en/ (last updated 5 Oct. 2011).
[32] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 1 (2010).
[33] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 1 (2010).
[34] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 1 (2010). *See also* Philip Thornton, CGIAR, *Recalibrating Food Production in the Developing World: Global Warming Will Change More than Just the Climate*, Policy Brief no. 6, at 6 (Oct. 2012), http://cgspace.cgiar.org/bitstream/handle/10568/24696/CCAFS_PB06-Recalibrating%20Food%20Production.pdf?sequence=1 (discussing the many different types of legumes that could be used to intercrop and their respective resistance to climate change and protein values).
[35] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 1 (2010).
[36] CGIAR, Research Program on CCFAS, *Actions Needed to Halt Deforestation and Promote Climate-Smart Agriculture*, Policy Brief no. 4, June 2011, at 5, 9, http://cgspace.cgiar.org/bitstream/handle/10568/10233/CCAFS_Brief04_web.pdf?sequence=6; Eva Wollenberg et al., CGIAR, *Helping Smallholder Farmers Mitigate Climate Change*, Policy Brief no. 5, August 2012, at 3. Utilizing technical capacity to increase "production limits of crops through more efficient plant physiology" is offered as an

Water Harvesting and Use**:** Practices that improve water harvesting and retention are necessary, such as building "pools, dams, pits, retaining ridges, etc."[37] Water efficiency is imperative as well through improved irrigation systems (this has positive spillover effects for soil quality as well since poor irrigation can cause salinisation and acidification[38]), which increases production and helps mitigate the effects of more irregular rainfall from climate change.[39] Agroforestry, reduced tillage, restoring wetlands, and restoring degraded lands with vegetation will allow for improved natural watershed regulation and ultimately benefit agro-ecosystems' functionality.

Pest and Disease Control**:** Incorporating genetic diversity into cropping systems will help resist total loss from new pathogens to which there are not well-adapted, resistant varieties. This is an additional reason agriculture should mitigate its contribution to climate change—pathogen adaptation to climate change means that new aggressive strains of crop disease may spread to places that "previously [were] not favourable".[40] As discussed above, CAFOs are garnering increasing criticism in developed countries from animal health and welfare advocates, local residents who cannot stand the smell, environmentalists worried about the manure management issues, as well as consumer pushback from awareness campaigns.[41] Incorporating livestock into smallholders' operations, however, allows for diversification and utilizing manure as a substitute for external inputs, which are climate-smart practices applicable to any context.

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adaptation suggestion; but technical capacity could potentially serve a mitigation role as well if plants' carbon-sequestration abilities were improved. CGIAR, Research Program on Climate Change, Agriculture and Food Security, *Actions Needed to Halt Deforestation and Promote Climate-Smart Agriculture*, Policy Brief no. 4, June 2011, at 4-5, http://cgspace.cgiar.org/bitstream/handle/10568/10233/CCAFS_Brief04_web.pdf?sequence=6.

[37] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 1 (2010). Presumably these techniques are all presented from a small-scale perspective since building large-scale commercial dams is quite controversial from an environmental perspective. The example presented in the literature is from the Yatenga province in Burkina Faso, where "farmers reclaimed degraded farmland by digging planting pits, known as zaï. This traditional technique was improved by increasing the depth and diameter of the pits and adding organic matter. [These pits] concentrate both nutrients and water and facilitate water infiltration and retention. Thus, lands which used to be barely productive can now achieve yields from 300kg/ha to 1500kg/ha, depending on rainfalls. In the same province, famers, with support from Oxfam, began building stone contour bunds to harvest rainwater. The bunds allows water to spread evenly through the field and infiltrates the soil and also prevents soil and organic matter being washed away. Thanks to local networks of farmers these techniques are now used on 200,000 to 300,000 ha." *Id.* at 2 (citing Reij, 2009).

[38] The Prince's Charities, Int'l Sustainability Unit, *What Price Resilience? Towards Sustainable and Secure Food Systems*, at 16 (2011).

