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From Theory to Practice: Perspectives on Climate-Smart Agriculture in India and Africa

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ABSTRACT As global food production faces the negative consequences of climate change, best practices in climate-smart agriculture (CSA) must be promoted to achieve food security. This requires adequate financial and human resources to be channeled to the upscaling of CSA activities in high-impact, priority areas. Considering India and Africa's complementary sectoral priorities and their similar roles in evolving global food markets, various opportunities exist for their collaboration in the agricultural sector. The two regions can share expertise in areas of technology transfer, information and knowledge management, and CSA financing. This brief identifies best practices across the entire agri-food system, starting from production level aspects to developing output markets. It should assist policymakers, development practitioners and researchers to flag out other opportunities for further consideration in nurturing CSA.

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INTRODUCTION

The impact of climate change on agricultural food systems the world over cannot be overemphasised enough. A strong scientific consensus has already been reached regarding the projected long-term impacts of climate change globally, regionally and locally. (FAO, 2018) It is expected that climate risks related to extreme weather events – such as droughts and floods, and changes in local weather patterns – will affect ecosystems and, by extension, communities. Therefore, communities and ecosystems will need to adapt to the emerging conditions and build their resilience.

Indeed, the world's population is expected to reach 9.1 billion by 2050, or 34 percent higher than today. A massive proportion of this increase will occur in developing countries. Therefore, food production must increase by at least 60 percent to meet the global food requirement (FAO, 2009). In India and Africa, two of the world's flashpoints of climate change, food production must increase while keeping in mind the goals of minimising negative impacts on the environment. "Climate-smart agriculture" presents an opportunity to meet the challenge.

Climate-smart agriculture (CSA) is the name given to an approach to agricultural systems that supports development while ensuring food security in the context of a changing climate. CSA aims to tackle three main objectives: increasing agricultural productivity and incomes in a sustainable manner; building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible (FAO, 2013). Since the introduction of the concept in 2010 by the Food and Agriculture Organization (FAO), a number of technologies have been developed and applied in Africa and India. These innovations were done at the community level by farmers on sustainable soil and land management practices, water management practices, and crop and livestock production systems. These practices are trusted by farmers, research organisations and development practitioners and certified as "best practices" based on reliable scientific and experiential evidence. For these best practices to be upscaled and replicated in other areas with similar agro-ecology and institutional arrangements, they require conducive policies, institutions and financing. It is when they are upscaled that they can have a substantial impact on global food security.

In this brief, the terms "upscaling" and "outscaling" are used to describe activities and processes required in the diffusion of technologies, dissemination of knowledge, technology transfer, and mainstreaming or uptake of best practices in climate-smart agriculture. The aim of upscaling is to bring more quality benefits to more people over a wider geographical area, more quickly, more equitably, and for a longer period of time (IIRR, 2000, in Franzel et al., 2001). Therefore, "scale" refers to the benefits from intervention not only in terms of the number of people and the geographical area, but also in terms of time and equity scales (Pachico and Fujisaka, 2004).

Africa and India share much in common in terms of agro ecology, economic conditions and civilisation. Africa as a continent, and India as a country, remain entities with characteristically low productivity in agricultural value chains attributable to a considerable extent, to climate change. Although India is almost self-sufficient in

production of staple crops such as rice, wheat, pulses, sugarcane and cotton, there are still significant inefficiencies in the country's agricultural value chains. There is thus a need for more value chain actors to adopt best practices in climate-smart agriculture to reach a higher scale and increase food security. What is "food security", to begin with? "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." (World Food Summit, 1996). This definition covers four dimensions: physical availability of food; economic and physical access to food; meeting nutritional requirements; and stability of these three aspects over time (Stamoulis and Zezza, 2003). These four dimensions are directly or indirectly influenced by the level of agricultural productivity.

