Nature-based Solutions in Agroforestry

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KEY MESSAGES

- Africa faces multiple challenges to improve the livelihoods of a rapidly growing population, most of whom are dependent on rural livelihoods that have already put pressure on African landscapes. These landscapes have been declining in productivity and are now becoming increasingly exposed to uncertainties arising from climate change.
- Nature-based solutions (NBS) will play a major role in managing these environmental concerns. NBS harness the power of nature to help build resilience against a range of environmental hazards. NBS also tend to create job opportunities for local people and encourage local ownership of the outcomes.
- Agroforestry, a land management practice where trees are grown around or among crops, pastureland, or homes to provide shade, shelter, fertilizer, fuel, food, fodder, and other products, is an important NBS that fits well with African farming systems, skills, and livelihoods.
- Many have simply called for more agroforestry and the planting of more trees. But agroforestry solutions must be carefully tailored to locations, to existing livelihoods, community skills and priorities, and to local markets.
- Despite lamentably poor financial support African scientists are tackling questions of finding the best solutions—site selection, farming system

and species selection, to name a few—but there is a need to blend this knowledge with that of communities to find solutions that fit the physical location and the communities' priorities. This requires a true co-production of solutions.

- Doing so will require new modes of continuous learning, better mechanisms for financing multiple agroforestry projects, and possibly recreating forms of governance based on traditional multilayered structures rather than the currently dominant top-down structures.

With its natural resources, in particular its rich biodiversity, the Democratic Republic of the Congo has the ambition to be a world leader in the use of nature-based solutions to strengthen its resilience. However, we are missing the financial resources that could help us contribute to a beneficial solution for all to climate change, setting up both mitigation and adaptation instruments. I therefore invite our development partners to support the Africa Adaptation Acceleration Program to help us achieve the objectives that we have set ourselves."

H.E. Félix Tshisekedi
President of the Democratic Republic of the Congo

INTRODUCTION

A theme of the Africa Climate Week held in Gabon in September 2022 was that even as the continent urgently seeks increased support for responding to climate change, it also has many resources both for mitigation and adaptation solutions.[1] It has large renewable energy potential, several minerals that are in high demand for energy production and batteries, and the potential for many nature-based solutions (NBS) that can support food production, conservation, and tourism among others.

The 2019 report Creating a Sustainable Food Future, the culmination of a multi-year collaboration between the World Resources Institute and several major international organizations, focused on how to feed 10 billion people by 2050 while protecting natural ecosystems.[2] If the target of limiting global warming to 1.5°C above pre-industrial levels is to be met, the report found, global greenhouse gas (GHG) emissions from agriculture need to decline by two-thirds, and almost 600 million hectares of abandoned or unproductive agricultural land need to be reforested. These multiple challenges will require the intensification of agricultural production in many areas, and the conversion of former cropland to more natural ecosystems in others. In many parts of the world, agroforestry—a blend of agricultural and pastoral practices with selective tree establishment—offers a unique opportunity to boost crop productivity, reduce GHG emissions, and restore ecosystems, all together. This is especially so in Africa.

This chapter reviews agroforestry as a particularly important category of NBS for Africa. It is organized into four sections. The first reviews NBS as a critical part of adaptation for the African continent. The second presents a deep dive into agroforestry as an NBS in Africa, with a specific review of lessons learned from programs that did not achieve their full potential. The third section proposes institutional and policy changes needed to make agroforestry an effective solution to climate adaptation and multiple other benefits. The final section presents the chapter conclusions.

NATURE-BASED SOLUTIONS IN AFRICA

Modern Africa has high reliance on natural ecosystems, as about 56 percent of its people, almost 790 million, live in rural areas.[3] These populations depend at least to some extent on agriculture, forests, and savannas to support their livelihoods—or else on sectors such as tourism that rely on wildlife within those natural systems. Africa has also long used green solutions, hereafter

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called NBS, to reduce the impacts of a variable and changing climate. In this section we discuss how the concept of NBS has been defined, and specific ways in which NBS are being used in Africa.

