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Ecosystem-based Adaptation for Food Security in Africa

Ecosystem Based Adaptation (EbA) for food security in Africa

UNEP

Towards a Comprehensive Strategic Framework to Upscale and Out-scale EbA-driven Agriculture In Africa

REPORT FROM THE CONTINENTAL TASK FORCE ON EbA FOR FOOD SECURITY IN AFRICA

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Acronyms

AU	African Union
CA	Conservation Agriculture
CSOs	Civil Society Organizations
EbA	Ecosystems Based Adaptation
EbAFoS	Ecosystems Based Adaptation for Food Security
FMNR	Farmer Managed Natural Regeneration
GM/CCS	Green Manure Cover Cropping Systems
HHs	House Holds
IPCC AR4	Intergovernmental Panel on Climate Change Assessment Report 4
IPCC AR5	Intergovernmental Panel on Climate Change Assessment Report 5
ISFM	Integrated Soil Fertility Management
NEPAD	New Partnership for Africa's Development
NGOs	Non-Governmental Organizations
PHLs	Postharvest Losses
RECs	Regional Economic Commissions
SDGs	Sustainable Development Goals
SMEs	Small and Medium Enterprises
SOPVs	Sorghum Open Pollinated Varieties
SSA	Sub-Saharan Africa
SWC	Soil and Water Conservation
UNEP	United Nations Environment Programme
UNFAO	United Nations Food and Agriculture Organization
UNFCCC	United Nations Framework Convention on Climate Change

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Executive Summary

Africa faces a myriad of hurdles on its way to achieving the Millennium Development Goals (MDGs) and the post-2015 development agenda. Climate change, population growth, youth bulge, widespread unemployment, extreme poverty and hunger are some of the challenges that the continent is grappling with. Africa's agricultural potential is immense. It is estimated the continent holds up to 65% of the world's arable land and 10% of internal renewable fresh water sources. On incomes and poverty reduction, evidence from the World Bank is reported that in Africa, a 10% increase in crop yields translates to approximately a 7% reduction in poverty, greater than the 5% reduction reported in Asia. Neither the manufacturing nor services sectors can achieve an equivalent impact. The reason for this could be that in Africa, agriculture is not only a source of food but of livelihood, employing up to 60% of labour in the continent, a majority being small holders at 60%.

However, astride this potential is the unfortunate fact that about 25% or approximately 240 million people in the continent go to bed hungry, over 200 million suffer the debilitating symptoms of chronic to severe malnutrition, which also contributes to over 50% of infant mortality in the continent. In addition, poverty is rife with 50% in the continent estimated to be living in extreme poverty, on less than USD 1.25 per day. The region currently spends more than USD 35 billion on food imports per year and it is projected that by 2050, Africa's population will increase from the current 1.1 billion to 2.4 billion and that two out of every five children globally will be African.

The AU has appreciated the potential contribution of Agriculture to Africa's food security and economic transformation. The Maputo and Malabo declarations as well as the recently launched AU Agenda 2063[1] are a testament to this. An overriding theme in these continental strategies is the need for modernization and enhanced productivity of Africa's food production systems while at the same time ensuring the productivity of the very ecosystems that underpin agricultural productivity are enhanced.

This strategic policy framework seeks to build on the key theme of enhancing productivity of Africa's food systems, by proposing a holistic approach that considers productivity of the agriculture value chain as a continuum. It contrasts the proposed approach with conventional systems by discussing both paradigms. Under conventional approaches to food production, increased production is achieved through 'intensification', - expanding cropland through clearing more land, and misusing mineral fertilizers, without considering the impacts of such practices on ecosystems. Under a changing climate, such approaches are not sustainable as they end up destroying the very ecosystems that underpin food production. This then impairs community and societal resilience as communities depend on these very ecosystems to adapt to climate change. In addition, with the ability of ecosystems to produce food being impaired, a lot of potential food is lost – for instance in cereals, which are a major staple in the continent, an estimated 6.6million tonnes of grain annually are lost due to degraded ecosystems. These yields would be enough to meet annual calorific needs of approximately 30 million people in the continent. In addition, conventional approaches do not consider the value chain holistically, which leads to postharvest losses estimated at 23% of field harvests. Low productivity also results to food importation, which costs the continent up to USD 35 billion annually.

The proposed paradigm shift framework put forward policies suggestions which seeks to enhance productivity of the entire value chain by applying ecosystems based approaches to enhance on-farm production, which results in not only increased yields, but also enhances the productivity of ecosystems and consequently builds community resilience against climate change. Beyond the farm gate, this paradigm proposes value addition through food processing and the application of storage and mobile technologies to reduce postharvest losses and unlock additional income and job opportunities. Affordable storage technologies and deployment of mobile innovations to enhance market and financial access are among the propositions discussed.

Cumulatively, the proposed holistic policy paradigm shift potentially brings 5 distinct benefits to Africa's food sector – enhances food and nutritional security, enhances ecosystem productivity, builds community climate resilience, enhances value chains by linking on farm production with opportunities for both demand and supply value chains, creates jobs and more incomes. Examples of successful application of this paradigm across the continent as captured in literature are elucidated. In addition, empirical findings from cases studied across the continent are analysed. Findings demonstrate the practicality of this paradigm and the need to urgently up-scale it. This paradigm will embed ecosystems based adaptation for food security across the continent and ensure Africa becomes food secure while enhancing the earnings of the agriculture sector under a changing climate. The recommended measures to ensure both vertical and horizontal up-scaling of the new paradigm shifts and key policy as well as legislation that will incentivize investment in this paradigm by actors at all levels within a country. A strategic framework to operationalize the new agriculture paradigm that imbeds ecosystem based adaptation approaches is documented. This framework captures key operational aspects of institutions, financing, knowledge management and monitoring & evaluation. The case for a stronger political and financial support is made for investments in ecosystem based adaptation for food security in Africa as this provides an opportunity to pave forward a future that is not marked by conflict but by cooperation, not by human suffering, but by human progress as we seek to achieve, in the words of Nelson Mandela, "an Africa where there is work, bread, water and salt for all'.

1 **Agriculture a strong component of Agenda 2063 -** http://summits.au.int/en/22ndsummit/events/agriculture-strong-component-agenda-2063

1. Background and Context

Africa has been tagged as a rising continent. Indeed, both the 2013 Africa Economic Outlook[1] and the 2013 African Competitive[2] reports observe that the pace of GDP growth in Africa has been impressive, averaging 5.1% since 2000 and doubling the average growth rate of the 90's. Other estimates peg Africa's GDP growth rate at approximately 6% per year, with 6 of the world's 10 fastest growing countries over the past decade being African, and a growing middle class with 20% of the population having daily incomes of over USD 10[3].

The continent however stands at a crossroads. Besides the impressive headline growth, the continent faces transecting challenges of hunger and malnutrition, the growing and increasingly young population, youth unemployment, climate change and poverty, which together form a nexus that threatens the otherwise optimistic future outlook anticipated of the impressive growth figures. Almost 1 in every 2 Africans lives in extreme poverty today and with the current trend, by 2030, it is projected that a vast majority of the world's poor will be located in Africa[4]. The 2014 Africa progress report[5] reiterates this. It notes that too many of the continents inhabitants remain stuck in poverty with nearly 50% of the population living on the poverty line of USD 1.25 per day[6] and those below the poverty line living on an average of just 70 US cents per day[7].

Hunger and malnutrition is also rife. The United Nations Food and Agriculture Organization (UN FAO) reports that nearly 240 million people or 1 in every 4 persons in Sub Saharan Africa (SSA) lacks adequate food[8]. Over 200 million[9] suffer debilitating symptoms of chronic to severe malnutrition, which also contributes to more than half the deaths of children below 5 years.

On population, the current global stands at approximately 7 billion while Africa's is at approximately 1 billion people. On the continents youth bulge and unemployment, it is projected that another half a billion people will be added to the continent by 2030, culminating to an estimated population of 2 billion inhabitants by 2050[10]. The youth of age 15 - 25 who currently constitute a majority, at 200 million, are projected to double by 2045[11]. They are also the majority unemployed, with 60% youth unemployment[12]. Few opportunities do exist for active youth participation in the decision making process due to limited access, control and ownership to skill, tools and resources among both young people and governments that are required to engage in meaningful consultative processes and implementing action plans in support of EbA. Often, government lack understanding of the benefits of youth involvement in consultation processes, and advocacy based groups have limited capacity to maintain momentum of continued actions in promoting EbA to enhance food security. Going forward, it is estimated that 350 million young people will be entering the labour market by 2035[13]. This presages more mouths to feed and more jobs to create.

This dichotomy reiterates the general finding of the 2014 progress report that economic growth in Africa has not been inclusive.

In addition to raging poverty, malnutrition, the youth bulge and unemployment, climate change and its impacts on the agriculture sector, which is not only a source of food but of employment to 60% of Africa's labour[14] further compounds Africa's outlook.

Africa is reported by the IPCC AR4[15] as being among the most vulnerable regions to climate change, with wide ranging impacts impinging on its economic growth. The varied impacts are articulated in the IPCC AR5[16] and the Africa adaptation gap report, and cover sectors including among others, healthcare, water resources, ecosystems and agriculture, which is 98% rain fed hence vulnerable to climate change[17].

The World Bank reports[18] that by the 2030s, climate change impacts in SSA, such as droughts and heat, will leave 40% of the land now growing maize unable to support the crop, while rising temperatures could cause major loss of savannah grasslands, thereby threatening pastoral livelihoods. The implication is that by 2050, depending on the sub-region, the proportion of the population undernourished is projected to increase by 25 – 90% compared to the present. This will cascade onto labour availability and productivity and intensify poverty.

However, Africa is not without solutions. By focusing on agriculture, a sector which not only employs up to 60% labour in the continent, but in which, women produce up to 80% of food[19], inclusivity in economic progress can be greatly enhanced.

For agriculture to succeed, committing to, building on and implementing continental wide initiatives, like the AU/NEPAD[20] Comprehensive African Agriculture Development Programme[21] (CAADP) as well as the Malabo Declaration[22], which builds on the CAADP will have to be prioritized. With such success, the nexus challenges of climate change, food insecurity and related loss of livelihood can be solved. To this end, this brief hopes to enhance the realization of the Malabo Declaration and related vision 2025 for Africa's agriculture - 'shared prosperity and improved livelihoods'. This by building on its strategic action areas as captured in the implementation strategy[23] including increasing sustainable agricultural productivity in an inclusive manner, increasing resilience of livelihoods and production systems to climate variability and change among others through recommending the upscaling of EbA for food security while simultaneously embracing agriculture value addition so as to optimize productivity.

1.1.1 Business as usual

In seeking solutions to challenges confronting African agriculture, interrogating the outcomes of conventional/current agricultural practices in the face of climate change is warranted.

Food and nutrition security has been defined by the World Food Summit[24] as the condition where all peoples at all times have social, economic and physical access to sufficient, safe, and nutritious food to meet their dietary and preferential needs for an active and healthy life. For food security to be realized, the four pillars of food security, i.e. physical availability of food, economic and physical access to food, food utilization and stability of the three aforementioned pillars over time, must be satisfied simultaneously as discussed by the UN FAO[25].

While these pillars provide a useful framework for understanding food security, the vital environmental dimension of food security, the ecological foundation of the food system which technically underlies food production, encompassing the resource base supporting food production (land & water) and ecosystem services provided by nature (such as soil formation, nutrient recycling, off and on-farm biodiversity etc.) form a major component of food systems that remains largely ignored under conventional farming systems[26]. This has led to the degradation of ecosystems and subsequently contributed to food security challenges in Africa.

With degraded ecosystems, the capacity for future food productivity is also lost. Conventional food systems, which degrade ecosystems therefore result in loss of potential food.

For instance, on land clearing alone, the threat of conventional farming systems on forest ecosystems in Africa is manifest. Between 2000 and 2010, up to 13 million hectares of forest were cleared[27] annually primarily to expand land for food and fuel[28]. Under these conventional systems, food is not only lost as opportunities for food production through degradation of ecosystems, including agro, forest and aquatic ecosystems, but also as direct post-harvest loss (PHLs), especially in the field, storage, or during transportation. This is due to the conventional systems' focus on expanding production by increasing yields on the farm, instead of a wholesome consideration of the entire food production value chain.

On PHLs, sub Saharan Africa (SSA) loses food worth up to USD 4billion annually, enough to feed 48million people per annum[29]. PHL accounts for up to 67% of total food lost in SSA. The loss is attributed mainly to inadequate financial and structural resources for proper harvesting, storage and transportation, as well as unfavourable climatic conditions for food preservation[30]. These contribute toward making Africa less food secure. By focusing on the value chain, through the application of appropriate technology and value addition and conversion strategies at and beyond the farm gate, the threat of PHLs on Africa's food security can be significantly reduced.

Presently, SSA is not food secure despite its vast potential for food security - holding 65% of the world's arable land[31] and 10% of internal renewable fresh water sources[32].

By reorienting toward ecological food systems that take into account sustainable productivity at the farm level so as to secure the ecological foundation of food production as well as appropriate value addition strategies along the entire food value chain, such losses can be averted, and Africa's food security enhanced.

The fact that conventional food production systems are undermining the ecosystem services that food production depends on should be appreciated. By focusing on expanding production only, they fail to take into account the bigger picture constituting sustainability in productivity and appropriate value addition strategies along the entire value chain to unlock more opportunities. Consequently, significant amount of potential and harvested food is lost, making Africa less food secure. To safeguard future food security in the face of climate change, it is necessary to implement approaches that will not only focus on enhancing agricultural production, but also safeguard the ecosystems which underpin agricultural productivity through their services and enhance their resilience to ensure their sustained productivity under climate change.

1.1.2 A paradigm shift

However, Africa is not helpless. By investing in its ecosystems and working with nature, Africa can climate proof its food production systems and contribute to sustainable agricultural productivity hence enhance food security under a changing climate. Together with investments in value addition processes along the agro- value chain, potential opportunities for employment for the growing and increasingly young population are created. Thus can Africa unlock its vast potential in the agriculture sector, which is accessible to the majority in the continent.

Ecosystem approaches, an alternative to conventional approaches, aim not only to maintain but also to improve the fertility and productivity of ecosystems. They often include traditional practices such as conservation agriculture, crop rotation, inter-cropping and biological control of pests. Such sustainable approaches are implemented to prevent soil erosion, improve soil fertility and enhance biological diversity. And with this, is an enhancement of productivity of ecosystems and consequent improvement in potential yields.