AGRICULTURE AND CLIMATE CHANGE IN AFRICA AND INDIA

The African continent, while responsible for a relatively low proportion of global greenhouse gas emissions, is very much under threat from climate change. These threats emanate from changes in precipitation levels, likely increase in temperature extremes, and rising sea levels. (FAO source book, 2013). For its part, India is under pressure to help mitigate climate change by controlling its own emissions. The change in agricultural productivity patterns as a result of climate change could reduce annual agricultural incomes in the country by between 15 percent and 18 percent on average, and between 20 percent and 25 percent for unirrigated areas. (India Economic survey report 2018)

In Africa, projections on crop yield reduction show a likely drop of up to 50 percent by 2100. The agriculture sector is also likely to experience periods of prolonged droughts and /or floods during El Niño events. Agriculture losses of between two to seven percent of GDP is expected by 2100 in parts of the Sahara, two to four percent, and 0.4-1.3 percent, respectively, in Western and Central Africa, and Northern and Southern Africa. (IPCC report, 2007)

The following paragraphs describe the agricultural sectors of Africa and India.

Africa

- Agriculture is mainly rain-fed and dominated by small-scale farmers, especially in the medium to high-potential and semi-arid areas. Smallholder farms in sub-Saharan Africa number around 33 million, represent 80 percent of all farms in the region, and contribute up to 90 percent of food production in some sub-Saharan African countries. (Africa Agriculture Status Report, 2018)
- It is estimated that agriculture is Africa's largest economic sector, representing 15 percent of the continent's total GDP, or more than US$100 billion (Sh10 trillion) annually. However, the contribution to GDP covers a range from below three percent in Botswana and South Africa, to more than 50 percent in Chad—this implies a diverse range of economic structures. Egypt and Nigeria account for one-third of the continent's total agricultural output, and the top 10 countries generate 75 percent of all agricultural income. (OECD-FAO Agricultural Outlook paper 2016-2025)

- Africa is a significantly low source of greenhouse gas emissions compared to other regions of the world. It accounts for only three to four percent of the world's total greenhouse gas emissions. According to the World Resources Institute, sub-Saharan Africa's total emissions in 2014 amounted to approximately 2,450 $MTCO_2eq$ (metric tonnes of carbon dioxide equivalent), out of the world's 48,892 $MTCO_2$ eq. (WRI, Climate Watch)

- Out of the 2014 average greenhouse gas emissions of approximately 2,450 $MTCO_2$ eq in Sub-Saharan Africa, 378 $MTCO_2eq$ is attributed to agriculture. (WRI, Climate Watch)

- An analysis of Africa's export and import regimes yields interesting insights. For one, agricultural exports are comprised of a small number of products: cocoa (which alone accounts for 70 percent of the continent's agricultural exports), coffee, tea, cotton, sugar, fish and shellfish. They also include exports of fruit (pineapple and bananas). Diversification, both within agricultural products and towards other industrial products, has not been enough to increase the export base. The base is largely unprocessed products (less than six percent of African cotton is processed, and only 25 percent of cocoa), as most of the processing is done in importing countries. (NEPAD, 2014)

- Imported products represent 1.7 times the value of exports. Africa therefore imports products that compete with its own: meat, dairy products, cereals and oils. All subregions are in a deficit situation and the agri food trade balance has generally declined over the last 10 years. (NEPAD, 2014)

India

- Agriculture is mainly rain-fed and dominated by small-scale farmers. Rain-fed crops account for 48 percent of total area under food crops and 68 percent under non-food crops. Smallholder farmers are vital for India's agriculture and rural economy. Defined as marginal and sub-marginal farm households that own or/and cultivate less than 2.0 hectares of land— smallholder farmers constitute 86 percent of the country's farmers. (India Agriculture Census 2015-2016)

- Agriculture is one of the most important sectors of the Indian economy and provides employment to 50 percent of the workforce. The Indian GDP composition in 2017 for Agriculture was 15.4 percent, with production of agriculture activity worth US$375.61 billion. India accounts for 7.39 percent of total global agricultural output (Central Intelligence Agency, USA). India is a significantly high source of greenhouse gas emissions compared to many other regions in the world. India alone accounts for about 6.5 percent of the world's total greenhouse gas emissions. According to the World Resources Institute, India's total emissions in 2014 from all GHGs amounted to approximately 3,200 $MTCO_2eq$ out of the world's 48,892 $MTCO_2$ eq. (WRI, Climate Watch)