What are Nature-based Solutions?

The International Union for the Conservation of Nature (IUCN) describes NBS as "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human wellbeing and biodiversity benefits."[4]

It has long been understood that human wellbeing depends on the diverse range of services produced by healthy natural and managed ecosystems.[5] With the increasing threats to human wellbeing from the loss of healthy ecosystems—whether from direct human damage or more complex threats such as those from climate change—solutions that benefit both humans and natural systems are needed.

Various major international efforts have addressed the interface of natural and human systems, using different terms. The Millennium Ecosystem Assessment, for instance, used the term "ecosystem services" to highlight how ecosystems contribute to the economy and support human wellbeing.[6] The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) referred to "nature's contributions to people."[7] Other terms used to describe climate solutions involving ecosystems have included "green solutions," "green–grey solutions," or "ecological engineering."

Many organizations, including IUCN in the past, have used the term "ecosystem-based adaptation" (EbA).[8] An expert group convened jointly by the Convention on Biodiversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC) defined EbA as an approach that "integrates the sustainable use of biodiversity and ecosystem services into an overall adaptation strategy" to help people to adapt to the adverse effects of climate change while recognizing that human wellbeing is critically dependent on the presence of healthy ecosystems, which should also be fostered.[9] But many saw this definition as being too human-centric and sought to promote actions that were more focused on the protection and rehabilitation of natural systems. Others felt that concepts such as EbA failed to encompass all the various components that contribute to human wellbeing, including cultural and ethical issues.[10]

The term "nature-based solutions" was first coined by a World Bank team in 2008,[11] but it was not fully described or defined at the time. IUCN began giving more emphasis to NBS over the past decade, providing the definition cited above and developing a global standard with eight principles underpinning the NBS approach.[12] Some argue that only actions that meet all eight principles should be called NBS, and any deviation from this standard weakens the meaning and value of the term.[13]

An editorial in the journal Nature in 2017 took a broader approach, recognizing "nature-based solutions" as an umbrella term for the multiplicity of terms already in use to cover efforts to achieve both healthier natural systems and improved human livelihoods.[14] It described NBS as "a newly coined umbrella term intended to sweep up all of the [existing] phrases, … and dump them into a policy-relevant pot, where sustainable practices that harness the natural world … can be devised, analyzed and then pulled out for use by politicians, scholars and researchers." Here we follow the advice of the editors of Nature and use NBS as an umbrella term.

The Potential for Nature-based Solutions in Africa

NBS are being applied widely across Africa, including in water security, human health, livelihoods, disaster risk reduction, and climate change mitigation and adaptation.[15] They are a core component of the Africa Adaptation Acceleration Program (AAAP), the Green Cities Initiative, and the West Coast Management Program (WACA).

There is huge potential for NBS in Africa, and there are frequent calls for the wider adoption of NBS from heads of state to local leaders. Technical documents on adaptation are replete with statements of the opportunities associated with NBS. For example, they are discussed in 14 places in the Africa chapter of the latest Intergovernmental Panel on Climate Change (IPCC) assessment on climate risks and adaptation.[16] The IPCC found that 36 percent of adaptation actions identified in Nationally Determined Contributions (NDCs) submitted by 52 African countries as of early 2020 involve NBS.[17]

NBS are best planned at a landscape scale and designed to meet critical needs both now and under future climates. As an example, NBS opportunities often arise in Africa in managing degraded water catchments by restoring vegetation based on local species. The goal may be not only to maintain high water yields from a catchment, but also to moderate extreme low and high flows. This can be achieved by establishing open woodlands with native tree species and grasses to sustain water yield, and reestablishing wetlands to moderate peak flows and also improve water quality by trapping silt. Species can also be selected with wider value to local communities, such as timber and fuel-wood, fruit or of cultural significance. In Africa, non-native species such as eucalyptus and wattles often need to be removed to better manage water flows and make way for native ecosystems to be reestablished. NBS also tend to create job opportunities for local people and encourage local ownership of the outcomes.