As examples, maize rotated with soybean yields 5–20% more than continuous maize monocultures. Rotating peas with wheat increases soil nitrogen levels by 6–14 kg/ha, and with this, an 8% increase in wheat yields[33]. Intercropping lablab beans2 with maize will increase maize harvests by over 50% by the second year, provide a widely consumed bean containing 23% protein, and will fix over 40 kg/ha of nitrogen.

Sustainable ecosystem based approaches are also easily adaptable in most rural communities, since they involve agricultural practices that have been used traditionally. Considering that 60% of African farmers are rural and small holders[34], this fact constitutes a big plus. Ecosystem approaches are also more effective and cheaper[35] to maintain.

Ecosystems approaches will significantly reduce amount of potential food lost, boost Africa's food productivity and hence contribute toward enhancing Africa's food security and adaptation to climate change.

This new paradigm is more than sustainably increasing productivity at the farm level. It integrates value addition processes along the entire value chain by linking farm production activities/operations and produce with value addition service providers such as suppliers of inputs, processors of produce, transporters, storage services etc., at and beyond the farm gate including market access and distribution. It takes a holistic perspective to enhance productivity and reduce food waste along the value chain while unlocking opportunities for income generation through the value addition processes. In the words of John Kufuor former Ghanaian president, who is recognized across the continent for his personal commitment and visionary leadership to alleviate hunger and poverty, "while increasing crop yields is vital, it is of little use if the product cannot be stored safely or transported to markets[36]." Hence the logic behind this integrated holistic paradigm. This paradigm enhances green value chains[37], by embracing sustainable ecological food production techniques that prevent degradation and enhance ecosystems at the farm gate level while aiming at reducing food loss along the entire food value chain by exploring and exploiting value addition processes along the chain.

Greening the value chain

Consideration of "green value chains" is important from ecological agriculture perspective to assist businesses adopt eco-friendly practices. Greening value chains refers to implementing processes that proactively facilitate environmentally sustainable food system development and promote adaptation and resilience to a changing climate through efficient use of natural resources; minimizing environmental pollution; and minimizing the vulnerability of human and natural systems to extreme climate events due to climate change.

Greening value chains involves implementing green activities (as defined above) with the full range of actors (agricultural input providers, farmers/producers, service providers, traders, cooperatives, agri-businesses and other actors) along the value chains of specific commodities and building synergies along such value chains to reduce environmental impacts. The concept of greening value chains also incorporates activities to help the various value chain actors to adapt to a changing climate and develop more

2 lablab beans, known as njahe in Swahili are widely known and hence better referenced in Africa

resilient livelihoods. It includes (1) ensuring efficient and sustainable use of natural resources on the input side and increasing returns to products that have undergone processes that are environmentally sustainable and/or climate smart on the output side (2) maximizing material and energy efficiency at each stage of the value chain (3) reducing negative environmental impacts and GHG emissions at all points of the chain; (4) using climatic information and forecasts for decision-making; and (5) exploiting opportunities for promoting more sustainable practices beyond the particular value chain.

Postharvest losses

On PHLs, value addition and applying innovative technology has the potential to reduce losses in storage and transport. The hematic bag an affordable intervention[38], has demonstrated its efficacy in reducing storage losses. Mobile innovations can be applied to link rural farmers with large-scale buyers with potential to deploy effective vehicles that ensure minimal loss on the road hence significantly reduce transportation losses. Traditional and affordable indigenous knowledge based value addition processes such as earth pots to store and preserve yam harvests by burying, smoking of fish and meat[39], innovations such as solar based milk coolers[40] etc. are further examples of affordable value chain processes that are integrated into ecological agricultural production techniques to unlock income opportunities and prevent food loss in this new holistic paradigm.

Together, investing in ecological techniques that improve agricultural productivity without jeopardizing the capacity of ecosystems to sustain future productivity, as well as taking a value chain perspective of the entire food production chain, to ensure unlocking of additional income opportunities along this chain constitute the paradigm shift, that takes a holistic perspective of agricultural productivity.

To safeguard Africa's food and livelihood security, policy and institutional reform is only one of several recommendations that can aid in operationalizing the new paradigm. Others include strengthening knowledge management, increasing communication and outreach, supporting capacity building, reinforcing economic incentives and private sector engagement[41]. All these will need enabling policies to actualize.

For a start, it is an imperative that current successful application of EbA for food security techniques in the continent be understood. This will aid in identifying gaps to bridge, suggest requisite linkages, actions and support needed to upscale EbA for food security both horizontally and vertically, through a comprehensive strategy to embed it into regional and national food security and climate change frameworks. In addition, it will aid in attracting investment at individual country level toward making this become the framework for all food security and climate change adaptation initiatives in the entire continent.

Understanding different Ecosystems based action techniques and successes will help in suggesting the kind of enabling policies and legislation needed to incentivize countries to invest in them.

This policy – strategic brief, hopes to energize practical evidence-based policy actions for food security at national and regional levels in Africa by showcasing, through both a review of literature and empirical data from projects, cases of successful application of EbA for food security in individual countries and the benefits to farmers thereof. In addition, it hopes to identify gaps and barriers to successful horizontal and vertical upscaling and country investment as deduced from literature and analysis of findings from questionnaires circulated to a wide cross section of organizations in the non-governmental, CSOs, public and private sectors applying these techniques across the continent. In the end, a way forward to achieving scale and country level investment is suggested.

2. Paradigms of agriculture development in Africa

2.1.1 Business as usual – Conventional food production systems

Conventional food production approaches, that involve massive land clearing, the overuse and or misuse of fertilizers and other chemicals that pollute the soil, water and air, result in degraded lands as a result of cutting trees and clearing vegetation which exposes it to erosion & loss of biodiversity. The chemicals on the other hand kill insect pollinators. All these reduce the capacity of ecosystems to provide food[42], and therefore jeopardize future food production.

Deforestation is among significant threats earlier adduced, with annual losses of up to 13 million hectares of forested lands. Going forward, deforestation is projected to increase, with an additional 120 – 140 million hectares being converted by 2030, much of it in Latin America and Sub Saharan Africa, primarily for food production[43].

Clearing land for agriculture threatens environmental sustainability as well as future food security as forests ecosystems play an essential role in food security, providing fundamental ecosystem services such as water filtration and regulation, habitat for wild pollinators, soil erosion control, nutrient cycling that enhances agricultural productivity and climate change mitigation through carbon sequestering.

Preserving forests from further degradation as well as restoring forest landscapes is therefore an important component to food security and income generation. Africa has the greatest recovery potential with 720 million hectares of restorable forests[44]. Restoring these forests will go a long way in ensuring sustainable livelihoods.

In agro-ecosystems globally, it is estimated that on average, between 2 and 5 million hectares of land is lost yearly due to land degradation, primarily through soil erosion. Africa is most severely impacted by land degradation and loses 2 to 6 times more than this global average[45]. Consequently, yield reductions due to land degradation in some African countries are as high as 40%, while the global average is between 1 – 8%[46]. Africa's food loss due to agro-ecosystem degradation can therefore be proportionately 32% higher than the global average. If at the global[47] level, an estimated 10 million hectares of cropland is lost annually due to soil erosion, equivalent to a loss of 5 million tonnes of grain in potential yield, and enough to meet the annual food calorie needs of 23.8 million people, then proportionately, at 32% more, Africa's loss in potential yields is substantial, and could be as high as 6.6million tonnes of grain annually, enough to meet annual calorific needs of approximately 31.42 million people. Theoretically, a conservative estimate would suggest that restoring degraded lands in Africa could potentially make 30 million people food secure.

At the country[48] level, Kenya has registered yield declines on 40% of crop lands, while South Africa has registered on 41% of crop lands due to land degradation associated with conventional farming systems. In Ethiopia, forest area declines by 1% annually[49] due to unsustainable use of forest resources.

SSA is reported as having the world's lowest crop yields, with cereal yields of 1.5 metric tons per hectare reported in 2011 being roughly 50% of the world's average[50]. With low yields on one hand coupled with a growing population on the other, SSA is compelled to meet a significant amount of its food demands through imports. Besides a food import bill of USD 35 billion incurred in 2011 (excluding fish)51, in 2010, Africa imported[52] 14% of its animal products, 25% of cereals and 66% or two thirds of its vegetable oils. As of 2013, it was reported that SSA relies on imports for approximately 20% of its staples[53].

The above statistics demonstrate two key issues.

- One, that SSA is not food secure despite its vast potential for food security - holding 65% of the world's arable land and 10% of internal renewable fresh water sources.
- Second, that a significant amount of food is lost as opportunities for food production through degradation of ecosystems, including agro, forest and aquatic ecosystems.
- SSA is being economically and socially crushed by the weight of food import bills
- SSA food chain system is stunted by food imports resulting from land degradation, low productivity and high postharvest loss

Under conventional systems which focus on expanding production using unsustainable means such as overuse of inorganic fertilizers and agrochemicals without consideration of the whole value chain that also includes value addition processes such as storage, transport, processing etc., food is not only lost as opportunities for productivity, but a significant amount of food is lost as direct post-harvest loss (PHLs), especially in the field, storage, or during transportation. Under the new perspective where the whole agriculture value chain, from supply, to on farm ecological production and beyond farm gate value processes such as storage, transport, marketing etc. are viewed as a continuum, productivity and efficiency of the entire value chain is enhanced by ensuring sustainable increases in yields on the farm using EbA approaches, and preventing yield losses both on and beyond the farm gate through application of appropriate value addition technology and strategies.

As earlier adduced, PHLs cost Africa as a region significantly. On specifics, Africa's cumulative grain PHL's range between 10 – 23%, with field losses at 4 -8%, storage, both at farm and market at 9%, and total transport losses going up to 6%[54]. As an absolute figure, it is estimated that the annual PHL's in cereal grains, roots, tubers, fruits, vegetables, meat, milk and fish for SSA were valued at more than USD 48 billion in 2010[55]. When juxtaposed with Africa's USD 35billion food import bill, recovering these losses would essentially eliminate the need for imports without increasing production.

Statistics at the country level corroborate the significance of these losses. In Kenya[56], since 2007, PHL's in maize, currently estimated at 23.4% of total harvest, have cumulatively constituted 125% of total imports. It is argued that reducing these losses by an estimated 75% could make Kenya self-sufficient in maize without increasing production.

Nigeria[57], the largest producer of tomatoes in SSA loses an estimated 45-60% in PHL. Consequently, only a third of its tomato processing capacity is supplied. Subsequently, Nigeria has become the largest importer of tomato paste in Africa, costing it USD127 million 2012.

Reversing these losses means recovery of finance, job opportunities in the processing industries as well as buffering food security, considering that food loss and waste is not only a threat to food security but also has significant economic costs.

Going forward, it is increasingly being appreciated, that conventional food production systems that focus on expanding production are undermining the ecosystem services that food production depends on, and do not necessarily take into account a whole some perspective of the entire food value chain to enhance efficiency both within the farm gate and beyond. Consequently, a significant amount of food is lost within and beyond the farm gate, making Africa food insecure. To safeguard future food security in the face of climate change, it is necessary to implement approaches that will not only focus on enhancing agricultural production, but also safeguard the ecosystems which underpin agricultural productivity through their services and enhance their resilience to ensure their sustained productivity under climate change as well as focus on increasing efficiency and productivity of the entire food value chain thereby cut food losses. This is the basis of the paradigm shift envisaged.

2.1.2 A paradigm shift – building sustainable food systems and value chains

As earlier noted in the preceding section 1.1.2, ecosystem approaches represent an alternative to conventional approaches[58], and aim not only to maintain but also to improve the fertility and productivity of ecosystems. This then enhances potential yields.

To safeguard Africa's food and livelihood security, practical demonstrations at country level lay ground for a paradigm shift toward ecological agriculture. The UN Global Compact[59] backs this, by noting that in order to increase food security for a growing global population, it is crucial that sustainable agricultural practices that prevent land degradation and restore degraded land are implemented.

Furthermore, as earlier elucidated, the new paradigm being proposed does not only seek to sustainably improve productivity at the farm level, but seeks to optimize productivity of the entire food value chain, by preventing food loses both at the farm gate in form of lost opportunities for productivity due to degraded ecosystems and at and beyond the farm gate by application of technology and value addition strategies to prevent PHLs either due to transportation, storage etc. and unleash additional productivity and income enhancing opportunities. By preventing environmental degradation, enhancing ecosystems and optimizing productivity and reducing food loss along the entire value chain, this paradigm also promotes green value chains[60].

On storage losses, the hematic bag earlier mentioned has demonstrated its efficacy in reducing losses. Demonstrations on the bags' effectiveness in West and Central Africa have cumulatively registered about USD 500 million annually in saved grain[61].

On transportation losses, poor roads in Africa are the major cause. The application of innovative mobile technologies that link rural farmers with large-scale buyers with potential to deploy effective vehicles that ensure minimal loss on the road presents a potent solution. This has real potential given that Africa is the fastest-growing mobile phone market in the world[62].

A number of mobile innovations[63] that link farmers to potential markets already exist, and include MLOUMA in Senegal, ESOKO in Ghana, POULTRY GUIDE in Uganda among others. These can be modified to incorporate transport dimensions. Mobile innovations are therefore applicable as among value addition strategies and technologies that prevent can PHLs.

Indeed, mobile technology is set to play an increasing role in Africa as it is projected[64] that by 2025, half of Africa's 1 billion population will have internet access and there will be 360 million smartphones on the continent.

Consequently, as smartphone technologies become cheaper, application of internet technology is estimated could increase agricultural productivity in the continent by USD 3billion[65].

This by improving access to value added services such as advice on latest farming techniques, enhancing supply chain efficiency through provision of real-time product-market information, supply of inputs, enhancing access to financial transactions and insurance services among others. Additional micro-tech start-ups providing mobile driven value chain interventions in the continent can be cited.

In Nigeria[66], a startup firm, Doreo Partners is enhancing supply chain efficiency by applying mobile innovations to bridge the gap of access to credit by small holders. The firm has linked up with Swiss RE to insure farmers against drought. In addition to insurance, the firm also hopes to reach 1 million smallholders by 2025 by providing technology, fertilizer and seeds to farmers, who will pay back when their profits increase.