[39] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 1 (2010). Efficient management technologies and methods exist (e.g. drip irrigation systems in Kenya) and must be widely disseminated and implemented in smallholder appropriate practices. *Id.*; *see also* One Acre Fund: Farmers First, *Drip Irrigation: Growing Vegetables in the Dry Season*, 26 Feb. 2010, http://www.oneacrefund.org/blog/?p=120.

[40] *See, e.g.*, Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 2 (2010) (explaining the emergence of "multi-virulent, aggressive strains of wheat yellow rust adapted to high temperatures"). Another example is the wheat disease Spot Blotch "causing heavy losses in Southern Brazil, Bolivia, Paraguay, and Eastern India, due to a lack of resistance to the disease. As wheat growing areas of Asia become warmer, the pathogen is likely to spread even further and cause further losses." *Id.* This is a MAJOR concern for global food security as wheat is a staple crop in many countries.

[41] *See Factory Farms: Are They the Best Way to Feed the Nation?*, 17 CQ RESEARCHER 25-48, 12 Jan. 2007, http://prairierivers.org/wp-content/uploads/2009/12/factory-farms.pdf. *But see* Rachel Dennis, *CAFOs and Public Health: Risks Associated with Welfare Friendly Farming*, Purdue Extension, ID-359-W (2007), https://www.extension.purdue.edu/extmedia/ID/cafo/ID-359-W.pdf (arguing the risks involved with taking away subtherapeutic antibiotic feed for large-scale poultry production and other "risks" from the production practice promoted by animal welfare advocates – though this ignores the question of whether this form of production in CAFOs is appropriate in the first place).

Resilient Ecosystems**:** Intercropping and other non-monocropping practices are positive for biodiversity and the health of the ecosystem. The ecosystem services this can provide may "lead to more resilient, productive and sustainable systems that may also contribute to reducing or removing greenhouse gases."[42] These "[s]ervices include control of pests and disease, regulation of microclimate, decomposition of wastes, regulating nutrient cycles and crop pollination."[43] Also, since "[g]enetic make-up determines a plants and animals tolerance to shocks such as temperature extremes, drought, flooding and pests and diseases[,] . . . regulates the length of growing season/production cycle and the response to inputs such as fertilizer, water and feed," preserving and developing tailored varieties to ecosystems and farmers' adaptation needs, as well as allowing for natural evolutionary adaptation, will aid agriculture's resilience within the agro-ecosystems.[44]

Harvesting, Processing, and Supply Chains: Post-harvest losses can be significantly avoided by ensuring sufficient storage facilities, processing, packaging, transportation to allow for market access, and infrastructure to accomplish transportation, storage and processing.[45] Processing also allows for value-added income and the ability to stagger sale of products rather than forced sale of perishable products even though price may be low due to over-supply and low demand.[46] Better storage ability offers increased food security and income stability as well.[47]

For production system-specific analyses of the risks, changes, and benefits that are possible from general climate-smart agriculture practices, please refer to the more extensive discussion in Annex I.

2.3 Kenyan-specific climate-smart agriculture practices

2.3.1 Kenyan landscape

The country is home to four different types of agroecological zones—arid, semi-arid, temperate, and humid.[48] "Kenya has climate and ecological extremes, with altitude varying from sea level to over 5000 m in the highlands."[49] With huge variations in rainfall over the "total area of 580,367 km^2, . . . only 12% is considered high potential for farming or intensive livestock production."[50] Another 5.5% is classified as medium potential, mainly supporting livestock (e.g., sheep and goats).[51] The remaining 82% "is classified as arid and