NBS can be combined with "hard" interventions such as recontouring landscapes or canal construction to assist in managing water flow. These are often called green–gray solutions. The important point is not to jump immediately to an engineered ("gray") solution to the problem, but to integrate both green and gray solutions from the outset, while also looking more widely at actions that will provide additional benefits to communities and help maintain biodiverse and healthy ecosystems. (A recent report from WWF has more examples of this type of NBS in Africa.)[18] The challenge is to create teams with skills in designing natural solutions and have them work with planners, engineers and financial specialists to create solutions at the scale needed to solve the problems facing us.

Put simply, NBS harness the power of nature to help build resilience against a range of environmental hazards. At the same time, they can provide or maintain wider social benefits, such as employment and continued access to traditional resources.

AGROFORESTRY AS A NATURE-BASED SOLUTION FOR AFRICA

While there are numerous NBS practices with direct relevance to Africa's adaptation,[19] this chapter focuses on agroforestry to allow for a more detailed discussion. Some of the messages presented here for agroforestry are applicable to other approaches that intend to leverage nature in adaptation programs.


Photo: Ministry of Environment - Rwanda

Agroforestry is, essentially, agriculture with trees. This includes trees within agricultural landscapes, farming within forests, and tree-crops such as cocoa, coffee or rubber (see more examples on the World Agroforestry webpage).[20] The trees can be retained from the forests and woodlands present before the farmed land was converted to agriculture, or they can be specifically chosen and planted as part of the farming practice.

The benefits the trees bring are manifold and can include shade for crops, livestock and people; soil stabilization to prevent erosion from wind or water; improved soil nutrition and structure; and products such as food, fodder, and fuel. They also contribute to climate change mitigation by increasing the amount of carbon stored in the

landscape. Agroforestry can thus contribute to food security and climate objectives while preserving and strengthening the environmental resource base of Africa's rural landscapes.

Agroforestry has been used in one form or another in traditional agricultural practice throughout Africa, and over the past few decades has often been promoted as an option for smallholder farmers to increase and stabilize their agricultural production, especially in degraded landscapes.[21] Well-planned agroforestry builds upon existing farming skills, retains jobs, and can provide many intangible benefits, such as strengthening cultural connections.

In order to be considered an NBS, agroforestry must also benefit local biodiversity and the health of local ecosystems. This is usually readily achieved, but it requires the coming together of a range of skills: scientific and local, agricultural and biodiversity, financial and cultural. A well-designed agroforestry outcome derives from a true co-production incorporating multiple skills, multiple values and multiple players.

Issues in Agroforestry: A Review of Recent Research

While many agroforestry practices have numerous benefits, including adaptation, a recent review of agroforestry solutions in Africa provided some firm warnings, including that "policies that institutionally segregate forest from agriculture miss opportunities for synergy at landscape scale," and that "not all agroforestry options are viable everywhere, and the current state of knowledge offers very little guidance on what systems work where, for whom and under what circumstances."[22] Quantitative studies that integrate multiple aspects of agroforestry are rare, but there is activity in Africa that is helping to identify pitfalls in agroforestry planning and practice and to point to solutions and opportunities. A few of these are described below.

First, scientific research is often driven by narrow objectives relating to increased productivity but insufficiently related to the wider context of human livelihoods, including security and equity. A common reason for agroforestry is to rehabilitate degraded soils. A review of agricultural land rehabilitation in the Sahel found that most research efforts directed at soil rehabilitation and productivity improvement were driven by a single factor: the addition of chemicals and fertilizers.[23] Most showed positive outcomes from chemical additions in terms of yield, but few looked at the effects of combining the treatment with crop diversification, an approach that is already relevant in a region subject to climatic variability and that is likely to become more so with climate change.