- Out of India's 2014 average greenhouse gas emissions of 3,200 $MTCO_2$ eq, 626.86 $MTCO_2eq$ is attributed to agriculture. (WRI, Climate Watch)

- India is one of the world's largest producers of fresh fruits like banana,

mango, guava, papaya, lemon and vegetables like chickpea, okra and milk, major spices like chili pepper, ginger, fibrous crops such as jute, staples such as millets and castor oil seed. The major agri-exports of India are cereals (mostly rice), spices, cashew, oilcake/meals, tobacco, tea, coffee and marine products. The value of agri-exports to total exports of the country ranges from 15 to 20 percent. (FAO World Agricultural Statistics, 2018)

- To feed its richer, younger and more urban population, India's annual agricultural imports continue to rise and are expected to grow further in the future. Since 2010, India's annual agricultural imports increased by more than 60 percent, from US$14.1 billion to US$22.8 billion in 2015. Imports of bulk and intermediate goods, like pulses and edible oils, more than quadrupled over the past 10 years. (USDA, 2016)

In the coming years, agricultural trade could undergo further changes, reflecting the uneven and disproportionate impact of climate change on agricultural sectors across the globe. As climate change alters the comparative advantage and competitiveness of agriculture across regions and countries, some nations could lose as others gain.

International trade can play a particularly important role in adaptation efforts, contributing towards food security in many countries. In the short term, by moving food from surplus to deficit areas, trade can provide an important mechanism to address production shortfalls due to extreme weather events. In the long term, international trade can contribute towards adjusting agricultural production in an efficient manner across countries. Trade can also be central in climate change mitigation efforts. If trade can provide the necessary signals to farmers to produce low carbon-footprint products, emissions can be reduced globally. (FAO, 2018)

BEST PRACTICES IN CSA

Agricultural value chains can act as a delivery mechanism for government and private extension services, financing and input subsidy programmes. They offer market-driven products and services that may provide a demand-led strategy for upscaling best practices in climate-smart agriculture. Therefore, upscaling existing best practices and technologies is an efficient way to reach large numbers of farmers with reduced transaction costs. According to Kaplinsky and Morris (2001), value chains describe a full range of activities required to bring a product or service from conception through different phases of transformation to final delivery to the consumer.

The agriculture systems of both, India and Africa have undergone rapid transformations over the past few decades, particularly after the economic reforms of the 1990s. The emergence of integrated agriculture and food supply and value chains is one of the most visible market phenomena in both regions. Increasing concentration on processing, marketing and export is being observed in all segments of the chain. Traditional methods of food production are being replaced by practices that are more similar to manufacturing processes, with greater coordination across farmers, processors, retailers, exporters and other stakeholders in the agriculture value

chain. (Kumar et al. 2011) To identify best practices in climate-smart agriculture that can be upscaled, it is prudent to take a holistic view of the entire food system and consider how it will be affected by climate change and where it is most vulnerable. This involves analysis of three interconnected levels: the core level comprising production, aggregation, processing, distribution and consumption; the support services level; and the enabling environment dealing with matters of policy and legislation. (FAO Sourcebook , 2013)

Value chains in both Africa and India are similar in terms of structure, conduct and performance, irrespective of the enterprise. What differentiates one chain from another is the length of the chain, determined by activities and processes as the product or service moves along the chain from producer to consumer. The longer the chain, the more the value chain actors and potential of the chain to impact livelihoods especially in rural areas. Identification and packaging of best practices in climate-smart agriculture for upscaling by use of the agri -food system approach is in itself a best practice and provides a more simplistic way to flag out the best technologies and innovations. It also helps identify the barriers to their adoption. A typical agricultural value chain will have segments (see Table 1) under which examples of best practices have been teased out for further analysis.