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[42] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 2 (2010).
[43] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 2 (2010).
[44] Leslie Lipper et al., FAO, *"Climate-Smart" Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, at 2 (2010).
[45] FAO, *Climate-Smart Agriculture: Food Production System Elements*, no. 6, http://www.fao.org/climatechange/climatesmartpub/66303/en/ (last updated 5 Oct. 2011).
[46] *Id.*
[47] *Id.*
[48] Elizabeth Bryan et al., Int'l Food Policy Res. Inst. (IFPRI), *Agricultural Land Management: Capturing Synergies Among Climate Change Adaptation, Greenhouse Gas Mitigation, and Agricultural Productivity*, Note, Kenya Smallholder Climate Change Adaptation, at 1 (April 2011), http://mahider.ilri.org/bitstream/handle/10568/3856/Kenya_Project_Note_4.pdf?sequence=1.
[49] Jane Kabubo-Mariara & Fredrick K. Karanja, *The Economic Impact of Climate Change on Kenyan Crop Agriculture: A Ricardian Approach*, 57 Global & Planetary Change 319, 319-20 (2007).
[50] *Id.* at 320.
[51] *Id.*

semi-arid and is largely used for extensive livestock production."[52] These differences in soil, climate and hydrological factors mean that the high and medium potential zones boast the highest agricultural productivity and incomes whereas the arid and semi-arid areas obtain the lowest.[53]

2.3.2 Agriculture in Kenya

Agriculture is a key component of Kenya's economy. It directly comprises 26% of the GDP and indirectly another 25%.[54] More than 70% of informal employment in rural areas is in the agricultural sector,[55] and "women are responsible for 80 percent of paid and unpaid labor in food production, including staple crops."[56] Six sub-sectors make up agriculture in Kenya—"industrial crops, food crops, horticulture, livestock, fisheries and forestry."[57] Following many years of decline in the sector, mainly related to low investment, mismanagement, collapse of the agricultural institutions, and importantly, neglect of agricultural extension and research, agriculture was given new priority in 2004 with the creation of the *Strategy for Revitalizing Agriculture* by the Government.[58] "The strategy set out the vision of the Government as: To transform Kenya's agriculture into a profitable, commercially-oriented and internationally and regionally competitive economic activity that provides high-quality, gainful employment to Kenyans."[59] Its framework focuses on "improv[ing] agricultural productivity and farm incomes, while conserving the land resource base and the environment."[60] In short, the goal was to "shift from subsistence agriculture to agriculture as a business that is profitable and commercially oriented."[61]

2.3.3 Predicted impacts of climate change on Kenyan agriculture

The IPCC 4th Assessment Report predicts that "Africa will be the region most affected by climate change, due to both the changes in mean temperatures and rainfall, as well as increased variability associated with both."[62]

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[52] *Id.* This low-productive land offers "habitat for wildlife both in and outside national parks and game reserves" as well. *Id.*
[53] *Id.*
[54] Republic of Kenya, *Agricultural Sector Development Strategy 2010-2020*, at 1 (2010), http://www.kilimo.go.ke/kilimo_docs/pdf/ASDS_Final.pdf.
[55] *Id.*
[56] USAID, Kenya: FY 2011-2015 Multi-Year Strategy, U.S. Govt., at 8 (2011), http://kenya.usaid.gov/sites/default/files/KenyaFTFMulti-YearStrategy.pdf. "Although all parts of Kenya are facing significant challenges, poverty density, food production, and density of malnourished children vary significantly across Kenya's agro-ecological zones and within the urban areas. The high rainfall zones – 11 percent of Kenya's land – produce 70 percent of its agricultural output. These high potential zones have attracted large populations, resulting in sub-division of land, decreasing productivity, and high densities of impoverished and malnourished Kenyans. Semiarid regions produce 20 percent of Kenya's agricultural output. Traditionally these areas received less rainfall than high potential areas. Climate change is already evident in the increasingly erratic rainfall patterns. Yet this region offers significant potential for increases in agricultural output, if water management and harvesting, irrigation, and crop varieties can be improved. Lastly, Kenya's arid regions take up 68 percent of the land area, and produce 10 percent of Kenya's agricultural output, largely livestock. Although poverty and malnutrition rates are high in the arid regions, the population density is low, meaning that the total number of poor and malnourished Kenyans is relatively low in absolute terms when compared to high rainfall and semi-arid regions." *Id.*
[57] Republic of Kenya, *Agricultural Sector Development Strategy 2010-2020*, at 1 (2010), http://www.kilimo.go.ke/kilimo_docs/pdf/ASDS_Final.pdf.
[58] *Id.* at 3.
[59] *Id.*
[60] *Id.*
[61] *Id.*
[62] Giacomo Branca et al., *Identifying Opportunities for Climate-Smart Agriculture Investments in Africa*, FAO, at 7 (2012), http://www.fao.org/docrep/015/an112e/an112e00.pdf (citing the IPCC 4th Assessment Report 2007).