In Botswana[67] start-up Modisar tracks cattle herds and gives advice on feed, vaccinations and finance by text message. It won the Orange African Social Venture award last year.

Cameroon's[68] Mewanko Farm has set-up an online marketplace for farmers to sell fresh produce in a scheme it hopes will increase the income of 13 million people.

The growth in the use of technology in Africa could enhance agricultural productivity for hundreds of millions of poorly-organized and isolated people in rural communities by linking them to global supply and demand markets.

Together, investing in ecological techniques that improve agricultural productivity without jeopardizing the capacity of ecosystems to sustain future productivity, as well as taking a value chain perspective of the entire food production chain, to prevent both on farm losses and PHLs and ensure unlocking of additional income opportunities through value addition along this chain constitute the paradigm shift.

Several African countries have demonstrated quantitative gains of increased food production coupled with enhanced ecosystem productivity through application of ecological agriculture techniques. This is food that is not only increasing community food security and resilience to climate change, but providing livelihood opportunities. Others have gone a step further and implemented the full paradigm by incorporating value addition strategies and unlocked additional income opportunities.

In Zambia[69], farmers increased crop yields by 60% by switching from monoculture practices to intercropping and other sustainable methods. Through agroforestry (intercropping, barrier crops and nitrogen-fixing crop use), smallholder farmers also produce more diverse crops, which means they can potentially serve a wider market and earn more incomes. By incorporating marketing services as a value addition strategy in their enterprise, the improved crop yields and diversity can be leveraged to service a larger market and enhance incomes to these farmers.

In Senegal[70], farmers using the Farmer-Managed Natural Regeneration (FMNR) technique have regenerated indigenous trees on 40 000 hectares of cropland. This ecological technique has increased tree density on cropland from an average of 4 to 33 trees per hectares and improved soil fertility, crop yields, and wildlife, and reduced soil erosion.

In Niger, FMNR has populated over 5million hectares with trees, and in Mali, over 500,000 hectares.

A similar initiative in Ethiopia[71] has restored 2 700 hectares of barren mountain terrain. Reported benefits include increased food security and reduced poverty through increased income from forest products and livestock fodder; improved water infiltration, which has improved the ground water levels as well as reduced flash flooding; and reduced erosion and increased soil fertility in the region. The participants also earn carbon credits through the Clean Development Mechanism.

Niger[72], which was strongly hit by droughts in the 70s and 80s, rehabilitated 300 000 hectares of its crusted and barren, lands by promoting simple soil and water conservation techniques such as contour stone bunds, half moons, stone bunding, and improved traditional planting pits (zaii). Consequently, both crop yields and tree cover increased and as a multiplier, expansion of the rehabilitated area continued without further development assistance and a land market was developed, suggesting a positive learning process and a green economy-thinking that became self-driven by 2010.

In Kenya, mangroves, which traditionally provide wood and non-wood forest products and services such as seafood (are a breeding and nursery habitat for fish - approximately 31 per cent of the fish landed in the area in 2010 was directly related to the mangrove habitat[73]), firewood, building poles, and traditional medicine to the local communities, had been extensively used and degraded since the 70s. Loss of mangroves led to shortages of firewood and building poles, a decline in fisheries and increased coastal erosion[74], hence the urgent need for the rehabilitation, conservation and sustainable utilization of the mangrove

Rehabilitation led to recovery of mangroves, whose total economic value was estimated at USD 3,000 per hectare per year[75].

The project restored and arrested deforestation activities on 107 ha, generating 3 000 tonnes CO2-equivalent of carbon credits to be sold on the voluntary carbon market, generating approximately USD12,000 yearly for the local community[76]. This was a demonstration of a value chain opportunity. A third of the annual carbon income generated through the project will be used for the rehabilitation and protection of mangroves.

Unleashing Value Chain Addition in Africa through EbA driven Agriculture

While ecological techniques ensure sustainable increase in crop yields and increased climate resilience, factoring in value addition and agribusiness along the food production value chain means more incomes and more jobs are created sustainably. Failure to do so translates to substantial income losses. For instance, while Nigeria spent USD 42million to import[77] over 70,000 tonnes of glucose in 2011, the same could be produced locally from processing cassava, Nigeria's most important food crop, and in the process, the USD 42million would be incomes earned and jobs created by Nigeria's economy.

African agriculture and agribusiness is estimated, could be worth USD 1trillion by 2030[78]. An agribusiness private sector working alongside government could link farmers with consumers and create many jobs. Further, Foreign Direct Investment (FDI) in African agriculture is projected to grow from less than USD 10billion in 2010 to more than USD 45billion in 2020[79]. In addition, growth in this sector can reduce poverty twice as fast[80] as growth in other sectors. Africa should capitalize on this.

Opportunities inherent in Africa's agribusiness value chain have been demonstrated in a number of countries, both by enterprises and individual entrepreneurs. In taking these opportunities, incomes are generated and poverty reduced.

In Uganda[81], SESACO Foods Company is leveraging on value addition along the food supply chain. By this, the company employs 80, 55 being women, and generates monthly revenues averaging USD 39,000. In the same country, AGROWAYS (U) LTD., offers cleaning, drying, grading, and storage services to small holder farmers at affordable prices. Through this value addition, farmers are reducing post-harvest loss.

In Nigeria[82], a fruit processing enterprise, REELFRUT, managed to expand to 20 retail outlets within three months of establishment. The enterprise processes and packages health snacks made from freshly dried fruits – mangoes and pineapples.

Individual entrepreneurs and the youth are also creating jobs by leveraging ecosystem services.

In Ethiopia[83], a young farmer is applying irrigation, and in the process, produces fruits and vegetables on 25ha, and cereals on another 12ha, and employs 50 young persons.

In Lesotho[84], a young entrepreneur is leveraging livestock production to generate income, create employment, offer training services and expand into additional businesses in other sectors

Youths "Youthing[3]" the Value chain?

To realize this potential, there is need to enhance the capacity of African youth to engage in agribusiness, hence ensure they generate incomes while feeding Africa. The African Development Bank[85] highlights the need to build the capacity of youth through entrepreneurship training to enable them take advantage of agribusiness value-chains and enable them create livelihoods. As practical demonstration of youth engagement, in Uganda, a project – teens Uganda - is engaging the youth by creating an enabling environment with better education, exposure and linkages to markets, and in the process, making the community food secure and creating employment opportunities for the youth.

In addition[86], the master card foundation has partnered with SNV to facilitate access to secure jobs, financial services and skills for young people to grow their own businesses, making the case for agriculture as a business that offers several pathways to steady employment or entrepreneurship through the Opportunities for Youth Employment[87] project (OYE). From this project, it is envisaged that 20,500 disadvantaged young people will acquire improved skills training in agribusiness and biogas and at least 80% of those young people will be employed or will start their own business in high-growth agriculture and biogas sectors.

These examples demonstrate that the vital role Africa's youth have to play in building a food secure continent and creating jobs will be unleashed with appropriate capacity building interventions.

Ecosystem based approaches have proven their potency in ensuring increased agricultural productivity while simultaneously enhancing climate resilience. However, the scale of these initiatives has remained out of the mainstream[88] of agriculture policy at both national and regional levels in Africa. The fact that concepts of EbA are considered relatively new[89] is a possible explanation. Related to this, is the need to accelerate scaling up of these approaches, so as to make them more visible to main stream policy makers.

To upscale this paradigm, policy and institutional reform, strengthening knowledge management, increasing communication and outreach, Educationalizing[4] EbA driven agriculture, supporting capacity building, reinforcing economic incentives and private sector engagement are among measures[90] that will be needed.

3 Youthful agriculture based entrepreneurs – agripreneurs: http://www.ypard.net/testimonials/agripreneur-new-breed-young-entrepreneurs-combining-their-love-farming-and-agriculture-

4 Integrating EbA and its principles in formal curricula at elementary, high school, or tertiary/university levels

3. EbA techniques and their benefits for Africa: Through the Science and Evidence Lens

Among key challenges[91] affecting African crop yields include land degradation which affects 65% of African land, annual loss of 6 million hectares of productive land, degraded to highly degraded soils weathered and depleted of nutrients affecting over 95 million hectares or 75% of arable land, climate change and resulting effects such as moisture stress, a function of not only short lived erratic rains, which come in torrents and result in 25 - 50% runoff loss and increased erosion, but also of the soils inability to hold and release moisture due to degradation, with 10 – 30% water lost to drainage[92]. This is particularly important in light of the fact that over 60% of SSA population[93] depends on rain based rural economies. As earlier explained, the potential yield loss from degradation of agro ecosystems alone is substantial, and could be as high as 6.6million tonnes of grain annually. This needs to be addressed urgently.

A number of EbA techniques can be applied to address some of these challenges that conventional systems have proven ineffective against.

Small scale water harvesting techniques[94] such as planting pits (zaii), rock lines, vegetation strips, ridge tillage will trap water that would otherwise be lost as runoff thus improve infiltration rates, reduce erosion and hence build resilience against both water stress and intensive rain events. Diversifying[95] crops to include moisture resistant species will also diversify household economies and ensure income generation and food security even during droughts. Applying crop residue and compost, agroforestry, integrated soil fertility management (ISFM) using micro-dosing are examples of techniques[96] that will amend soil organic matter and structure to retain nutrients and soil moisture in the root zone and avoid drainage loss. Agroforestry will also reforest bare lands, act as buffer against wind erosion, add organic matter to soil, shade crops and stabilize soils hence enhance reversal of degraded soils, prevent further degradation, enhance moisture retention with resultant improvement in yields. Theoretically speaking, it has been argued that conservatively, restoring degraded lands in Africa could potentially make an estimated 30 million people food secure based on global proportions[97].

Using green manure and cover cropping systems (gm/ccs) such as legumes has a myriad of food security, competitiveness and ecological benefits. Among these include increased organic matter and soil nutrients, where gm/ccs can potentially add up to 50 metric tons/hectare[98] (MT/ha) or more of organic matter to soil with benefits such as improving soil moisture holding capacity,

increasing total soil nutrients, improving nutrient balance, structure etc.,. Additionally, legumes can fix nitrogen ranging from 50 – 400 kg N/ha[99] depending on the particular plant. These can produce savings of an equivalent of USD 75/ha[100] otherwise spent on purchasing chemical fertilizer by substituting with 140 kg N/ha added by gm/ccs. In addition to zero transport costs as they are produced in the field where they are used, gm/ccs can also reduce the amount of chemical fertilizer by 60 – 80% without lowering yields[101]. These, in addition to cost saving, contribute to emissions reduction hence climate change mitigation.

Gm/ccs also improves competitiveness of small holder farmers in weed control against large scale conventional farmers who use tractors, as they allow application of zero tillage, eliminating the need for expensive tractor tillage operations to control weeds. Application of zero tillage in South America has resulted in small holders producing a sack of maize at 30% less[102] than nearby wealthier farmers using tractors. In addition to cost control and competitiveness, climate change mitigation is also achieved with zero emissions.

Soil erosion is higher in conventional agricultural systems involving conventional techniques e.g. intensive soil tillage than in soil subjected to conservative practices e.g. no-till. No-till is reported to reduce erosion by 2.5 to over 1000 times[103], with median and mean values of 20 and 488 times respectively, relative to conventional tillage practices.

Diversified agriculture is more resilient to climate change and has better mitigation potential. Agro-ecology systems incorporating techniques such as crop diversification, tree planting, mulching and terraces which could serve as barriers are more resilient to climate change and related extreme weather events such as flooding, drought, hurricanes and landslides due to improved soil filtration, and less soil erosion. Improved diversity of species can also protect against invasion of new pests, weeds and diseases, likely stemming from global warming. On mitigation potential, agro-ecology practices are better at mitigation as they reduce greenhouse gas emissions relative to conventional agriculture and improve ability of the soil to serve as a carbon sink due to improved soil organic matter. In developing countries, agro-ecological systems could potentially sequester 1.2 – 3.1 billion tonnes of CO2 annually[104], and increase yields of grain and root crops by 30 – 42 million tonnes per year[105]. High biodiversity correlates positively with high yields.

At country level in the developing world, a study of about 300 agricultural projects covering 37 million hectares across developing countries documented myriad of benefits[106] from ecological resource-conserving practices, including a 79% average yield increase, substantial carbon sequestration, more efficient water use, reduced pesticide use, and increased ecosystem services.

3.1 DOCUMENTED EBA DRIVEN AGRICULTURE BENEFITS

3.1.1 Benefits documented from individual country examples

In Southern Africa[107], Agroforestry in Malawi is reported to improve maize yields by about 50% by planting nitrogen fixing Faidherbia albida trees. Quantitative increases from 4.6 T/ha to 5.7 tons/ha have been reported in test/monitored fields in the country. In Zambia, crop rotation results in 50% more maize crop yield than conventionally tilled maize.

Across West Africa[108], ISFM across over 200,000 ha has resulted in yield increases of 33-58% over four years, and accompanying revenue increases of 179% for maize and 50% for cassava and cowpea. Specifically, ISFM using micro-dosing has been applied by about 500,000 small holders in Mali, Burkina Faso and Niger, with associated increases in millet and sorghum yields of 44 – 120% along with 50 – 130% increases in family incomes.

In Burkina Faso, using small scale water harvesting techniques such as zai and stone bunds to capture rain water and reduce runoff has improved yields from 400 to over 900 kg/ha, increasing yields by 50 – 100%. In addition, farmers have doubled grain yields using multiple water harvesting techniques that include zai pits and stone bunds.

Well managed agroforestry can generate a variety of benefits in addition to enhanced crop yields and include depending on the species of trees, a source of fruit, nuts, medicines and fibre. Large branches can be used as poles or sold for income; smaller ones can be used for firewood, pods and leaves can be used for animal fodder, leaves can also be sold as the case in Niger, where mature baobab leaves are sold for USD 28 – 70, an amount sufficient to buy at least 70kg of grain in the market.

Studies[109] conducted in Kenya and Malawi indicate that using agroforestry – involving use of natural fertiliser trees - and 'push-pull' ecological pest control strategy is more cost effective and results in higher incomes and yields than using in-organic mineral fertilizers and chemical pesticides respectively. This was achieved due to a combination of better yields and lower production costs. For instance, in Kenya, farm costs are lower for agro-forestry, 9% of total production compared to chemical fertilizer – even subsidized fertilizer, which takes up 32%.