In fact, most studies appeared to be disconnected from existing farmer practice and from the benefits of agroforestry practices that use trees for shelter and soil improvement and provide a diversity of products useful to the farmers. This problem is not confined to chemical trials. IPBES found that many studies of the impacts of climate change treated it as the single factor affecting biodiversity, thus failing to take into account the wider context relating to human livelihoods.[24]

These results are in contrast to the rise of Farmer Managed Natural Regeneration (FMNR), a low-cost land restoration technique that was developed specifically to build upon the existing pool of species using practices and seeking outcomes largely managed and determined by local farmers. It relies on the fact that many woody species can survive heavy cutting or grazing and remain as root stocks in the soil for decades. By working with local communities, simple methods and incentives have been found to encourage these root stocks to grow stems, which with careful pruning leads to a healthy small tree in a few years. This approach has been adapted and applied to meet farmer's preferences for several decades and is often credited with helping to regreen much of the Sahel. A study by World Vision Australia looked back at the development of the FMNR and described 24 beneficial outcomes from the practice.[25] But it also recognized that there were no substantial, controlled studies to back these benefits and to suggest ways of scaling up the approach even further. So here we have co-production of a valuable technique, but little "hard" scientific evidence to back it.

NBS are often cited as producing multiple benefits for agricultural yields, biodiversity, carbon storage, and ecosystem services such as wildlife attractive to tourists. A study in Ghana asked whether there were tradeoffs between these potential benefits from the threatened expansion of cocoa production into forests.[26] One option is to adopt high-yield, intensive farming on already cleared land, thus allowing forest to be spared elsewhere for conservation (land sparing); another is to adopt lower-yield, extensive farming over a greater area that retains more biodiversity and protects ecosystem services through wildlife-friendly agroforestry. By studying a series of existing cocoa plots, the researchers concluded that intensive cocoa production was actually the most effective in conserving biodiversity because it spared more of the original forest. However, the best carbon storage outcome depended on the cocoa yields that could be achieved in particular locations. These tradeoffs between clearing, cocoa production and biodiversity production will vary with location, but the study gives a sense of the analysis and planning that is needed before promoting and engaging in large agroforestry projects.

A study in Togo analyzed 25 agroforestry plots using satellite mapping of forest cover, field measurements and farmer interviews.[27] The researchers found rural development benefits were positively associated with adaptation benefits, but negatively with mitigation benefits (carbon storage). Biodiversity benefits showed no clear relationships with the other benefits. However, they identified a group of plots that provided a good range of benefits that point to management options and careful selection of species that may be able to support high delivery across all benefits. In this region of Togo, the most beneficial agroforestry mix includes shade trees, fruit trees, palms and bananas. It is not this particular solution that is important; rather, this type of study needs to become much more common in planning new agroforestry ventures.

A study in Madagascar took a broader look at land selection and management actions used in vanilla growing to understand how agroforestry affected biodiversity across a wide range of plant and animal species.[28] Vanilla is an orchid that is grown either on trees within an existing forest, or on trees established on fallow land that was formerly used for rice cultivation. Vanilla cultivation within old-growth forests led to the loss of 47 percent of endemic species, whereas vanilla established on trees planted on fallow land, i.e. agroforestry, provided substantial vanilla yields and could eventually reestablish 38 percent of the endemic species. The study concluded that agroforestry on previously cleared land can provide significant benefits for farmers and for biodiversity, especially if attention is paid to the diversity most sensitive to management practices.

In each of these examples, the selection of trees and associated species is one of the most important decisions in achieving a successful outcome. The goal in agroforestry, then, is not simply to reestablish the local species that existed on the site before it was cleared for agriculture, as they may not be suited to the new "ecosystems" that are being established by agroforestry practices or to changing climates.

Some trees are well suited for agroforestry in Africa, but again, not in all locations. The legume Faidherbia albida, for instance, is a nitrogen-fixing tree that is widespread and native to Africa. Its

leaves are useful fodder for livestock, and it has an unusual annual growth cycle in that it sheds its foliage early in the rainy season and only regrows it early in the dry season. This means that it provides little competition to crop species as they grow during the rainy season, and so it has become a favored agroforestry species.[29]

In general, tree species selection for NBS should be based upon both local and scientific knowledge of the characteristics of indigenous species for local conditions. A study in Ethiopia, for example, found several dozen species in use in particular conditions.[30] The authors recommended three to six species for special consideration in each of the three geographic regions of Ethiopia. This is an important step to facilitate cooperative planning of agroforestry based on both scientific and local knowledge and community priorities.