The continent has seen an increase of half a degree Celsius already this last century, and by 2080 average annual temperatures are expected to rise by about 3-4 degrees.[63] This warming and precipitation changes "will stress agricultural and natural systems through: increased water shortages, shorter growing periods in some areas, increased magnitude and frequency of flooding and drought, changes in plant and animal diseases and pest distribution patterns and, more generally, reduced suitability of some areas for agriculture."[64] A scary prediction is that decreases of 15-35% in agricultural productivity could be witnessed in the parts of Sub-Saharan Africa hit hardest, which are highly vulnerable areas already.[65]

2.3.4 Possible country-appropriate climate-smart agriculture practices

Kenya's adoption of climate-smart agriculture practices perfectly demonstrates the fact that these need to be context- and location-specific.[66] Highly diverse in soil and climate conditions, the goal is to find the triple win combination appropriate for operation in each region. Despite lack of full understanding about the link between sustainable management practices and climate change mitigation, "Farmers have [] begun to shift agricultural management strategies due to perceived climate change."[67] Common adaptations include changing crop variety, changing planting dates, changing crop type, planting trees, decreasing the number of livestock, diversifying, changing, or supplementing livestock, changing fertilizer application, and using soil and water conservation (SWC).[68]

Some key findings from Kenyan-specific studies:

- Nutrient management is a key strategy.[69] However, it needs to be a combination of inorganic fertilizer, mulching and manure, not simply inorganic fertilizer by itself.[70] This appears beneficial for soil carbon sequestration potential and yields in every region.[71]

- Crop residues should be left on the field.[72] This has high potential to increase yields, net profits, soil carbon sequestration, and reduce labor costs (weeding and removing residue).[73] Combining with the

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[63] *Id.*
[64] *Id.*
[65] *Id.* (citing Stern 2006; Cline 2007; Fisher et al. 2005; IPCC 2007).
[66] Elizabeth Bryan et al., Int'l Food Policy Res. Inst. (IFPRI), *Agricultural Land Management: Capturing Synergies Among Climate Change Adaptation, Greenhouse Gas Mitigation, and Agricultural Productivity*, Note, Kenya Smallholder Climate Change Adaptation, at 1 (April 2011), http://mahider.ilri.org/bitstream/handle/10568/3856/Kenya_Project_Note_4.pdf?sequence=1. For an excellent table outlining the various practices and the extent of their mitigation and adaptation potential, please see the presentation by Claudia Ringler et al., IFPRI, *Triple Wins for Kenyan Agriculture—Capturing Synergies Between Agricultural Productivity, Climate Change Adaptation & GHG Mitigation*, World Bank, slide 6, 4 May 2011, http://cgspace.cgiar.org/bitstream/handle/10568/3875/Ringler_WBppt_mitigation.pdf?sequence=1.
[67] *Id.* "Though famers clearly perceive a link between deforestation and climate change, their survey responses reveal that farmers in rural Kenya know very little about the link between sustainable management practices and climate change mitigation." *Id.* at 2.
[68] *Id.* at 1.
[69] *Id.* at 2.
[70] *Id.*
[71] *Id.*; *see, e.g.*, Seth Shames et al., *Institutional Innovations in African Smallholder Carbon Projects—Case Study: Western Kenya Smallholder Agriculture Carbon Finance Project: Vi Agroforestry*, CGIAR Research Program on CCAFS, at 3 (June 2012). The Vi-Agroforestry project in western Kenya is an example of application of these nutrient management practices (composting of manure, compost application on fields, leaving crop residues on fields, minimum tillage, and livestock enclosures) to meet the sustainable agricultural land management (SALM) practices under the VCS standards. *Id.*

above fertilizer-manure practice increases benefits.[74] This may differ for rangeland-based systems where the farmer needs to remove the residue or allow grazing for animal feed.[75] Leaving a percentage in the field and purchasing feed replacement has proven profitable but "depends on the chosen combination of management practices, as well as the agro-climatic and soil conditions."[76]