In Kenya, studies conducted in two regions on maize indicated remarkable productivity differences. In one region, monthly profits were 3 times greater at USD 433 for 'push-pull' farmers than 'non-push-pull' farmers who registered USD 142 in profits. On a unit basis, 'push-pull' farmer's registered USD 291/hectare/year more profits than their 'non-push-pull' colleagues. In another region, average profitability was at USD 588/hectare/year for 'push-pull' farmers and only USD 193/hectare/year for chemical farmers, indicating 3 times more profitability for 'push-pull' farmers at USD 395/ha/yr. If the same was applied across the country, it is estimated farmers would more than double their incomes to average USD 2.7billion, a huge injection to the rural farmer community.

In Malawi, agroforestry using fertiliser trees results in maize profitability of USD 259/hectare/year and USD 166/hectare/year for chemical fertilizer farmers, a difference of USD 93/hectare/year, a significant difference accounting for nearly one-third of annual incomes in the country. Maize yields were also higher for agro-forestry farmers, at 1,137kg/hectare than the chemical fertilizer farmers who managed 828kg/hectare. It is estimated switching to agro-forestry fertiliser trees would earn Malawian maize farmers a combined income addition of USD 209million per year.

Combining these ecological techniques has reported a multiplier effect on yield increases.

- For instance, in Niger, while agroforestry alone results in cereal yields of about 500 kg/ha, integrating agroforestry and micro-dosing produces about 1000 kg/ha in yields.
- In Malawi, agroforestry combined with micro-dosing increases maize yields from 1.5 t/ha to 3 t/ha or even surpassing 4 t/ha. In the same country, conservation agriculture (CA) – minimum tillage, cover cropping and crop rotation – together with agroforestry improved yields to 7.2 t/ha
- In Burkina Faso, combining water harvesting techniques such as stone lines with agroforestry increases average sorghum yields by 100 – 200%. When micro-dosing is included, yields increase by an additional 40 – 44%. In the same country, combining simple water harvesting (zai) with micro-dosing in 2010, which was considered a good rainfall year produced sorghum yields nearing 1,900 kg/ha against an average of 200 – 400 kg/ha for untreated fields. This enables small holders to not only be food secure, but also have surplus stock to sell and hence improve household incomes. In 2011, which was considered a dry year, with below average rainfall and low yields for farmers who had not invested in water harvesting, farmers who had invested in zai or half-moons water harvesting techniques realized yields of up to 700 kg/ha. Those who added micro-dosing performed even better with yields of 1000 – 1100 kg/ha.

These examples underscore the fact that these ecological techniques contribute to both climate resilience and food security.

3.1.2 Value addition and unlocking opportunities for incomes and employment along the agro-value chain.

The increasing demand[110] for food variety across the continent, as demonstrated by the growing urban middle class who are demanding sustainably produced, more nutritious, varied and processed foods portends opportunities for value addition that are already being leveraged. This is generating new jobs and entrepreneurial opportunities for the youth, farm households and rural communities along the African agribusiness value chain.

20% of Africans are middle to upper middle class, with daily incomes of USD 4 – 20, while another 18.8% are high income with daily incomes > USD 20. Factoring in remittances from the diaspora, it is estimated that 300 million Africans, approximately a third of Africa's population, is middle class[111]. It is these that are generating demand for value addition along the agribusiness value chain, and thereby creating jobs.

Opportunities inherent in Africa's agribusiness value chain have been demonstrated in a number of countries as earlier discussed.

To ensure these benefits are realized on a wider scale, governments should create an enabling policy environment to incentivize small holder farmer adoption, private sector capital injection to strengthening sustainable agro-value chains, international partners and development assistance to invest in knowledge management, communication and outreach among others.

In addition to literature reviewed, additional empirical cases from individual projects implemented across Africa in recent times can be cited. These provide experience of practical application of EbA- driven agriculture and resultant benefits of enhanced food security, ecosystem productivity, inclusive income generation at rural economy level, climate resilience, and integration of productivity benefits to value addition chains to create further livelihood opportunities, all which enhance the achievement of proposed sustainable development goals[112] (SDGs) thematic areas such as food/nutrition security and sustainable agriculture, poverty reduction, land degradation, forests and biodiversity among others. Following is a sample of these cases.

3.2 CASE STUDIES AND SYNTHESIZED FINDINGS

This section documents a sample of seven out of a total of 200 ecosystems based adaptation driven agriculture projects analysed across Africa. However, synthesized findings from all the 200 projects are presented. Data for the study was collected by means of questionnaires circulated to a wide cross section of stakeholders and organizations in the non-governmental, CSOs, public and private sector applying these techniques across the continent. A total of 300 questionnaires were circulated out of which 200 were used in the analysis. Non-probabilistic or judgmental sampling methodology was used to select cases, the main criteria being those actors that had demonstrated longevity, having operated successfully in the continent for at least 5 years. Other than its cost effectiveness and time saving advantages, judgemental sampling was considered most appropriate because of the fact that concepts of EbA are considered relatively new[113] and EbA techniques despite their benefits remain largely invisible to mainstream agriculture across the continent and so the selection of informative cases could not be left to chance. Selected respondents were those successfully applying EbA and agribusiness and were considered well versed on the subject. These projects showcased the new agricultural paradigm. They demonstrated successful application of the following 4 specific EbA techniques for enhanced food security, climate resilience, and ecosystem productivity i.e. i) CA techniques that improve soil fertility and water use efficiency – (no tillage; mulching and cover cropping; crop rotation / diversification), & agroforestry – ii) biodiversity and forestry management -, iii) water harvesting, and iv) livelihood diversification / alternative livelihood. In addition, linkages to value addition chains and creation of opportunities for incomes and job creation along the value chain cascade were also realized by these projects.

Synthesized findings

A total of 200 samples were used for analysis, representing a significant response rate of 66.7%. Analysis involved two levels of reduction using excel spreadsheets. Final analysis was conducted by the African Centre for Economic Transformation[114] (ACET). Based on this analysis, the most abundantly applied technique (most popular) across Africa was biodiversity and forest management, applied by 68.75% of cases studied. Next were conservation agriculture techniques (43.75% cases), livelihood diversification (25% of cases) and water harvesting (18.75% cases) in that order. No individual project applied all the 4 techniques simultaneously, while 6.25% used 3 of the techniques, 43.75% used 2 techniques and 50% used 1 technique.

It was also found that projects applying one EbA technique tend to have the highest food security impact, the highest rate of enhanced community climate resilience, and the highest job creation potential. On specific EbA techniques, CA techniques contributed most to increased yields; biodiversity and forest management tended to contribute most to building community climate resilience, while water harvesting technique was creating the most value addition and income generation opportunities. It was also found that the number of techniques applied correlated positively with all the envisaged benefits of the new paradigm i.e. climate resilience, ecosystem productivity enhancement, food security, value chain opportunities and income generation. Consequently, to reap maximum benefits from EbA, based on this analysis, there is need to invest in a variety of EbA approaches in a given community

setting.

Some of these empirical results are illustrated below

Figure 1: Percentage popularity of techniques

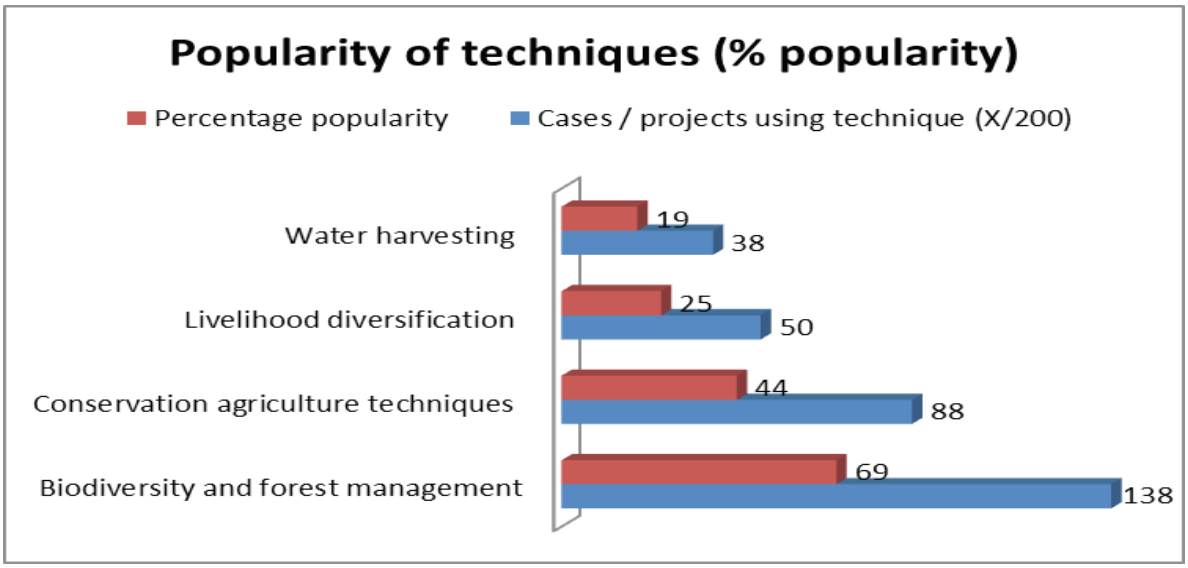
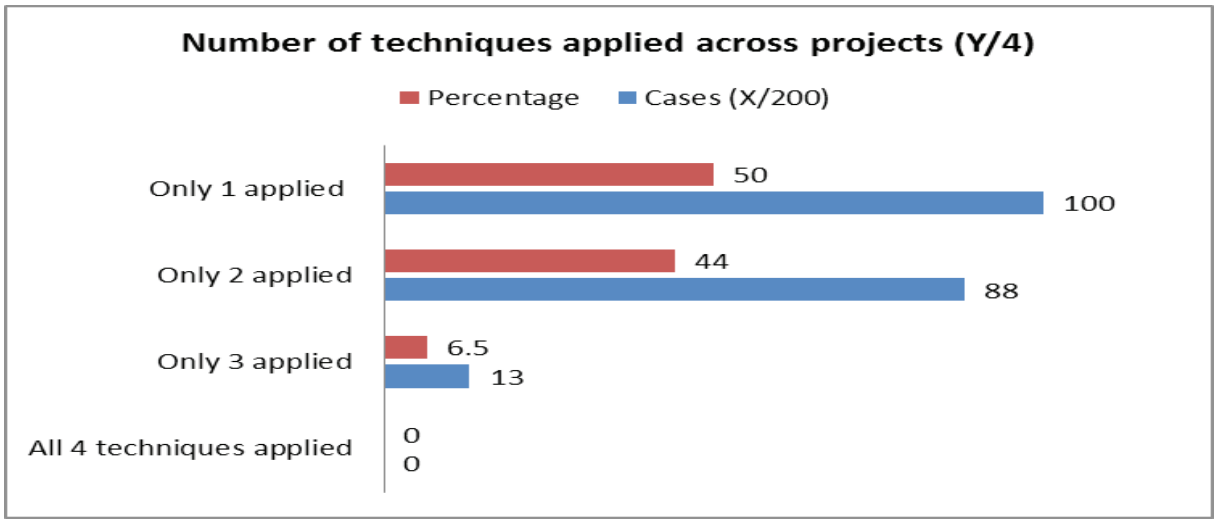


Figure 2: Proportion of techniques as applied across projects



Examples of some case studies that contributed to the Analysis

3.2.1 The Lake Chilwa Basin Climate change Adaptation project – Malawi

The problem: unsustainable land use practices over the years resulted in the degradation of ecosystems in the project site. This included degradation of forest catchment areas that resulted in impacts such as increased soil erosion leading to increasing siltation in water bodies, receding lake, which was close to drying in 2012, and hydrological regulation problems of droughts and floods.

Techniques: EbA technologies that included CA; and Reforestation; as well as capacity building /training of local and district institutions on natural resources management to enhance community capacity to implement adaptation actions and introducing alternative livelihoods (animal and fish farming) and drought resistant crops enhanced food security and built the communities resilience to climate change effects especially drought, while simultaneously restoring the ecosystem and enhancing its productivity and ensuing services such as hydrologic regulation to control flooding.

Results:

Capacity building for climate adaptation at local and district level

A total of 53 stakeholder groups (973 people) including members of parliament, district technical personnel, extension workers, community based environment and natural resources management committees and radio listening clubs were trained in climate change mitigation and adaptation. 5 radio listening clubs were established and developed and broadcast over 30 climate change programmes on public radio. This increased climate change knowledge and food security enhancing adaptive techniques to 70% of community up from a baseline of 15%.

Food/nutrition security enhanced

The Programme supported 269 smallholder households to undertake conservation agriculture on 44 hectares. With this support, house hold yields increased from 200kg (lasting 4 – 6 months) to at least 750 kg of maize per household per annum, enough to last all the year round. This totals average yield increase from 0.5 to 1.25 MT/Ha, improved maize yield of between 2.8 and 3.2 t/ha from 1.5 t/ha previously.

21,000 of 184,000 people (4,536 households of 40,000 HHs) were made food secure. 210 farm families were supported with start-up inputs for alternative livelihoods (100HHs given 48 piglets and 462 HHs given 2756 chickens) to diversify food and nutrition sources and ensure security even when staples fail.

- -1000 farm families supported with 12,000 fruit trees - grafted mangoes, avocado, pears and citrus fruits. These provide vital vitamins improving on the community's nutritional security.
- -3,702 smallholders supported with cassava, sweet potatoes that were planted on 73 ha; production approx. 1200MT
- -Early maturing drought resistant crop varieties help farmers escape hunger in dry months

Climate adaptation / resilience building

Improved forest management/governance and restoration of degraded forests provided resilience against flooding and soil erosion. 20 Village Forest Areas were established and a total of over 1 million tree seedlings planted in the once degraded basin ecosystem. In addition, fire management efforts improved. The area damaged by fire reduced by 22.5% from the baseline of 102.6 ha. Early maturing drought resistant crop varieties also introduced to help farmers escape hunger in dry months.