Table 1. Value Chains and Best Practices for Adaptation and Mitigation

Value chain segment (core level)	Adaptation	Mitigation
Production	• Promote conservation agriculture and sustainable mechanisation. • Diversify through agroforestry, intercropping or other diversification strategies. • Identify and utilise improved seed varieties that are adapted to climate change (e.g. drought-resistant, heat tolerant and flood tolerant). • Expand irrigation as appropriate based on water availability.	• Promote sustainable land management practices to improve soil carbon storage. For example, Uganda, more precisely notes that agricultural soils represent the source of 36 percent of its agricultural GHG profile, setting a baseline and target, aiming to reduce emissions from managed soils by approximately 2700 kt CO2eq per year by 2030. (FAO, Rome 2017) • Improve fertiliser application practices to increase fertiliser-use efficiency. • Divert animal waste for reuse (e.g. organic fertiliser, biogas production). • Improve water-use efficiency e.g. through alternate wetting and drying in rice systems- adopt the motto of "more crops for every drop of water" as practiced in India

Processing	• Strengthen processing facilities to be able to withstand the potential impacts of climate change (e.g. extreme weather events, pest infestations) • Invest in packaging that maintains quality and safety under climate risks, such as extreme heat.	• Reduce energy use (e.g. invest in upgraded energy-efficient processing; use renewable energy sources, where possible).Rwanda is expanding local markets by constructing climate-proofed market facilities, village-based agricultural processing centers with biogas-digesters, compost plants, warehouses powered by solar energy and solar driers. (NDC, Registry)
Distribution	• Improve coordination within the value chain to increase efficiency in transportation to reduce post harvest losses.	• Encourage retail outlets to take measures to minimise refrigerant leakage and reduce energy use.
Consumption	• Promote local food products for perishable food	• Reduce food wastage at home and in restaurants and catering by encouraging sustainable consumption. • Encourage the use of more energy-efficient cooking methods e.g use of energy saving jikos in rural areas.
Support services level	• Increase access to crop and livestock insurance for climate risk mitigation • Improve agricultural extension services to increase adoption of climate -smart technologies by farmers. • Climate information services/climate models – to support farming decisions – develop agricultural advisories and disseminate to farmers based on the seasonal weather forecasts.	• Improve agricultural extension services to share knowledge on best practices in terms of reducing greenhouse gas emissions (e.g. sustainable soil management) • Provide inputs (e.g. fertilisers and packaging) that are less carbon-intensive e.g Hellagrolip fertilisers produced in Europe.
Enabling environment	• Encourage public and private sector investments in agricultural research and extension services and infrastructure. • Improve roads so that they are climate-proof • Effective policies, legislations and frameworks.	• Effective policies and legislations e.g the Agriculture (farm forestry) rules, 2009 (cap 318) in Kenya which aims to promote and maintain farm forest cover of at least 10 per cent of every agricultural land holding and to preserve and sustain the environment in combating climate change and global warming.

		• Consumer preferences – shaping demand for organic, healthier agricultural products which in turn will promote environmental conservation e.g. Promote organic honey production in less intensive crop production areas such as the arid and semi-arid areas of Africa and India.

UPSCALING BEST PRACTICES IN CSA: BARRIERS AND OPPORTUNITIES

Achieving well-functioning agricultural value chains that yield more and consistent benefits to value chain actors in the face of climate change requires that best practices in CSA be adopted by farmers, institutions and policymakers. However, despite the aggressive promotion of these practices, there still exist various barriers:

a) Investment costs associated with cost to acquire the factors of production such as the purchase equipment, machinery, or materials, labour and entrepreneurship. Therefore, any technology that requires new or specialised equipment will have low adoption by poor households. (Bishop-Sambrook et al., 2004)

b) The variable and maintenance costs include expenditures for consumables required to implement the best practices such as appropriate seeds and fertilisers.

c) Opportunity costs include costs of alternative factors of production allocated by the individual farmer relative to the adoption of best practices in CSA such as labour, land, materials for other activities versus CSA-related activities.

The assurance of private benefits in the short term provides farmers with more incentive to implement what they know traditionally, rather than long-term benefits such as carbon trading in carbon markets. These immediate benefits from CSA include increased yield, income, and food security.