- Conservation tillage would decrease soil disturbance leading to soil erosion and decreased soil carbon stocks.[77]

- Changing crop varieties, e.g., hybrid maize, does not appear to generally improve soil carbon sequestration (the mitigation part of a climate-smart practice) even if it helps with adaptation and higher productivity.[78] Specifically calibrating them to local conditions could potentially improve the mitigation potential though.[79]

- Crop rotations with beans is widely done but offers "only limited benefits compared to more explicit nitrogen input measures, such as the application of inorganic fertilizer or manure or both."[80] It helps with recharging soil fertility, but their low biomass does not contribute much to soil carbon stocks.[81]

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[72] *See, e.g.*, Seth Shames et al., *Institutional Innovations in African Smallholder Carbon Projects—Case Study: Western Kenya Smallholder Agriculture Carbon Finance Project: Vi Agroforestry*, CGIAR Research Program on CCAFS, at 3 (June 2012). "[L]eaving crop residues on fields" is one of the many sustainable agricultural land management (SALM) practices being implemented in this project area. This intervention, which "must be measurable within the 'Adoption of sustainable agricultural land management (SALM) by landholders and farmers' methodology under the Voluntary Carbon Standard (VCS)" and is primarily used in maize-based systems, is included in the category of "practices that sequester carbon in above and below-ground biomass by *increasing soil organic matter*." *Id.* (emphasis added). The other "practices that sequester carbon in above and below-ground biomass" that are implemented in the project are "woody perennials (tree intercropping and planting of woodlots), and nitrogen fixing plants." Credits are also available for avoided GHG emissions from biomass burning and NO2 emissions from inorganic fertilizers. *Id.*

[73] Elizabeth Bryan et al., Int'l Food Policy Res. Inst. (IFPRI), *Agricultural Land Management: Capturing Synergies Among Climate Change Adaptation, Greenhouse Gas Mitigation, and Agricultural Productivity*, Note, Kenya Smallholder Climate Change Adaptation, at 2 (April 2011), http://mahider.ilri.org/bitstream/handle/10568/3856/Kenya_Project_Note_4.pdf?sequence=1.

[74] *Id.*

[75] *Id.* "Producing enough biomass to cater for both adequate soil cover and livestock demands is a challenge. Replacing a food legume used traditionally in intercropping (such as beans) by a cover crop (such as canavalia or mucuna) might not be attractive to a farmer whose primary objective is achieving food security. This may explain the success that *Dolichos lablab* is having with Kenyan and Tanzanian farmers, as it is a multiple-purpose cover crop, able to provide food (both grain and leaves are edible), income, forage and soil cover." African Conservation Tillage Network et al., Conservation Agriculture as Practiced in Kenya: Two Case Studies, at xvi (Pascal Kaumbutho & Josef Kienzle eds., 2007), *available at* http://www.fao.org/ag/ca/doc/Kenya_casestudy.pdf.

[76] Elizabeth Bryan et al., Int'l Food Policy Res. Inst. (IFPRI), *Agricultural Land Management: Capturing Synergies Among Climate Change Adaptation, Greenhouse Gas Mitigation, and Agricultural Productivity*, Note, Kenya Smallholder Climate Change Adaptation, at 2 (April 2011), http://mahider.ilri.org/bitstream/handle/10568/3856/Kenya_Project_Note_4.pdf?sequence=1.