-Over 1000 people equipped with knowledge and skill in climate change adaptation, with over 100 programmes on adaptation played on national radio

- -834 small holder farmers undertaking conservation agriculture techniques (CA) on approx. 145Ha of land. CA increased productivity and resilience of soil system to drought, and erosion

- -surplus yields from crops and fisheries improve resilience of farmers to unpredictable rains and floods
- -weather and water monitoring assists stakeholders to take timely action in emergencies
- -210 farm families supported with start-up inputs for alternative livelihoods (70 families given pigs and 140 given poultry). Alternative livelihoods to increase resilience to climate related food stress
- -Mobilizing support towards the treatment of bilharzia: 9,095 people and 85 pupils treated; Mobilizing support towards addressing cholera. Under a changing climate, the IPCC AR5 reports that the prevalence of existing infectious diseases increases.

Ecosystem productivity enhanced

Restoration activities resulted in the establishment of over 30 Village Forest Areas and planting of over 1.6 million trees in the basin and former degraded fragile areas. The area damaged by fire has been reduced by 22.5% from the baseline of 102.6 ha. These has improved soil fertility, biodiversity (return of birds, insects mushroooms, wildfruits) while enhancing the capacity of this ecosystem to continue providing services such as flood regulation, erosion control.

- -water catchments have been protected from human degradation
- -river banks rehabilitated

Incomes / jobs created

Project trained and provided business support to 25 producer groups involving 300 business persons, who include women fish traders and pigeon pea farmers. Material support included construction and provision of solar fish driers and fuel-saving fish smoking kilns to 3 women fish trading groups and linking of smallholder pigeon pea farmers to lucrative markets in Blantyre. The solar-dried and smoked fish is packaged and sold in chain stores while the pigeon peas are sold in bulk to Processors in Blantyre. This resulted in 125% increase in revenue generated from fish sales while total revenue generated by pigeon pea farmers increased by 20%. In 2011, the farmers sold 28 tons of pigeon to Rab Processors, realizing approx. USD 8,500 income.

- -85 women fish traders produced over 8 metric tons (MT) of fish - registered a price increase of 170% (from USD2.86 to USD7.71 /Kg)
- -Marketing skills enhanced through agribusiness training. This increases earning potential of community
- -The program created self-employment to the beneficiaries in the areas of fish production and processing, honey production, marketing and trading of high value crops like rice, pigeon peas etc.

Value chains enhanced

Project has resulted in value addition opportunities cascading down the food production chain. Out of fish farming, fish smoking, drying and packaging have emerged as value adding activities that are creating livelihood/income opportunities for the community. Opportunities for solar driers and fuel saving smoking kilns enterprises have also emerged out of fish production activities in addition to fish packaging activities. Total of 698 households were supplied with improved cook stoves

- -170 enterprises given start-up capital for value addition of fish, rice, pigeon peas, chillies
- -85 women benefiting from solar fish dryers and improved fish smoking
- -many crop and fish enterprise groups linked to markets and banks
- -Mobile banking services mobilized for fishing communities, enhancing financial value chains

Vertical upscaling potential / suggested actions to influence policy / policy changes suggested

- The integrated approach, bringing together various sectors towards the management of resources through involvement of policy stake holders i.e. members of parliament as well as experts at local and district levels i.e. district technical personnel, extension workers, community based environment and natural resources management committees as well as successful implementation of the project increases chances that findings of this project will be used to inform policy making, hence ensure principles of EbA are integrated into national and local agricultural and natural resource management policy.
- Capacity building of extension officers who interact with farmers on the ground increases the chances of successful application of these techniques by farmers. – Based on experience from this project, integrating top-down policy influence through involving policy makers in critical phases of demonstration projects such as implementation of activities and sharing outputs in form of policy briefs, news flashes etc. to strengthen evidence based policy making with bottom-up capacity building of implementers such as training and practical involvement of extension officers and

farmers to enhance successful implementation of techniques and sustainability of the project outputs is suggested as a potent strategy to achieve vertical upscaling at country level.

Horizontal upscaling potential / suggested actions to enhance replication

- This project had significant replication potential. Some of the piloted initiatives systematically scaled out without further support. In addition, other projects in Malawi copied the approach, further indicating it's potential.
- Going forward, increasing communication and outreach about project activities achieved through the radio listening clubs that were established as well as the climate change programmes broadcast over public radio will also enhance the projects replicability by increasing awareness of the radio audience on the project success and potential benefits that could be ripped from implementing EbA initiatives as was the case in this project.
- Based on the project implementation, awareness raising through local, national and even international (internet/ websites) media is suggested as a possible technique of communicating project successes to a wide audience and enhancing chances of replication at both country and regional scale.

3.2.2 Fish and crab farming in Mozambique / Ecosystem Based Adaptation and Improved Livelihood of Zongoene and Mahilene Communities, Limpopo River Basin - Mozambique

The problem: ecosystem degradation brought about by unsustainable use of natural resources - i.e. mangrove deforestation - and compounded by climate change. This then led to a cascade of challenges, affecting both the food and nutritional security of the population, their livelihoods as well as hampering ecosystem services such as flood regulation.

- Influence of floods and droughts affecting key livelihood activities for the community: rain-fed agriculture, fishing and traditional livestock rearing.
- Destruction of extensive patches of mangrove during the 2000 floods, over exploration, and very poor natural regeneration.
- Decline in local fishery and low yields in agricultural production.

Techniques: Mangrove reforestation applied and a small dam constructed to address resilience to floods, droughts; alternative livelihoods - fish and crab farming introduced as an alternative income activity to cutting mangroves for sale to address mangrove degradation. This also increased community resilience by addressing nutritional and food security themes under climate change.

Results:

Capacity building for climate adaptation at community level

Approximately 1500 community members, students and community leaders benefited from capacity building. This entailed skill development, and increased awareness achieved through ensuring community participation in implementing project activities, hence broadening local knowledge on climate change adaptation and the need to sustainably manage ecosystems in order to benefit from their services and build resilience. In addition, mangrove restoration ensures not only flood protection but being breeding grounds for fish and crabs, enhances food and nutritional security, building resilience of community against climate change effects.

Food/nutrition security enhanced

From this project, 3000 fisher families were made food secure. A community once depended on declining sea fishing for significant dietary needs, which experienced on average 4-5 months of food shortage annually, now generating 1,066 Kg of fish produced in 4 ponds over 6 months; enough is generated for consumption - 300Kg consumed by local community; and a surplus of 766Kg sold. In addition, 84Kg of crab produced monthly in 84 cages to boost food security

Climate adaptation / resilience building

Livelihood diversification into fish and crab farming used to increase community resilience to declining sea fish; crab farming also reducing deforestation pressure on mangroves while creating demand for restoration activities. This builds on the mangrove reforestation which provides hydrologic regulation services to address floods and drought

- -Small dam constructed to regulate water flow to mangrove reforestation area, as well as harvest water and regulate floods, hence building community resilience to both droughts and floods

- Adaptive capacity of 131 households (HH) or 655 people enhanced by directly benefiting from crab farming (10HH), fish farming (20HH) and mangrove reforestation (101HH). 4HH permanently involved mangrove nurseries.
- Approx. 1500 community members, students and community leaders benefited from capacity building (skill development, and increased awareness hence broadening local knowledge on climate change adaptation)

Ecosystem productivity enhanced

The restoration of mangroves ensured the continued productivity of ecosystem by providing a nursery area for marine species like fish, crabs and shrimp. The following activities also enhanced the productivity of this ecosystem:

- Planting 50 ha of degraded mangrove area with over 2,000 plants per hectare restored the flood control, soil stabilizing aspects of this ecosystem
- Establishment of 1 mangrove nursery with a capacity for 50,000 mangrove seedlings to sustain reforestation activities into the future.
- Planting diverse species -6 mangrove species used for reforestation - enhance biodiversity
- - Mangrove replanting reclaiming degraded area -approx. 10ha of degraded mangroves reforested

Incomes / jobs created

With implementation activities, over 60 community members were employed in restoration and other resilience activities, including fish pond construction; dam construction; rehabilitating channels for mangrove irrigation and mangrove replanting; mangrove nursery management

- Within first period of project operation (approx. 6 months), a total income of USD 2,641 was realized from sale of fish, while USD 217 was realized from sale of crab

Value chains enhanced

The implementation of this project resulted in creation of opportunities along the value chain. The supply of fingerlings to restock fish ponds was a critical activity deriving directly from the success of this project. Other value chains enhanced included

- -Fish feed business enhanced;
- -Pond rehabilitation/construction activities supported (4 fish ponds of 400M2 and 3 ponds of 1200M2)
- -Management of mangrove nurseries supported;
- -Construction of crab growth cages supported (200 cages at start of project operation).

Vertical upscaling potential / suggested actions to influence policy / policy changes suggested

Though not directly addressed in this project, opportunities for future policy intervention are facilitated by this project in a number of ways

- Brings a new mindset to local community: based on the project, community members are willing to learn and adopt fish and crab farming as new livelihood strategies; Eduardo Mondlane University implementing commercial fish farming in the area. –Community involvement in different project activities e.g. trainings, capacity building, workshops, awareness has helped in making climate change a priority in local interventions
- Data and information sharing among stake holders on climate change adaptation technologies and best practices contributes to local knowledge on adaptation and widens livelihood strategies
- By enhancing community knowledge and information sharing on climate change, this project lays a basis for future bottom-up policy reform. With an informed public, chances of them demanding relevant policy that has proven to address their food and livelihood security and resilience building challenges is high.
- Based on this, community empowerment and capacity building through involvement in project activities is suggested as a technique to foster community led or bottom-up policy reform.

Horizontal upscaling potential / suggested actions to enhance replication

Across Mozambique, the potential is promising. This is because fish and crab farming, including mangrove reforestation is viewed by the local community as a means to food and livelihood security in the face of climate change.

-Based on this, it is suggested that EbA demonstration project interventions, that address prominent challenges be targeted to enhance chances of replication across a country or region.

3.2.3 Green water saving in Ngusishi catchment in Kenya

The problem: surface water depletion downstream due to global and micro-climate change

- deforestation (which threatens water infiltration/ground recharge & storage and related hydrologic regulation of floods)
- declining water quality which impacts living systems within catchment

Techniques: A wide range of techniques were applied, and included payment for ecosystem services to enhance soil & water conservation, rain water harvesting and storage; agro-forestry

Results:

Capacity building for climate adaptation at community level

By involving local farmers in project implementation activities e.g. water harvesting, payment for ecosystem services like water, it not only builds their knowledge, but improves sustainability as it enhances farmers' ownership and cooperation in the management of their catchment

Food/nutrition security enhanced

- 3.4% increase in crop yield, contributing to enhancing food security
- 3.4% increase in crop adaptation to drought/flood thus enhancing yields and hence food security.

Climate adaptation / resilience building

- 3.4% increase in crop adaptation to drought/flood improving community resilience to climate change food security related impacts of these challenges
- 3.4% increased adoption of water use quotas by farmers, thus enhancing resilience to water stress
- 20.7% increase in adoption of improved and cheap agro-technologies e.g. mulching, agro-forestry, use of multi-purpose trees that improve soil fertility, water retention capacity and structure even under a changing climate
- 19% adoption of rainwater harvesting and storage to improve community resilience against water stress.

Ecosystem productivity enhanced

- 17.2% increase in biodiversity specifically wildlife
- 20.7% increase in stream flow as a result of reforestation activities
- 12.1% increased soil fertility/declined erosion

Incomes / jobs created

Directly, job security in agriculture and irrigation improved as a result of mitigating agricultural water vulnerability to climate change

Value chains enhanced

Success and sustainability of this project indirectly, contributes to rainwater harvesting and storage/water tank equipment enterprise and its value chain

Vertical upscaling potential / suggested actions to influence policy / policy changes suggested

The project proponents suggested the following policy reform to ensure the project benefits are sustainable

- Create appropriate policy to ensure creation of an institution capable of managing resources in an efficient cost-effective way
- to ensure financial sustainability, put appropriate policy to facilitate local stakeholders' fund scheme rather than

relying on govt. and outsiders

Horizontal upscaling potential / suggested actions to enhance replication

Considerable potential - project being replicated in the whole catchment

- -Based on this, it is suggested that EbA demonstration project interventions, that address prominent challenges be targeted to enhance chances of replication across a country or region.

3.2.4 Experience of supporting forest adjacent communities to promote food security in Uganda

The problem: encroachment on protected forest area leading to deforestation; crop raiding by wild animals leading to food insecurity and loss of incomes

Techniques: Included reforestation; crop diversification to diversify both food and income sources; biological control by planting chillies as buffer crops against forest animals; sustainable forest management

Results:

Capacity building for climate adaptation at community level

Engaging the local community in project implementation and operation through training and supplying them with material to implement activities has enhanced their adaptation knowledge and capacity.

- - 347 chilli farmers were trained on best agronomic and climate smart agricultural practices, beyond the chilli growing 120 farmers were trained to diversify their knowledge.
- - 44 farmers supplied with agro-inputs including pumps, herbicides, fertilizers and seeds to enhance their production capacity under a changing climate.

Food/nutrition security enhanced

Significant reduction of crop damage by animals as a result of biological technique (planting chilli as buffer)

- -incomes earned from sale of chillies used to buy food items hence enhancing nutrition and food security
- -Increased crop production e.g. maize as a result of reduced crop raiding (by forest animals)

Climate adaptation / resilience building

Crop diversification to include planting of indigenous tree species that are resilient to local harsh climate conditions is being practised. Households' preference for these traditional crops over new varieties because of their better adaptive capacity is a sign of success of this technique. In total:

- 120 farmers trained on best agronomic and climate smart agricultural practices such as crop diversification
- 44 farmers supplied with agro-inputs including fertilizers and seeds to help implement climate smart practices, like micro-dosing.

Ecosystem productivity enhanced

- Approx. 31,272 tree seedlings planted to harness the ecosystem
- -Reduced disturbance of the ecosystem as access to forest is regulated and monitored
- To date, approx. 64,500 persons reached by project, including farmers, are focusing on implementing management plans to enhance their ecosystems.
- 50 farmers supplied with tree seedlings to establish 40 acres of agro-forestry plots and 15 acres of woodlots. These not only restore but enhance biodiversity of this ecosystem hence its productivity

Incomes / jobs created

- -0.5tonnes of chilli marketed in off-peak dry season earn households approx. USD60/week
- -3tonnes of chilli marketed in peak season earn poor households approx. USD240/week

» -Woodlots provide opportunity for additional income once they mature and are ready for sale.