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INSTITUTIONAL CHANGE TO LEVERAGE AGROFORESTRY FOR CLIMATE ADAPTATION AND MULTIPLE BENEFITS

Not all smallholders are keen to adopt unfamiliar farming systems. The study in Ethiopia found constraints to the wider use of agroforestry approaches, including the belief by many smallholder farmers that trees are inevitably competitors with their crops, a lack of local knowledge of the value of their benefits as food, fodder and fuel, and an unwillingness to invest in land over which the farmer had limited tenure.[31]

Co-production of knowledge is needed to understand both local biophysical and socioeconomic conditions to address farmers' immediate needs and preferences.[32] Traditional knowledge pertains not just to the biology of a prospective species, but also to the particular benefits that it can contribute, its acceptability to the community, the workload involved in cultivating and managing any planting, and who will be expected to bear that workload.

Many smallholders will need external knowledge and financial support to make the transition from their current practices and turn to or retain cropping systems integrated with natural resources. They will also face commercial pressures to use new and expensive crop varieties and fertilizers. This constitutes a significant livelihood risk both to the smallholders and to those directly supplying financial support, whether that be local entrepreneurs, local banks, or civil society organizations. This risk is even greater for smallholders who focus on internationally traded products, such as cocoa and vanilla, and are exposed to the uncertainties of international trade.[33]

A detailed review of the practice and direct benefits of agroforestry across the African continent noted a lack of holistic studies of the benefits and potential problems of agroforestry on people's livelihoods in Africa.[34] Studies are scattered and often focus on only a few aspects of the agroforestry enterprise and its effects on livelihoods. Non-market benefits and disbenefits are usually overlooked or undervalued in their contribution to livelihoods. The opportunities for the protection or reestablishment of cultural benefits, including religious and traditional ceremonies and medicines, through agroforestry are rarely taken into account. The review authors looked to changes in African research institutions, and possibly stronger engagement by the private sector, to support their need for robust value chains to help address these gaps.

We have a glimpse of what some of these institutional changes could be in the lessons from the Great Green Wall (GGW) initiative. The initiative

was originally designed in the late 2000s to create a 15 km-wide band of trees stretching 8,000 km across the southern boundary of the Sahara Desert. However, after rapid learning from many failures of tree planting and a greater recognition of the needs of local people, the emphasis moved from creating a wall of trees to improving the livelihoods of local people by a mix of sustainable land and water management and agroforestry actions. These fall under the umbrella of the global goal of The Bonn Challenge to restore 350 million hectares of degraded land globally, and also of AFR100, an initiative to restore 100 million hectares of degraded land in Africa by 2030 largely by tree planting.[35] Thirty African countries have pledged to take part, and currently the pledges exceed the original goal of 100 million hectares by 25 percent. However, restoration of the pledged land is still in its early stages.

Restoration across much of the Sahel and West Africa is supported by the Sahel and West Africa Program (SAWAP), run in partnership by the Global Environment Facility (GEF) and the World Bank to support the GGW. Under SAWAP, 1.6 million hectares have been restored from 2012 to 2019. The World Bank has recently reviewed progress and has found that while almost 20 million people have benefited, the range of activity types and sizes across projects has made it difficult to draw comprehensive conclusions.[36] But some lessons are emerging. Despite seeking a programmatic approach, most activities are being managed as small projects very specifically tuned to local conditions and preferences. Cost-effectiveness also varies greatly between projects, with some being prohibitively expensive to apply at scale and others very cost-effective. Projects rely too much on national agencies for implementation, with few achieving decentralized approaches leading to community empowerment and ownership. And the use of incentive payments to adopt specific practices appears to inhibit community ownership and may crowd out alternative approaches.