[77] *See* African Conservation Tillage Network et al., Conservation Agriculture as Practiced in Kenya: Two Case Studies, at xiv, xvi (Pascal Kaumbutho & Josef Kienzle eds., 2007), *available at* http://www.fao.org/ag/ca/doc/Kenya_casestudy.pdf. These case studies found that difficulties exist for farmers when trying unconventional tillage, like reduced tillage, ripping, or no-till. Many who switched went to the intermediate step of reduced tillage instead of straight to no-till due to lack of access to no-till seeders.

[78] Elizabeth Bryan et al., Int'l Food Policy Res. Inst. (IFPRI), *Agricultural Land Management: Capturing Synergies Among Climate Change Adaptation, Greenhouse Gas Mitigation, and Agricultural Productivity*, Note, Kenya Smallholder Climate Change Adaptation, at 2 (April 2011), http://mahider.ilri.org/bitstream/handle/10568/3856/Kenya_Project_Note_4.pdf?sequence=1.

[79] *Id.*

[80] *Id.* at 3.

- Agroforestry and afforestation of marginal agricultural lands.[82]

- Water management practices depend on agroegological zone. Arid sites need irrigation and SWC to maximize soil carbon and profits, but humid sites obviously have enough water but lack soil nitrogen.[83] So irrigating or SWC there has lowered average yields and profits, "possibly due to increased nitrogen leaching from the soil."[84] Semi-arid sites see increases in yields and profits from irrigation and SWC, but soil carbon sequestration is maximized by integrating soil nutrient management as well.[85] Temperate sites see improved yields from SWC and irrigation, "but not as significant[] as [from] nutrient inputs; and soil carbon sequestration is highest with soil nutrient management."[86]

- Improved livestock feeding practices help farmers adapt to and mitigate climate change by increasing milk production, lowering the methane emissions per liter of milk, and thereby increasing net profits.[87] Additionally, crop residues can remain on the fields, increasing productivity and income in that facet of the business as well.[88]

2.3.5 Examples of climate-smart agriculture projects in Kenya

- Pilot Project: Enhancing agricultural mitigation within the East Africa Dairy Development (EADD) Project in Kenya—implemented by Heifer International in partnership with the International

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[81] *Id.* This is seen in the separation by the Vi-Agroforestry project of SALM practices contributing to VCS standard credits as opposed to other SLM interventions. "In addition to climate-friendly practices, Vi also works with farmers on SLM interventions including water harvesting structures, crop rotations, integrated pest and disease management, and the provision of certified seeds." Seth Shames et al., *Institutional Innovations in African Smallholder Carbon Projects—Case Study: Western Kenya Smallholder Agriculture Carbon Finance Project: Vi Agroforestry*, CGIAR Research Program on CCAFS, at 3 (June 2012). So good management practices that might increase yields and help with adaptation may not technically be classified (yet) as climate-smart agriculture practices since they do not have mitigation potential. This type of separation seems overly critical from a good practice standpoint since they all are beneficial, but if private investors are going to be convinced to fund projects, there has to be some type of return generated (other than CSR or supply chain insetting). That's where the mitigation potential comes in and why it's a necessary part of the climate-smart practices that will be able to participate in carbon markets.

[82] Esther Magambo, *Developing NAMAs in Kenya: The case of the KCCAP; the agricultural example*, Climate Change Unit, Ministry of Agriculture, slide 7 (July 2012), http://foris.fao.org/meetings/download/_2012/workshop_on_namas_national_mitigation_planning_and/presentations/magambo_developing_nama_kenya_agriculture.pdf.

[83] Elizabeth Bryan et al., Int'l Food Policy Res. Inst. (IFPRI), *Agricultural Land Management: Capturing Synergies Among Climate Change Adaptation, Greenhouse Gas Mitigation, and Agricultural Productivity*, Note, Kenya Smallholder Climate Change Adaptation, at 2 (April 2011), http://mahider.ilri.org/bitstream/handle/10568/3856/Kenya_Project_Note_4.pdf?sequence=1.