Value chains enhanced

Marketing of chillies creates opportunity for marketers and other interveners e.g. transporters, and middlemen

Vertical upscaling potential / suggested actions to influence policy/ policy changes suggested

The project proponents suggested the following policy reform to ensure project benefits are sustainable

» Implement relevant existing natural management policies fully

» Put policies that ensure all actors including communities, government are involved in governing the natural resource

» Put appropriate policy that facilitate forest estate managers support for communities who have no land to invest in tree planting to accommodate them in conservation activities

Horizontal upscaling potential / suggested actions to enhance replication

» Formation of management structures staffed by locals, and which are now the foundation for developing and implementing management plans provides template structure that makes replication and upscaling easier.
The project demonstrates that local engagement can yield vast improvements (an investment of USD13.26/person/year over 4.5 years generated significant gains in ecosystem protection and livelihood improvement while over 31,000 tree seedlings were planted). Considering its cost effectiveness and other benefits, upscaling to other forest-adjacent communities throughout Africa offers major promise

3.2.5 Sorghum and Millets Improvement Programme/Promotion of Science and Technology for Agriculture Development in Africa - Zambia

The problem: Food insecurity, soil degradation, frequent droughts and poor social economic status

Techniques: Conservation agriculture (zero-tillage) for soil retention; Use of improved seed varieties i.e. Sorghum Open Pollinated Varieties (SOPVs) for efficient soil moisture use

Results:

Capacity building for climate adaptation at community level

Appropriate training on use of SOPVs and climate adaptation provided to community thus improving their resilience. A total of 1880 small scale farmers, (including 300 who were not in the project areas), and 4 large scale farmers not in the project areas benefited. On marketing, there are 80 beneficiaries of market linkage training workshops

Food/nutrition security enhanced

SOPVs are tolerant to drought and hence ensure food security even under changing climate. With the SOPVs, complete crop failure is avoided(food available even during droughts)

» -SOPVs are indigenous within the already existing agro-ecosystems, hence are accessible to ensure food security in these areas

» -Total of 1884 farmers, representing 1884 families made food secure

Climate adaptation / resilience building

Disseminated technology (SOPVs) are tolerant to drought (can grow with minimal water). This helped 1884 families to adapt to drought disasters that are a result of climate change

» -appropriate training on SOPVs and adaptation provided to community

Ecosystem productivity enhanced

SOPVs on average are more resilient to climatic factors than other cereals and this has ensured the sustained productivity of the agro-ecosystems even under changing climate

- -SOPVs use soil moisture more efficiently hence ensure sustainable use of available moisture to enhance productivity of the ecosystem over a longer period relative to other crops that would rapidly deplete moisture.
- -Zero-tillage maintains soil structure and helps prevent soil erosion, ensuring productivity of the soil is maintained over time

Incomes / jobs created

Farmers generate incomes through sale of sorghum to large scale consumers (over 2696 metric tons (MT) of sorghum consumed by over 7 breweries) as well as small scale and individual entrepreneurs

- - Zero tillage technique saves on labor man hours as well as cost. Also the SOPVs adopted (ZSV-36R) is tolerant to birds, thus save man hours that would otherwise be spent minding the birds. Man hours saved represent incomes saved and can also be deployed into other income activities.

Value chains enhanced

- -Brewery processing chain enhanced – 8 breweries supplied with and consumed over 2696 MT of sorghum.
- -8 private entrepreneurs and self-help groups in the Sorghum Marketing businesses benefited indirectly from networking and collaboration opportunities
- -80 beneficiaries of market linkage training workshops
- -The new variety has market in stock feed, hence enhancing value chains in animal feed

Vertical upscaling potential / suggested actions to influence policy/policy changes suggested

To influence policy toward adoption of this technology, a policy brief, working paper or fact sheet based on this project and/or the SOPVs technology to be prepared and shared with policy makers at regional events / national level in relevant ministries and governmental department heads in individual countries.

Horizontal upscaling potential / suggested actions to enhance replication

The potential is high along the Luangwa and Zambezi river basin due to food in security among the rural communities and frequency of droughts. In places where markets are easier to access replication of the value chains potential is easier. The following incentivize replication: -
Within Zambia, an advantage for upscaling is that the technology is readily available from the Sorghum Breeding Programme at ZARI.

- -The high cost of agriculture inputs has forced a number of farmers to try this technology as a cheap alternative
- -The technology also has commercial value and can help contribute to the poverty reduction among rural communities using the sustainable value chains that it feeds into as demonstrated in this project. This is highly replicable across Africa where sorghum is grown, seeing that poverty is rife in the continent's rural areas

3.2.6 Promotion of soil and water conservation practices in Buluganya sub-county, Bulambuli District – Uganda

The problem: Land degradation; low crop productivity; use of un-sustainable farming practices

Techniques: Soil and water conservation (SWC) - contour bunds, tree planting, digging trenches, mulching

Results:

Capacity building for climate adaptation at community level

- -108 individuals comprising 25 females from 36 households (hhs); 46 pupils from P7, P6, P5 & P4 classes, and 10 teachers from Buluganya P/S trained in SWC practices
- -Socially, through organizing communities into groups led by 'champions', the project led to social cohesion within the parish in which other issues affecting the community were discussed. On several occasions, the groups were visited by health officers, agricultural extension workers and politicians to discuss issues / pass over key information on adaptation.

Food/nutrition security enhanced

With adoption of SWC, crop health has improved significantly. From observation, banana & coffee plants now have fruits& berries respectively and are greener and healthy compared to the previous scenario before SWC

- - Increased production of Napier grass improves cattle productivity hence enhances food security.

Climate adaptation / resilience building

- -108 individuals comprising 25 females from 36 households (HHs); 46 pupils from P7, P6, P5 & P4 classes, and 10 teachers from Buluganya P/S trained in SWC practices, increasing their adaptation knowledge
- -Erosion prevention enhanced. 5000 m of contour bunds raised on 50 farmers' fields. 4,000m of napier grass planted on the contour bunds. Initially, only 10% farmers knew about bunds and fewer (5% farmers) reported having contour bunds on their farms to prevent erosion
- -12,500m of trenches established. Initially, only 12% farmers were knowledgeable on trenches and fewer (less than 8% farmers) reported having trenches on their farms. These prevent loss of nutrients from land as soil washed during storms is trapped and can be returned to farm.

Ecosystem productivity enhanced

- -35 farmers mulched their plantations (bananas/coffee). Initially, no farmer practiced this technique. This improves soil moisture and fertility. Health of trees observed to improve, hence soil nutrients enhanced due to mulching.
- - 7,500 indigenous trees planted. These improve soil quality and biodiversity. Initially, only 4% considered them as important in soil and water conservation.

Incomes / jobs created

- -Tree planting initiative has potential to earn community incomes from carbon financing
- - Increased production of bananas and coffee due to good soil and water conservation practices can go a long way to boost farmers' incomes
- -temporary employment: Individuals were hired to make trenches, collect mulch and also to maintain tree nurseries.
- - The 7,500 indigenous trees planted are a source of direct income for community from charcoal/timber trade.

Value chains enhanced

With increased cattle, the cattle dung produced has possible spinoffs for biogas industry enhancement.

- -Tree planting initiative is an avenue for the community to benefit from carbon financing, and also provide opportunities in tree nurseries as part of the supply chain for the tree planting

Vertical upscaling potential / suggested actions to influence policy/policy changes suggested

Considering the important role played by trees in conserving soil and water, and current practice where farms are congested with perennials mainly, bananas and coffee, leaving limited space for tree planting, a policy to inculcate agro-forestry in farming practice is suggested.

Horizontal upscaling potential / suggested actions to enhance replication

Considering high demand for similar initiatives from neighboring communities, replication potential is high

3.2.7 Universities on Ecosystem-based Adaptation in Rural Communities in Zimbabwe

The problem: In the project area, climate variability causing short lived, intense and erratic rainfall results in increased run off causing loss of top soil, increased leaching of nutrients, crops failing to reach maturity (due to shorter unpredictable rain seasons). The specific problems addressed were; food insecurity and desertification of the local habitat

Techniques: ecosystem restoration (reforestation); conservation agriculture (micro-irrigation), alternative livelihood (fish and poultry farming)

Results:

Capacity building for climate adaptation at community level

- -Workshops on climate change resilience conducted
- -Community taught conservation agriculture (CA) by the university faculty of agriculture staff
- -Project providing community with sound knowledge on climate change adaptation. As an indicator, community now involved in gully reclamation
- -Women empowerment enhanced. They have time to attend workshops on food security and climate change, improve their knowledge because of boreholes providing water readily

Food/nutrition security enhanced

- -Food production enhanced because of water availability
  -university spearheading methods of food preservation hence enhancing food security
- -Community practicing Poultry, fish, vegetables production, bee keeping, shomwe (marula seed) production thus enhancing food security
- -50 households (250 people) in a desperate food situation uplifted from high food insecurity
  -Availability of food all year round because of irrigation infrastructure (productivity in irrigation schemes is 2-3 times more than in dry land)
- -Nutrition garden (monitored by experts from the university) established on 2 acre plot has enhanced villagers' nutritional needs
- -significant decrease in reported cases of child (0-59 months) malnutrition, from 12.5% in 2010 to 9.9%
- -Vitamins from vegetables (medicinal herbs) and protein from poultry, fish increase micro nutrient level of the food in the community
- -community uses incomes generated to buy what they cannot produce hence enhancing their nutritional security
- -A wide variety of vegetables now available (onions, tomatoes, carrots, beet root cabbage, rape, nyeve, medicinal herbs, etc.) to enhance nutrition.
- -Experimentation with black jack to increase iron content in food

Climate adaptation / resilience building

Micro-irrigation and alternative livelihoods employed to enhance resilience to inadequate rain or crop failure

- -nutritional garden equipped with pumped water (boreholes drilled, tanks installed, gen-sets provided)
- -workshops on climate change resilience conducted
- -community taught CA by faculty of agriculture staff to increase local resilience knowledge
- -project providing community with sound knowledge on climate change adaptation
- -Level of deforestation is reduced as traditional leaders take charge of re-forestation activities
- -Community is establishing indigenous and exotic fruit tree plantations that are more resilient to local microclimate
- -Community involved in gully reclamation -water security enhanced; the boreholes supply water for watering the gardens and for human consumption

Ecosystem productivity enhanced

Micro-irrigation, is restoring the ecosystem by improving soil moisture content, at the same time promoting food security in the community

- -reforestation activities enhancing ecosystem biodiversity

Incomes / jobs created

- Community has realized total of USD 16,000 from sale of their produce
- vegetables, poultry, bee products, and fish
- 12 men and 6 women were employed during the construction of a concrete tank -10 youths employed during erection of fence around the project land

» -200 households are self-employed in the garden

Value chains enhanced

This project encourages the following value addition enterprises:

» -Oil extraction from oil rich seeds (amarula/shomwe, Chakata, matamba, makwakwa)

» -Marketing of traditionally prepared amarula wine (mukumbi)

» -micro-nutrient extraction from oil-rich seeds to use as dietary supplements

Vertical upscaling potential / suggested actions to influence policy/policy changes suggested

Project proponents suggested that existing / current national policies on ecosystem based approaches should be implemented in full

Horizontal upscaling potential / suggested actions to enhance replication

The replication potential is considerable. The approach as modeled by the Midlands State University (MSU) the main proponent in this project, is replicable by all similar institutions of higher education in all geopolitical systems

» -To date, the approach is slowly being rolled out to other semi-arid districts like Chivi and Buhera

» -The MSU project is used as an incubation center of the adaptive approach used in this project. A local business man has already adopted the MSU approach

4. Upscaling and out scaling of EbA driven Agriculture and Orchestrating the new paradigm Shift– What is needed?

The overarching objective of scale is to link sustainable climate resilient agricultural productivity with value addition in processing and storage, input supply and output delivery chains from and to other enterprises and unlock cascading opportunities for employment and income generation along the entire food value chain, from external interveners and suppliers to the farm, and all the way to retailers and final urban high value consumers. By this, a shifting paradigm on to a new narrative, of climate resilient agri-business (farming as a business) for Africa, producing enough to feed the continent and a surplus to enhance global food security, while simultaneously generating livelihood opportunities for a growing youthful population and the rest in Africa, both at the rural farmer and primary processing level as well as urban second order processing entrepreneurs and industries is envisaged.

A number of measures are proposed to achieve this scaling up.

- **First,** while the food security challenge seems shared across afflicted countries in the continent, the enabling environment that needs to be harnessed at individual country and regional level to combat this challenge by upscaling ecological agriculture techniques that have proven effective is heterogeneous and very context specific. Consequently, any effort to scale up, amplify and transfer successful technologies and strategies should be done in ways that allow for unique national and regional approaches[115]. For a start, locals, comprising government bodies, institutions, professionals etc. should take the lead in implementation of any proposals as much as possible, with external experts and parties providing technical and financial backstopping and playing oversight especially where financial support has been provided, to oversee prudent utilization of these resources. The UNEP Regional Ecosystem-based Adaptation for Food Security Programme[116] (EbAFoS) is a good example that is charting a new paradigm shift towards making the case that addressing food security across the continent needs to be looked at a regional rather than national level, and that regional integration if driven by foods security concerns has a lot of potential for development in Africa
- **Second,** barriers to adopting EbA technologies by farmers should be addressed. From literature, the four A's model as postulated by Bain and Company[117] provides a theoretical basis for transforming obstacles toward the adoption of technologies by small scale farmers in Africa into drivers of adoption. According to this analysis that is based on 4 pillars, farmers will adopt a particular technology if they are aware of its existence and have the technical knowhow to effectively apply it. Gender sensitivity is required when dealing with issues of awareness, advantage, affordability and access. To increase chances of adoption therefore, early adopters should be strategically targeted to build trust with them, then leverage them as 'promoters' to spread and sustain awareness later in the adoption cycle, as the technology advances to reach the late adopters. Another pillar in this analysis is advantage – that farmers will adopt a technology to the extent to which it demonstrates to increase their financial standing. This was found as the strongest driver of adoption in the study toward developing the 4 A's. Up to 60% of farmers surveyed indicated that they tried a new product / service because it would increase their wealth. The implication is that farmers must be trained and demonstrations done to facilitate their understanding on how a particular technology will offer them concrete financial benefits over what they are currently using. Affordability is another key aspect that influences adoption. That a particular innovation should be priced affordably and made available at that price at the time when farmers have the money to buy it, considering their seasonal cash flow cycle. It brings to the fore, the issue of timing, that when a particular technology is priced at a premium, it should be introduced to farmers when they have received income from say a previous good harvest. Access is another pillar of this model. That technology must be available when and where it is needed. This is particularly important considering the infrastructure bottlenecks especially in rural Africa, where most farmers reside, and also the seasonal cropping / livestock cycle, since for instance a product/service may be relevant only during the planting season. Appropriate contextual supply chain strategies must therefore be developed to ensure products reach farmers, and the timing should also match the particular period of the cropping/livestock cycle.