Many have proposed that greater capacity building is needed to fully integrate natural and human systems to the benefit of both. However, the finance and efforts directed toward capacity building over the past few decades have been substantial. We need to look more closely at just what is meant by capacity building in the context of what is needed, and what can be done. There still seems to be an assumption that there is a pool of existing technical knowledge that can be brought to participants via capacity building. Maybe we need to recognize that the technical know-how is weak and also needs to be considered along with traditional knowledge and community preferences to develop projects that are not only cost-effective, but also meet the needs

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of the community such that they take ownership of the task of continuing to create better and resilient livelihoods.

We also need to continue to explore more comprehensive models for financing. Multilateral and bilateral financing will always be cumbersome, as the funder must be able to show transparency and due diligence in the allocation, disbursement and outcomes of their funding. Financial intermediaries may offer a better model. The GEF and the African Development Bank have outsourced funding from the multilateral development banks to aggregators such as Althelia, E3 Life and the Moringa Fund, which are better equipped to manage the perceived risks of local investment.[37] Such an approach can help reassure investors—whether they be multilateral organizations, governments or banks, and especially the smallholders who will be risking their livelihoods on the outcome.

Some assessments, such as by IPBES[38] and the IPCC,[39] call for a form of polycentric governance system, claiming that it has always been practiced in Africa and has effectively addressed different interests in managing natural resources. Polycentric governance has multiple, often overlapping centers of decision-making, each of which operates with some degree of autonomy, while taking other centers into account.[40] It strikes a balance between the common centralized (e.g. national government systems) and fully decentralized community-meeting styles of decision-making.[41] It is grounded on processes of accountability through stakeholder and actor engagement, promoting learning and trust, harnessing co-benefits and added value, addressing tradeoffs, and adaptability when faced with new situations. But polycentric governance and top-down public and private management models often appear not to sit well with each other. This is an area that needs active engagement and experimentation.

CONCLUSION

Most of the reasons Africa has declining agricultural production and is losing tree cover are not the direct result of climate change. They include population pressures, weak governance, and conflict in many areas. These must be tackled, and now tackled with the additional uncertainty of climate change, if major improvements in agricultural productivity, livelihoods and equity are to be achieved.

It is important to go beyond the exhortations to protect forests, to plant more trees, and to tap the potential of agroforestry. The latest IPCC assessment report noted that from 1990 to 2019, only 3.8 percent of climate-related research funding was directed to research on Africa, and only 14.5 percent of that went to African institutions.[42] Research support is notoriously difficult to track, but to have less than 4 percent of funding going to support the climate future of Africa, when the continent has 15 percent of the Earth's population, is a severe mismatch.

It is essential to continue building the case for NBS as a critical adaptation measure, to set goals, and to seek financial support. However, it is equally important to mobilize the necessary support to identify which actions are cost-effective and most beneficial for both the farmers engaging in NBS and the ecosystems on which they are based. There are many examples of poorly designed efforts that are likely to undermine the goals of development, biodiversity maintenance, mitigation and adaptation.

Each type of project (agroforestry, catchment protection, barriers to desertification, or cooling villages and even cities) and each region will need to ask local questions of how to match NBS with the needs and skills of local communities, as also questions such as where to establish agroforestry and where to conserve or regenerate forests, and what type of plantings and with which species. To answer these questions traditional and local knowledge must be brought together with wider scientific knowledge in a true co-production of workable solutions.

The solutions to the above questions also need a new model for capacity building that seeks solutions based on technical skills, holistic insights and lived experience in a comprehensive co-production of knowledge focusing on solutions. It is critical to recognize that learning is a continuous process of adjustment, whether this is labeled "trial and error," "learning by doing," "continual learning," "ok-to-fail" or "adaptive management."

Many of the changes described here may seem small in the global response to climate change, but each is consistent with reducing the impacts of climate change and is potentially life-changing at the individual human scale. This is the transformation that is needed.