Opportunities for upscaling

To overcome bottlenecks in upscaling of best practices in CSA in African countries and India, local delivery systems need to be effective. Public and private service providers must be armed with the requisite knowledge, skills, and tools. Increased effort and resources will need to be dedicated to achieving this with and through existing and new programmes that consider, maintain or strengthen best practices for CSA that benefit value chain actors at different segments of the chains. The pathways include the following:

- **Technological transfer.** The digital revolution is accelerating the growth of CSA technologies that can maximise the efficiency of existing processes. ICT can be leveraged to address gaps in agricultural value chains in terms of increasing the value of precision agriculture, addressing knowledge gaps at the local level due to inadequate extension services, and

innovative agricultural value chain financing using blockchain technology.

- **Information and knowledge management.** A key driver to the uptake of best practices in CSA is access to appropriate technologies. Of particular importance is the provision of improved information and access to a range of alternatives on markets, technologies and better agronomic and resources management practices to agricultural value chain actors. The smart villages model like what are done in Asian countries remain important platforms for engagement of farmers, development practitioners, policymakers and researchers. Research can only be meaningful if it is demand driven and linked to capacity building to equip small holders to adapt and benefit from agricultural projects and programmes.
- **Financing of CSA projects and programmes.** Increasing climate adaptation and resilience of agri-food systems requires investments at different scales to access, adopt and uptake best practices in CSA. To achieve this, various interrelated systems and their distribution channel actors, service providers, market actors and producers need access to various forms of finance. Effectively linking finance is key to increasing their adoption.

Case study: The Kenya Livestock Insurance Program.

Background

Kenya is 80 percent classified as Arid and Semi-Arid Lands (ASALs), and these areas are home to approximately 30 percent (~15 million) of Kenya's people, 50 percent of its livestock, and 75 percent of wildlife. The ASALs are prone to both droughts, and even floods despite the low rainfall they receive. Kenya experiences major droughts every decade and minor ones every three to four years; flood events are also common in ASALs when rainy seasons become extremely wet (Herrero et al., 2010).

Pastoralists in Kenya are at the forefront of climate change, with extreme weather posing a potentially fatal threat to livestock. Climate change-related droughts are a major source of vulnerability for those who depend on livestock for income and food in the ASALs of Kenya. Livestock losses alone have accounted for approximately 70 percent of the USD 12.1 billion damages caused by drought between 2008 and 2011 (World Bank, 2011). Without adequate protection and response measures, the impacts of drought on livestock threaten to cause setbacks to the overall economy.

The KLIP initiative

To address this challenge, the Kenyan government together with the private insurance sector initiated the Kenya Livestock Insurance Program (KLIP) in 2014. KLIP is an index-based livestock insurance programme that protects pastoralists in the remote, arid and drought-prone lowlands of Kenya from the impacts of extreme weather. The programme uses satellite technology to monitor the level of greenness and the state of vegetation available to livestock. KLIP design is based on satellite data of the vegetation cover to assemble an index of seasonal forage availability/scarcity, referred to as Normalized

Differenced Vegetative Index (NDVI) that is used to determine when payouts are made.

- At the initial stage the national government provided 100-percent premium support for five Tropical Livestock Units (TLUs) for vulnerable households.
- As of October 2018, KLIP has made available a 50-percent premium support for up to 10 TLUs

When drought becomes particularly severe, payouts are triggered based on the index data and are directly transferred to the pastoralists with the help of mobile payment systems (M-PESA technology).

Impacts

With these payments, pastoralists can purchase water, veterinary drugs and fodder to sustain tropical livestock such as camels, goats and cows through the drought period. This agriculture insurance initiative is not only an efficient financing tool but also helps vulnerable communities avoid catastrophic livestock losses in the first place, and thus reduces the negative impacts of climate change. The government benefits from transferring the unknown cost to the private sector and targeting vulnerable households directly.

The programme currently covers close to 18,012 people and 90,060 Tropical Livestock Units (TLU). Since 2014, payouts of more than KSh 700 million have been made to 32,000 pastoralists in need of drought assistance in eight counties of Marsabit, Turkana, Wajir, Isiolo, Mandera, Tana River, Garissa and Samburu.