[84] *Id.*

[85] *Id.*

[86] *Id.*

[87] There is a detailed breakdown of seven tested regions and what each fed their dairy cattle as an alternative in Table 2 of Elizabeth Bryan et al., Int'l Food Policy Res. Inst. (IFPRI), *Agricultural Land Management: Capturing Synergies Among Climate Change Adaptation, Greenhouse Gas Mitigation, and Agricultural Productivity*, Note, Kenya Smallholder Climate Change Adaptation, at 3 (April 2011), http://mahider.ilri.org/bitstream/handle/10568/3856/Kenya_Project_Note_4.pdf?sequence=1. "[T]he greatest potential improvements [were] evident in the arid pastoralist zone" but that is where "farmers graze livestock and do not generally purchase feed." Thus, purchasing improved feed would lower their net profits per liter of milk, so additional incentives would be required for adoption of this improved practice. *Id.*

[88] *Id.*

Livestock Research Institute, TechnoServe, the World Agroforestry Centre, and the African Breeders Service Total Cattle Management, and funded by the Bill & Melinda Gates Foundation.[89]

- Kenya Agriculture Carbon Project—implemented by the Swedish Cooperative Center's NGO ViAgroforestry, with the BioCarbon Fund, a public-private initiative administered by the World Bank, as the funder and set to purchase the carbon credits it generates.[90] Of note, this was the first Emissions Reduction Purchase Agreement signed for an African soil carbon project.[91]

- Western Kenya Smallholder Agriculture Carbon Finance Project—implemented by ViAgroforestry and funded by the Vi Planterar trad foundation, the Swedish international development agency (Sida), and the World Bank Biocarbon Fund.[92]

- Kenya participates in the Strategic Renewable Energy Program (SREP)—supported under the Climate Investment Funds (CIF).[93]

Please note that the World Bank Biocarbon Fund projects have received criticism for touting climate-smart agriculture as the way forward for developing countries but have so far failed to produce project descriptions and evidence of accomplished objectives. Instead, "scaling-up" continues to be promoted.[94]

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[89] Int'l Livestock Research Inst., *East Africa Dairy Development (EADD) Project*, http://www.ilri.org/EADD (last accessed 8 Nov. 2012); Luise Zagst, *Socio-Economic Survey EADD-MICCA Pilot Project in Kenya*, Final Report, FAO (April 2012), http://www.fao.org/climatechange/32989-03e9a6693df0c024fe193dd15e7d6b710.pdf. This project aims to increase milk productivity, farmer income through cooperative organization and value-added processing, and UNDP has shown an interest with the Africa Facility for Inclusive Markets (AFIM) to partner with the program and provide a one-year grant to increase agricultural extension/advisory service programs. EADD Blog, *UNDP-Africa Facility for Inclusive Markets to partner with EADD*, 5 Sept. 2012, http://eadairy.wordpress.com/.

[90] The World Bank, *Climate-Smart Agriculture: A Call to Action*, at 7, http://climatechange.worldbank.org/sites/default/files/documents/CSA_Brochure_web.pdf. ViAgroforestry is "an NGO well-known in the Lake Victoria Basin for participatory approaches leading to increased farm productivity and sustainable management of natural resources." *Id.* "The project seeks to provide technical support to about 60,000 farmers aggregated in farmer groups, managing a total of 45,000 hectares in the Nyanza and Western provinces in Kenya." *Id.* The practices promoted for mitigation "include reduced tillage, cover crops, residue management, mulching, composting, green manure, targeted application of fertilizers, reduced biomass burning and agroforestry." *Id.*

[91] The World Bank, Carbon Finance Unit, *Kenya: Agricultural Carbon Project*, http://wbcarbonfinance.org/Router.cfm?Page=BioCF&FID=9708&ItemID=9708&ft=Projects&ProjID=58099.