  In terms of applying this model, Bain and Company report that while all the four pillars are vital, of particular importance at the introductory phase of a technology are advantage and affordability, while awareness and access become increasingly important as technology proponents progress toward achieving scale. This means proponents must invest to satisfy these 2 pillars first before going on to access and awareness later on as the market matures.

Demonstrating that a technology is affordable and will provide financial benefit to farmers are the greatest adoption factors that will then elicit farmers' interest to learn and increases their awareness of the techniques and take the necessary steps to acquire them.

In addition, since women produce most of the food in Africa it is important to ensure that extension services are available for women farmers and that new technologies are affordable for women smallholder farmers

» **Thirdly,** efforts should revolve around the needs of small holder farmers[118], who produce up to 80% of food in Africa. To this end, first, it should be noted that a majority of small holders are women[119] and they provide 60 – 80% of labor[120] for food production, both at household consumption and for sale. However, while this is the case, female productivity in agriculture is lower than men, primarily because in addition to the external constraints to productivity women farmers equally face with men, they also have an unequal access to resources – human controlled endowments necessary for increased productivity, such as land rights, education, access to technologies, labor, capital, support services and credit.

Considering that agriculture is becoming a predominantly female sector in sub-Saharan Africa, as a consequence of faster male out-migration, addressing women productivity constraints will go a long way in building their capacity, and enhancing up-scaling within this vital group. There is also need to recognize unpaid care work responsibility of women smallholder farmers who in addition to performing farming tasks have to fetch water, firewood , do domestic chores such as washing, cooking which though taking a significant amount of women's time and energy are not recognized as work. In some countries these tasks up to six hours each day. The interventions can be in the form of woodlots which can address firewood shortage, water harvesting technologies to reduce the amount of time spent on fetching water for

domestic use and child care centers which allow women to engage in other productive activities while their children are being taken care of at the child care centers.

In addition to addressing productivity constraints of women farmers, on a general scale, additional needs[121] of small holders include development of business management skills to help them better manage resources and risks, and improve decision making. This is to improve quality of interaction and decision making of farmers with businesses with which they interact along the supply chain, from input suppliers, service providers e.g. transporters, storage etc. to ensure profitability even at the farm gate level hence enhance sustainability of farming. This calls for entrepreneurial training for farmers at all levels.

Enhancing the sustainability of access to real time and better quality data and information on crop/animal husbandry and relevant market information relating to cost of inputs and services, produce prices, availability of markets etc. is another need that should be addressed. Mobile applications such as MLOUMA in Senegal, POULTY GUIDE in Uganda, COCOLINK in Ghana are among a dozen innovations[122] that have been applied widely to enhance this information aspect, resulting in better decision making to improve both agricultural and financial productivity of farms. In addition, strengthening extension services will go a long way in improving quality of information and hence decision making by farmers.

There is also need to link ecological agriculture produce from small holders to markets. This is an area that governments and the donor community can support farmers in order to create demand and an incentive to invest in ecosystem technologies, hence contribute toward achieving scale. For instance, the international market for organic products with premium prices is an opportunity for farmers to increase incomes. Africa can leverage the demand for organic products in industrialized countries[123] as an important growth factor. Another motivation is the maintenance and building of soil fertility on land threatened by degradation and erosion. Donors can support farmers by facilitating their access to specific markets in the developed countries. Governments can also engage in government to government agreements with market countries overseas so as to secure exclusive market deals for their farmers. In addition, as the international organic market continues to grow, governments should put in place appropriate policy and regulatory frameworks to organize the sector, e.g. appropriate labeling and certification guidelines and procedures, so as increase demand in quantity and variety of organic products from Africa in the international markets

Facilitating formation of farmer groups/organizations, as forums to share best practice, disseminate innovations, inform decisions, support cross-cutting functions such as farm and market advisory, supply of inputs etc. should also be addressed as another area of need for small holders.

Subsequently, addressing the needs of small holders will improve their capacity to not only use but acquire relevant technologies and this wide scale empowerment of small holders will enhance wide scale use of these technologies.

» **Fourth,** ongoing commitment from other actors involved in the food supply chain, specifically government, by establishing and communicating clearly and consistently a country vision for ecological agriculture, and supporting its implementation through appropriate policy and non-siloed, collaborative development and implementation of strategies and policies to ensure the effective application and allocation of resources, both budgetary and manpower to facilitate implementation of such policies and strategies. Donor agencies should also have ongoing commitment by investing in capacity building at all levels, from policy level where strategies are developed to farm level where implementation takes place & coordinating better with other donors to avoid duplication and build synergies.

» **Fifth,** the role of the private sector in investing in market-driven solutions should be defined and enabled where necessary. Government has a vital role to play to actualize this as development of relevant policies to create a conducive market environment and thus incentivize private sector action is the preserve of government. Examples of relevant policy and legislation can include those safeguarding free market, ownership of assets, incentives such as tax waivers on relevant imported industrial goods to facilitate local production, special economic zones etc., as well as clear policy guideline and regulation of targeted industries – clearly stipulating duties and responsibilities of all actors. The enabling environment should also include an effective legal system for redress, and availability of adequate good quality infrastructure (transport and communication, energy, water). Private sector actors bring in market components such as efficiency, technology, professionalism and competitiveness that are vital in achieving scale and sustainability.

» **Sixth,** affordable, sustainable and accessible financing/credit schemes are needed to enable scaling up of on-farm and post farm gate small and medium enterprises (SMEs). Finance will help both farmers and other post farm gate entrepreneurs to expand their businesses, and this is vital in creating the demand chain for these productivity increasing EbA technologies and hence contributing toward scaling up their use. In addition, those involved in the supply chain of these technologies, such as suppliers of improved seed varieties or tree nurseries for agro-forestry will benefit greatly

from affordable financing to expand their businesses, serve a larger market and thereby, create demand for upscaling the development of these technologies.

» **Seventh,** Educationalizing[5] EbA- Driven Agriculture is a key enabling step. The influential role and input of educational and research institutions in harnessing, and availing appropriate scientific data and information as well as developing, testing and demonstrating appropriate productivity improving EbA technologies to both policy makers and end users, i.e. farmers should be leveraged and strengthened through increased public investment for research and development capacity. In addition, education curricula should be reformed at elementary, secondary and university levels. Curriculum developers at each of these levels should ensure principles of EbA – driven agriculture are integrated from the earliest possible levels of learning to facilitate a generational appreciation of ecosystems, which will increase awareness and likelihood of their use by the population.

The media should also play its role by developing and disseminating programmes to inform the public of climate change and available ecosystems technologies to build resilience. This increased awareness will contribute to scaling up use of these technologies by the public.

» **Eighth,** as the maxim – what gets measured gets done. There is need to progress in strengthening metrics and bench marks to measure performance and achievement of objectives and enable accountability of ecosystem based adaptation actions by all actors – governments, farmers, private sector, civil society, donor community - involved in activities aimed at scaling up use of ecosystem based technologies. It is worth noting that measuring the benefits of EbA can prove to be quite complex, with different methods that can be applied and a number of uncertainties constraining current approaches. Scientists therefore need to establish and publish the most appropriate methods to measure costs and benefits of EbA. However, currently, methods do exist and are documented by both UNEP[124] and the economics of ecosystems and biodiversity (TEEB) in its publication[125]. Actors should use them appropriately to measure progress, identify accomplishments and gaps and inform further action toward fulfilling up scaling objectives.

» **Ninth,** there is a need to develop and package locality specific (agro-ecological zone and farm system specific) EbA techniques that can be used as a guide to optimize EbA benefits across the different contexts of application. This will help decision makers to support planning for concise actions to adopt EbA.

» **Tenth**, unfair trade rules – there is a need to reform international free trade practices / agreements that work to disadvantage African farmers in the global markets. While Africa and other southern farmers are forced to remove agricultural protections like quotas, tariffs, price controls, subsidies of inputs etc., as they are considered barriers to trade, many western governments are allowed to subsidize their agriculture. Consequently, African small holders and agribusinesses are forced to compete with highly subsidized[126] North American and European agribusiness. Such skewed trade practices mean Africa cannot be competitive in international trade and unfairly loses out on income opportunities. While African governments should individually and collectively, through RECs and the AU, continue to call for and negotiate for better trade terms at international forums, the continent's developmental agenda should not be held hostage by this state of affairs. Africa should take this as an opportunity to encourage and strengthen local, national and regional trading relationships, especially on agricultural produce. The goal should be progressing toward formalizing a regional commodities market for agricultural produce, which shall encourage more intra-regional trade on mutual terms, hence more income to the regions farmers. With a better market and increased incomes, enterprises flourish and scale is achieved.

» **Finally,** at the regional level, the vital role of regional intergovernmental organizations such as the African Union (AU), East African Community (EAC), Economic Community of West African States (ECOWAS), Southern Africa Development Community (SADC) etc. regional development finance institutions, primarily the African Development Bank (AfDB) in enabling wide spread policy interventions on continental opportunities and challenges should be leveraged. For a start, support for the implementation of the CAADP, that was the outcome of the Maputo[127] declaration and further recommitment to its ideals as captured in the Malabo[128] declaration should be a matter of urgency for these organizations. This policy brief hopes to contribute toward the achievement of the ideals captured in these continental blue prints, including the AU Agenda 2063[129], all which establish agriculture as a potent industry in ensuring sustainable and inclusive growth in the continent.

5 Integrating EbA and its principles in formal education curricula. Can be captured at elementary, secondary and tertiary/university levels

5. Enabling policy and legislation to incentivize country investment

A number of policies can be recommended in creating a conducive environment to facilitate investment in the new agricultural paradigm by actors within a country. This paradigm takes a holistic view of agriculture to ensure sustainability and increased productivity from on farm production and efficiency and waste reduction at and beyond to post-farm gate value addition. It involves application of ecological agriculture practices at the farm level to ensure sustainable crop productivity hence food and livelihood security while simultaneously enhancing ecosystem productivity and ensuring climate resilience and integrates value chain enhancement strategies and technologies along the entire food value chain to prevent food loss and create opportunities for off farm livelihood activities. This is in contrast to conventional food systems that focus on increasing production through excessive use of external inputs, mainly energy through mechanization, agrochemicals and fertilizer that jeopardize the long term productivity of ecosystems and does not incorporate value addition chains as a continuum.

A number of groups, within a country can be targeted with enabling policies to facilitate investment at their respective levels. From rural small holder farmers, vulnerable groups such as rural poor engaging in agriculture, to women and the youth, community based organizations, non-governmental organizations, private sector – both large enterprises and SMEs, donor community, educational and research institutions and local governments, all these can be enabled, through appropriate policies, to invest in and effect this new paradigm at their level within a country.

» Generally it is widely agreed that land rights are essential[130] in motivating short and long-term fixed investments in agriculture by diverse groups, from small holder farmers to larger investor groups in the private sector.

However, land tenure systems in Africa[131] are not adequately structured and not inclusive. Tenure of over 90% of land remains outside the formal legal system, and the risk of dispossession remains apparent[132]. Indeed, it is observed that only a small fraction[133] of land in Africa is subject to individual titling. Most of the land is community-owned, and in some countries state-owned. To incentivize small holders and other interest groups to invest in nature based

technologies, they need to feel secure about the ownership of their land. While individual titling is key to increasing land ownership by individual farmers hence incentivizing long term investment by small holders, a caveat is advised. Based on lessons from Latin America, where "Agricultural modernization" programmes gave title to individual farmers, with the end result that many of them sold huge quantities of land to wealthy nationals and international corporations, and were subsequently left as landless poor, extreme care must be taken to avoid a similar predicament Africa. Consequently, as a safeguard measure, it is recommended that:

i. If land is individually titled, it should not be subject for sale to those outside the village.
ii. If an owner dies without children, or the land is abandoned, that land should revert back to the village as a whole, to be titled again according to the village's decision.

In addition, women farmers, who make up 70% of Africa's farmers, are locked out of land ownership due to customary laws. Addressing such governance issues at the national level is vital for achieving increased investment and productivity from this group. For consideration, an appropriate policy that mainstreams affirmative action in land allocation and ownership could be considered as among interventions to bring women at a par with their male colleagues on access to land as a factor of production.

Other than developing and expanding policies, **existing policies should be maximized** and **reformed** where necessary.

For instance, outdated and counterproductive forestry legislation that discourages farmers from investing in protecting, regenerating, and sustainable harvesting of trees in agroforestry systems, through ambiguous provisions such as fines for unspecified offences that allow unscrupulous forest agents to exploit farmers should be abolished through a structured process reform. Such are common in a number of countries in West Africa[134]. These should be reformed to facilitate the involvement of farmers and forest communities in conservation measures. Appropriate policy at local level that gives farmers and forest community access to forests and assigns them responsibility and structure to preside over farmer managed natural regeneration of forest trees could be a viable strategy of involving communities in sustainable management of forest resources. There is also need for community seed banks to promote the use of agroforestry technologies as well as appropriate extension services for farmers engaging in agroforestry.

» Agricultural development policies that emphasize agricultural modernization through the increased use of mechanization and subsidized inputs, while neglecting measures needed to reduce land degradation, facilitate soil and water conservation among other ecological techniques constitute another area that needs agent attention throughout most of Africa. As an example, in Senegal[135], the Ministry of Agriculture had encouraged the use of tractors and animal ploughs to plow in straight rows, even if it meant destruction of existing agroforestry areas that had protected soil from erosion and helped to replenish soil organic matter and nutrients. Such policies are an impediment to investment in agroforestry and other improved land and water management practices and should be reformed, to ensure sustainable practices are mainstreamed.