Replication in other parts of the world

The replication of Index-based livestock Insurance can be applied in all countries with similar agro ecology where pastoralists and agro pastoralists thrive. Despite its relevance, the penetration of agricultural insurance is still low. Many markets know no agricultural insurance or have just commenced with their pilots. According to the World Bank, Africa's agricultural premium volume accounts for roughly US$ 200 million, which is less than one percent of the global agricultural premiums of US$ 25 billion, and disproportionately lower than Africa's overall share of 1.5 percent of the world's total premiums.

Therefore, a holistic and long-term view of the agriculture insurance market is required with commitment to increase insurance penetration and bridge the protection gap especially for vulnerable communities. This can be achieved through the following ways:

a) Stepping up the work around insurance education to include:

- Educating public officials at both national and local level.
- Promoting a successful local insurance education model, which is active and well respected at local level.
- Setting up train-the –trainers programmes in order to educate more people about livestock insurance.

b) Improving efficiency of claims pay-outs:

- Establish a system to capture accurate data about the beneficiaries and an effective means of verification.

- Collaborate with an efficient money transfer platform and provider.

c) Ensuring sustainability.

- Promote public-private partnerships to ensure cost of premiums is taken up by beneficiaries on realising the benefits of livestock insurance through education and subsidy.
- Develop a common understanding and shared vision of the insurance programme with regard to the design and operation by all stakeholders.

Moving towards a more sustainable livestock sub-sector in the face of climate change requires a sound, evidence-based and innovative livestock insurance programme. KLIP represents a model of value chain financing that can be modified and adopted as a CSA best practice based on the specific context of country and region.

CONCLUSION

This brief has endeavoured to identify best practices in Climate-Smart Agriculture that can be upscaled by farmers in Africa and India. However, Africa and India have a number of different options to increase the returns to agricultural value chain actors in the face of climate change. A country-specific evidence base is needed to weave a basket of options suitable to the needs and resource endowments of smallholder farmers in rural set ups who suffer most due to the impacts of climate change.

The following recommendations are offered in the adoption of best practices in CSA:

- To meet the ever increasing global food requirements due to global population increase, agricultural systems must be transformed to meet the twin challenges of food security and climate change.
- There are tried, tested and trusted climate-smart agricultural technologies and innovations that can be upscaled in different agro ecologies and regions.
- There exist Political, Economic, Social and Technological, Legal and Environmental (PESTLE) barriers to the adoption of best practices in climate -smart agriculture especially by small-scale farmers which must be overcome to increase agricultural productivity, enhance their resilience to climate shocks, and mitigate emission of greenhouse gases where possible.
- A strong cooperation between farmers, agro industry and technological research is key to success in adoption of best practices in CSA by value chain actors in agricultural food systems.
- Policies and legislation supporting climate agriculture need synchronisation and coherence across sectors relevant to the agricultural sector in order to drive agricultural transformation at the local, national, regional and international level.
- Upscaling of CSA best practices along agricultural value chains require innovative approaches to financing due to the unique structure, conduct and performance of the chains. Financing is a major barrier to growth in Africa's and India's agricultural sectors, particularly when it comes to smallholder farms. Interest rates in several African countries

> are extremely high at up to 47 percent. Farmers and businesses often lack collateral and banks struggle to price the risk of loans to smallholder farmers and small to medium-size agribusinesses. Less than three percent of total bank lending in Africa goes to the agricultural sector that accounts for about 70 percent of all employment and over 15 percent of the continent's GDP (Dr. Adesina, President, African Development Bank).

A significant uptake of CSA practices will therefore require private sector involvement in agricultural value chains financing by offering solutions to farmers across the globe in areas of credit access and crop and livestock insurance. When considering these recommendations, it is important to note that both African countries and India already have policies and legislations in agriculture, environment, trade among other sectors that have provisions that support the development and implementation of Climate-Smart Agriculture.Therefore, efforts geared towards developing a common vision that promotes coordination of policies and institutions across the sectors supporting agricultural development is key to upscaling of best practices in CSA. In this light, the networks developed at the local and national level in African countries can be leveraged to foster the much needed political, social and economic cooperation between the African continent and India in knowledge management, research and development, agricultural financing and technology transfer. Partnerships remain a critical step to achieving systematic change to address the challenge of global food insecurity and improving livelihoods in the face of climate change.ORF

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