[92] Seth Shames et al., *Institutional Innovations in African Smallholder Carbon Projects—Case Study: Western Kenya Smallholder Agriculture Carbon Finance Project: Vi Agroforestry*, CGIAR Research Program on CCAFS, at 3 (June 2012). Again, the BioCarbon Fund is going to purchase the generated carbon credits. *Id.* The Project is targeting the Kisumu and Kitale regions for "climate-friendly SALM practices on approximately 45,000 ha, 22,500 ha in each of these two project regions" and wants to see 64,800 households participating. *Id.*

[93] The World Bank, *Climate-Smart Agriculture: Increased Productivity and Food Security, Enhanced Resilience and Reduced Carbon Emissions for Sustainable Development—Opportunities and Challenges for a Converging Agenda: Country Examples*, at 19-20 (Oct. 2011), http://climatechange.worldbank.org/sites/default/files/documents/CSA_Paper_SouthAfrica.pdf. "[B]iomass accounts for 70% of final energy demand and 90% of rural household energy" in Kenya. *Id.*

[94] *See* Shefali Sharma, *An Update on the World Bank's Experimentation with Soil Carbon: Promise of Kenya Agricultural Carbon Projects Remains Elusive*, Inst. for Agric. & Trade Policy (4 Oct. 2012), http://www.iatp.org/documents/an-update-on-the-world-bank%E2%80%99s-experimentation-with-soil-carbon. "The concept note for the World Bank BioCarbon Fund's third tranche outlines a plan to develop a trading scheme centered on full landscape accounting (which would broaden this approach to include agriculture and forestry) and expand the types of agriculture credits that can be included in carbon trading. It is no coincidence then, that the [second Global Conference on Food Security, Agriculture and Climate Change] agenda featured these issues prominently. The Bank, in its conflicting roles as carbon broker and policy advisor for "climate smart" agriculture, has a financial interest in getting

Source: **FAO, *World Agriculture towards 2015/2030 (Summary Report)***
Download at ftp://ftp.fao.org/docrep/fao/004/y3557e/y3557e.pdf

Technology and policy choices

Many of the measures needed to reduce or adapt to climate change are valuable in coping with existing problems such as water and air pollution, soil erosion, and vulnerability to droughts or floods.

Measures to reduce greenhouse gas emissions:

- Removal of subsidies and introduction of environmental taxes on chemical fertilizers and energy inputs
- Improvement of fertilizer use efficiency
- Development of rice varieties emitting less methane
- Improved management of livestock waste
- Restoration of degraded lands
- Improvement of crop residue management
- Expansion of agroforestry and reforestation

Measures to promote adaptation to climate change:

- Development and distribution of crop varieties and livestock breeds resistant to drought, storms and floods, higher temperatures and saline conditions
- Improvement of water use efficiency through:

  - No-till/conservation agriculture in rainfed areas
  - Appropriate water pricing, management and technology in irrigated areas

- Promotion of agroforestry to increase ecosystem resilience and maintain biodiversity
- Maintenance of livestock mobility in pastoral areas subject to drought

Measures to reduce food insecurity:

- Reduction of rural and urban poverty
- Improvement of transport and communications in areas vulnerable to disasters
- Development of early-warning and storm-forecasting systems
- Preparedness plans for relief and rehabilitation
- Introduction of flood- and storm-resistant and salt-tolerant crops
- Introduction of land use systems to stabilize slopes and reduce the risk of soil erosion and mudslides
- Building of homes, livestock shelters and food stores above likely flood levels.

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support for the BioCarbon Fund's third tranche. The extent to which these carbon-market approaches are "climate-smart," contribute to real agriculture development, and meet urgent adaptation needs of food producers and farming systems in the Global South, merit carefully scrutiny and a rigorous public debate." *Id.*

RECOMMENDATIONS ABOUT POLICY DESIGN & IMPLEMENTATION

 **What's the policy goal?**	
Build on existing policy, or create a new one?	
Political aspects - Micro - National - international	
Financing strategy - public - private - local or FDI	
Legal aspects - is the policy legal? - Does the current law govern this policy or are new regulations needed?	
Institutional support/coordination - Are different Ministries involved?	
Ecological aspects	
Risks/unintended consequences? - **Safeguards necessary?** - **Monitoring strategy?**	
What else do we need to know? - any assumptions to check? - expert advice?	
Next steps?	