» Existing fertilizer subsidy policies should be maximized by reforming them to complement ecological approaches such as micro-dosing or integrated soil fertility management (ISFM) whose known benefits[136] include cost effectiveness and significant sustainable improvement in yields and hence incomes, improvement of soil fertility, all without degrading agro-ecosystems. It is also worth noting that fertilizer subsidies are costing African governments huge sums of money. For instance, it is reported that ten countries in sub-Saharan Africa are spending[137] up to USD 1.05billion annually on imported fertilizer subsidies programmes, representing approximately 30% of their agriculture budgets, while ecological approaches make use of locally available material, in addition to being cost effective, thus ensuring money circulates in local economy. In addition to cost savings, are mitigation (eliminating dependence on fossil fuels) and adaptation (enhancing ecosystems and climate resilience) benefits of ecological approaches. Based on this, African governments should progress toward eliminating chemical fertilizers and the accompanying subsidies and instead, re-invest these monies on promoting ecological approaches.

» There is also a need to maximize existing agricultural and other policy frameworks meant to attract investments into agriculture[138] such as those securing access to land and water, those guaranteeing well-functioning input and output markets / free market economy, effective mechanisms for enforcing contracts and compensating expropriation among others at country level.

Additional **policy actions** targeting individual interest groups are as follows:

» **First,** the private sector as a source of capital and investment should be incentivized. Government policies incentivizing private sector investment such as special economic zones, tax / duty waivers, tax rebates, favourable land lease agreements, etc. geared specifically toward encouraging private sector investment in ecological agriculture as well as agribusiness should be pursued. For this to succeed, commitment from both private sector (e.g. scaling up success,

developing new models for Africa, ensuring additional investment) and senior levels in government (creating and consistently nurturing an enabling business environment e.g. transparent and effective legal systems and appropriate structures to institutionalize good policies and ensure their continuation beyond elections) will be required. The government and private sector must also jointly think of formulating sustainable procurement policies that embrace the "Sustain or be Obsolete[139]" or sustainable procurement principle to further enhance the transition of supply chain operations to green value chains[140] also promoted by this paradigm.

» **Second**, policies and regulatory frameworks to facilitate inclusive partnerships along the agribusiness value chain among critical players whose investment in this new paradigm will be vital for growth are needed. These are partnerships involving the private sector, farmers, CSOs, public sector, donors and NGOs, research institutions working in collaboration to develop solutions to challenges such as access to markets, financing, developing low risk business models that deliver greater value, developing and testing newer technologies etc.

» **Third,** appropriate policy to productively engage Africa's youth and women in the agricultural sector and their entrepreneurial skill and spirit through skills development. Specifically, to attract the younger generation to the agri-food sector, the sector needs to be redefined through appropriate entrepreneurship training, and development of technical skills, to shade off its current image of manual labour and subsistence un-profitable farming. For women, who currently produce up to 80% of the food in Africa[141], affirmative action policies to ensure their access to training and assets/land ownership will be vital to enhance their productivity, and hence productivity of the sector as a whole . It is also important to recognise in these policies that women smallholder farmers are involved in agricultural production as well as care work which includes activities such as fetching water, firewood, child care among others which takes a significant proportion of their time. Currently the regional bodies do not have clear no clear policies as well as funds allocated to address access to water for drinking and domestic, firewood for cooking and child care in rural farming communities which are primarily done by women. There is thus need for an integrated approach which addresses care work as well as agricultural production.

» **Fourth,** policy to build capacity of small holders to access markets and unlock their entrepreneurial potential e.g. continuous skills development to comply with new market demand, product specification etc. is required to enhance their earning capacity from international markets

» **Fifth,** appropriate policy to deploy protection mechanisms and tools such as tariff and non-tariff barriers in favour of local farmers produce against unfair trade practices in the international markets is recommended. This will safeguard the local developing sectors and entrepreneurs against the more developed competitors in international markets

» **Sixth,** policy to facilitate easy access to micro-finance for women, the youth and small holders, who despite their potential, are perceived as high risk groups by conventional lending institutions is required. An appropriate policy to allow government to guarantee credit facilities offered to this group can be targeted.

» **Seventh,** policy to bridge the current rural infrastructure gap that is impeding trade and so facilitate economical access to local and regional markets e.g. prioritize funds/budget allocation for rural infrastructure development where farming is done is required as a matter of urgency. This will reduce current high costs such as transport, storage, in the agri-value chain, that are holding back investors.

» **Eighth,** policy to govern and regulate risk management instruments such as insurance will encourage investment from both small holders and SMEs as the market is assured of protection of investments in case of extreme events such as drought. It will also encourage service providers such as insurance and actuaries specialized to the agro-food sector to develop and participate as the business environment is organized and well regulated.

» **Ninth,** appropriate safety net policies to incentivize investment in technologies among the vulnerable groups like poor rural farmers who have low earnings but may have great entrepreneurial potential is recommended. These can include cash transfers, seed and tool distribution for start-up capital, mother-child health & nutrition & school feeding programmes to allow mothers more time to engage in agriculture.

» **Tenth,** appropriate policy to support research institutions on specific research agenda that supports this new paradigm is recommended. This support should be centred on strengthening delivery of the two key components of this paradigm, better context specific ecological agriculture techniques and identifying value chains and business models that will deliver greater value and reduce risks.

» **Eleventh**, policy to incentivize student investment and enrolment in agriculture programmes in institutions of higher learning and Educationalizing6 EbA driven agriculture. These can be in form of education grants and scholarships offered by governments to students who enrol in relevant agriculture, technology and business programmes. The government should also facilitate involvement of donors, the private sector and others of goodwill to support such an initiative. It is documented that most educated people confront a mismatch[142] between their training and available opportunities. In South Africa, for instance, firms report 600,000 vacancies, while 800,000 young university graduates are unemployed[143]. In universities across Africa, while 26% students enrol in humanities, only 2% enrol in agriculture programmes[144]. If this sector is to be the engine for growth and investment, sufficient manpower has to be generated.

Institutions of higher learning, colleges and universities should put in place policies to periodically review their curricula and taught material to ensure alignment with advances in technology, facilitate innovation and ensure greater relevance to a diverse and evolving agricultural sector. Currently, focus should be on agribusiness & entrepreneurship as well as sustainable agriculture through EbA. In addition, African universities need to revise their educational system to a Duo-Qualification Certificate System which emphasises integration of theory and practices even for non-science course students with the aim of fore fronting Agriculture and agri-business.

6 Developing a curriculum for EBA degree coursework

6. Strategic framework: Toward operationalizing the new agricultural paradigm in Africa Shift embedded in EBA-driven approach

This paper has, through a review of relevant literature and presentation of empirical findings, challenged the current food insecurity scenario in Africa by laying a case for a paradigm shift from current conventional agricultural approaches that destroy ecosystems through unsustainable practices like deforestation, overgrazing, mono cropping on a lower level and a focus on substituting natural processes like soil formation, and biodiversity with artificial ones reliant on overuse of external inputs like energy intensive high emitting mechanized tillage, agrochemicals and overuse of fertilizer to increase food production at a higher level, without considering the sustainability of the ecosystems that underpin food production and without considering the food value chain as a continuum. This approach it has been argued, will not build an economically and environmentally sustainable food system in Africa in the long run especially under the changing climate.

As an alternative, the new paradigm of holistic agriculture, that considers productivity and efficiency of the entire food value chain by integrating ecological on farm productivity using ecosystem based adaptation techniques like conservation agriculture, agroforestry etc. with value addition enterprises supported by appropriate technologies and business models on and beyond the farm gate so as to build sustainable food systems for Africa has been proposed.

To this end, two components, one - upscaling this new paradigm both ***vertically*** *in terms of influencing policy toward this approach and* ***horizontally*** *in terms of wide scale replication of successful application of this paradigm or its components and two - investment by various actors involved in Africa's food security, in this new paradigm to facilitate adoption have been suggested as the way forward to safeguard Africa's food security, adaptation and sustainability of its ecosystems under a changing climate while simultaneously creating income and job opportunities for millions in the continent.*

Considering the substantial influence appropriate policies have on ensuring positive change, this document has recommended a number of policies that will contribute toward attracting investment at country level as well as regional and continental. In addition, a number of measures have been recommended to achieve scale.

The strategic framework addresses the operational requirements needed to facilitate successful implementation of these components - the policy measures[7] to attract investment as well as measures to achieve scale. It is based on pillars that include appropriate institutions to embed policies in both public and private sector; resources, including financial support and human capacity to facilitate implementation of requisite strategies; knowledge management frameworks to guide development and implementation of strategies; and appropriate metrics to ensure effective monitoring and evaluation of implementation activities for both public and private sector.

Institutions are the foundation that embeds good policies in both the public and private sector, to ensure policies are grounded and sustainable over time. As discussed in this document, commitment by private, nongovernmental and public players is required to ensure continued investment in this paradigm shift. This commitment is concretized through institutions that transcend individuals. In the private sector, institutions that safeguard interests of businesses should be at the forefront in enforcing sector wide policies and mechanisms that will secure commitment of relevant players in this new paradigm. Similar institutions should lead in the civil society and NGO sector. In the public sector, line ministries should be in the forefront in ensuring that policies are embedded in program of works.

Budgetary allocation is another key operational parameter. Annual budgets by national governments should set aside funds specific to financing identified projects or programmes aimed at scaling up this new paradigm or attracting investment into this paradigm. Relevant training programs by line ministries should also be facilitated e.g. training of extension workers, or the small holder farmers or women and youth groups, to equip them with knowledge to implement this paradigm at their respective level.

There is also need for a concrete knowledge base, comprising traditional indigenous knowledge, scientific data, market information, and appropriate tools and mechanisms to facilitate its management and dissemination – publications, newsletters, websites - to users at various levels, so as to guide decision making at various levels, from policy level action, to private sector and small holder farm levels. The African Adaptation Knowledge Network provides a good model for operationalizing knowledge management for decision making. Such systems should be replicated and modified where necessary, to suit knowledge needs of the diverse actors in a country – private sector, public, civil society, community organizations, research and educational institutions.

7 Impactful policies - Policy measures (in terms of just devising, approving and legalizing intentions alone) are most of the times inadequate unless attention is paid to addressing: a) clear intent through coherent legal/policy documents; b) balancing contesting interests; c) devising and applying necessary and most appropriate instruments; d) putting in place appropriate and context specific implementation arrangements. See for example: UI Hassan, M M (2011). Analyzing governance reforms in irrigation: Central, South and West Asian experience. Irrig. and Drain 60(2):151-162.

Finally, as the maxim goes, what gets measured gets done. There is a need to develop appropriate matrices and benchmarks to ensure effective measurement of upscaling and investment efforts by various actors. Sector specific standards and metrics should be developed to enable the auditing of performance by the various players and identification of areas of improvement.

Putting EbA-driven agriculture in the vision of Africa's Development is Africa's own fierce urgency to leapfrog Africa into a world where, in the words of Nelson Mandela, there is work, bread, water and salt for all.

7. Annex

Annex 1 Data collection and sampling methodology

Data used to validate claims and recommendations made was collected using 2 approaches, literature reviews and questionnaires (for project cases studied).

Literature review

Three kinds of literature on EbA, food security, EbA for food security, agriculture value chains / value addition techniques and technologies mostly, African context sources were extensively reviewed.

1. Policy reports and documents
2. Practitioners reports and publications
3. Scientific literature

Empirical study

Considering that EbA and EbA for food security is being applied across the continent, empirical continental cases were also studied.

Practitioners across Africa, representing each of the sub-Saharan Africa regions- Southern, Eastern, Central, West Africa – NGOs, CBOs, INGOs, CSOs, private enterprises, government entities who have a portfolio of EbA / EbA for food security projects, were mapped out and used as study items.

Considering that concepts of EbA are considered relatively new and EbA techniques despite their benefits remain largely invisible to mainstream agriculture across the continent, selection of informative cases could not be left to *chance (probability sampling approach)*. Consequently, in considering its cost effectiveness and time saving advantages, in addition to the need to select informative cases, *non-probabilistic or judgmental sampling* methodology was used to select cases. Main criteria for selecting actors was those who have demonstrated longevity - have operated successfully in the continent for at least 5 years.

Sample size determination.

In ensuring a representative sample, informed assumptions and an appropriate formula were applied in generating an appropriate size of projects to be sampled. Considering that concepts of EbA are relatively new, a total of 400 active EbA projects across the continent was assumed (average of about 5-10 projects applied across the 54 countries). This is a small number (population) of projects, considering Africa's population of about 900 million inhabitants. Hence the small population formula to determine sample size was applied.

From literature, the sample size determination formula for small populations is

$n= (N * z^2 * p*q) / [E^2(N-1) + (z^2 * p*q)]$

Where

- n is the required sample size
- N is the population size
- p and q are the population proportions (are set to 0.5 each)
- z is the value that specifies the level of confidence you want in your confidence interval when you analyze your data. Typical levels of confidence for surveys are 95%, in which case z is set to 1.96.
- E sets the accuracy of the sample proportions. We assume an accuracy of + or - 3%, so E is set to 0.03.

Applying formula yielded the below:

$(400 * 1.96^2 * 0.5 * 0.5) / [0.03^2 (400-1) + (1.96^2 * 0.5 * 0.5)] = 291.14$

This was rounded up to 300.

Consequently, a target sample of 300 projects was judgmentally selected Data collection

Based on the target sample of 300 projects, 50 practitioners across Africa, representing each of the sub-Saharan Africa regions- Southern, Eastern, Central, West Africa – NGOs, CBOs, INGOs, CSOs, private enterprises, government entities who have a portfolio of at least 6 EbA / EbA for food security projects were targeted for study

Questionnaire design

- Questionnaires were used to collect data from the practitioners. They aimed at ascertaining whether the projects were providing the benefits of the proposed new paradigm as gleaned from literature – climate resilience, ecosystem productivity enhancement, food security, value chain opportunities and income generation.
- Questionnaires also established the type of EbA technique being applied.

Data analysis

Analysis involved data reductions using tables and charts

Assumptions

A small number of EbA for food security projects being undertaken across Africa – an average of 5 – 10 for each of the 54 countries which meant about 400 such projects. This was informed by literature that EbA principles are considered relatively new in the continent.

8. End Notes

(Endnotes)

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