

Commentary

African Lives Matter: Wild Food Plants Matter for Livelihoods, Justice, and the Environment—A Policy Brief for Agricultural Reform and New Crops

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Abstract: International agricultural policies to address hunger and malnutrition in the tropics and sub-tropics have typically been based on approaches to the intensification of farming systems effective in industrialised economies where the social, economic, and environmental conditions and the infrastructure are very different to those in Africa. The consequence of this short-sightedness has been that agricultural productivity, dependent on ecosystem services from natural capital, has declined in Africa due to ecological and environmental collapse. This has undermined the livelihoods of the millions of smallholder farmers living on the brink of the cash economy, leading to severe social injustice. This review summarises advances in smallholder agriculture's sustainable intensification in the tropics and sub-tropics, leveraging the domestication and commercialisation of wild indigenous tree species that produce nutritious, marketable, and useful food and non-food products. These are grown within diversified and multifunctional farming systems together with conventional food staples and local orphan crops to reduce land degradation, pollution, water extraction, and nutrient mining while promoting services such as pollination and other ecological functions. The benefits arising from this approach simultaneously address hunger, malnutrition, poverty, social injustice, and a stagnant economy, as well as important global issues such as climate change, loss of biodiversity and environmental degradation. Addressing these issues may also reduce the risk of future pandemics of zoonotic diseases, such as COVID-19. This set of serious global issues epitomise our divided and dysfunctional world and calls out for action. Enhancing sustainable smallholder productivity using indigenous and wild foods is an important international policy and business intervention, vital for achieving the 2030 Sustainable Development Goals and the rebalancing of the global economy by restoring natural capital within new African indigenous food industries.

Keywords: agriculture; agroforestry; biodiversity; climate change; ecosystem services; hidden hunger; indigenous knowledge systems; neglected crops; poverty; tree domestication; sustainable land use



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1. Introduction

In the wake of slavery and colonialism, the Black Lives Matter movement has done much to draw attention to racism, inequality, injustice, and prejudice in Developed Countries. However, on the other side of the same coin, there are unaddressed issues arising from the colonial days [1] such as: blindness to the marginalisation of poor, smallholder subsistence households across Africa, inappropriate policies for agricultural intensification and international trade that impede national programmes for food security, social justice, climate change and biodiversity retention. In the marginalised communities of developing countries, this dysfunctional situation is manifested as hunger, malnutrition, abject poverty,

and the severe degradation of natural and social capital, culminating in crop failure and famine. Consequently, hunger has greatly increased over the last three decades [2]. These severe consequences are exacerbated by pollution, water extraction, nutrient mining, habitat change, and fragmentation, which threaten sustainability, reduce resilience, and increase vulnerability to climate change. Intricately intertwined with this are issues of culture, sense of place, dignity, and environmental rights. These, in turn, are intimately associated with the use of traditional foods, medicines, and other items of everyday life originating from trees and herbaceous plants.

All these problems are ingrained in agricultural policy dominated by the concepts of industrialised approaches to farming led by corporate agribusiness with echoes of slavery and the subjugation of many Africans' rights. While there is no longer the cruel and disgraceful transportation of people away from family and homeland to foreign countries, there is a lack of recognition of indigenous peoples' rights and their traditional use of natural resources. This, together with its environmental consequences, are key drivers of social migration leading to the rapid urbanisation of Africa and its impacts on the dislocation of families, rising unemployment, and civil injustice in burgeoning city slums. Taken together, it seems that the current abuse of farming households can be attributed to capitalist business self-interest seen as more important than resolving the significant global issues of hunger, malnutrition, poverty, social injustice, environmental degradation, and climate change. In addition, there is a knowledge gap in seeking sustainable solutions to African development. Rather than adopting a 'Diagnosis and Design' approach, this gap results from researchers prioritising the pursuit of scientific discovery over the resolution of the practical problems facing most African farmers. Such problems are seldom solved by retrofitting solutions from interesting science. Beeckmans [3] expressed this as a need to 'decolonise' research and emphasises the importance and universality of interdisciplinary research.

1.1. African Context

Currently, 256 million people are malnourished, and 605.8 million people are considered to be experiencing moderate to severe food insecurity [4]. This same group of individuals is characterised by abject poverty and a reliance on inappropriate agriculture, which does not provide an income stream for its livelihood strategy. Despite 75% of smallholder subsistence farmers suffering from poverty, malnutrition, and hunger, they produce most of the region's food [5]. Africa's farming systems typically rely on just a few staple food crops [6], which produce only about 10–30% of their potential yield [7]. This is due, in part, to their poverty, vulnerability to climate and social shocks, their lack of access to essential inputs [8], and the harsh environment that reflects the climate, soils, and cultural norms [9].

As far back as 1963, the quest for an African ideology started with Pan Africanism that led to the establishment of the Organisation for African Unity, the predecessor for the African Union (AU), and to the ratification of the Convention on Biological Diversity (CBD) between 1992 and 1995 by more than fifty African countries. In addition, over the intervening years, the AU has put in place several plans and policies aimed at addressing food and nutrition insecurity, poverty, and inequalities. However, many of these initiatives were moulded around an agenda of Westernisation. They were built on the foundations of the Green Revolution led by the CGIAR, which brought advances in crop genetics and fertiliser use that were highly appropriate to industrialized agriculture. However, it has become clear that these intensification technologies are less fitted to the very small farms of the tropics and sub-tropics, the extreme poverty of their rural households, and the environmental and social conditions of Africa [9]. Nevertheless, there has been international political support for the Green Revolution in Africa, despite the recognition that intensive monocultures under subsistence smallholder conditions lead to minimal opportunities for income generation, dependence on starch-based diets and the overexploitation of natural

resources and ecosystem degradation, making them more vulnerable to environmental, economic, political, and health shocks.

Since 2000, there have been several ‘homegrown’ initiatives taken by the AU. In the first decade there was:

- The New Partnership for African Development of the African Union.
- The development of the Common African Agricultural Development Program.
- The Maputo Declaration on Agriculture and Food Security (2003).
- The endorsement of the African Green Revolution by African Heads of State at the 2006 Abuja Africa Fertilizer Summit.
- The formation of the Alliance for a Green Revolution in Africa (AGRA) in 2006.

These initiatives were then followed by:

- The 2014 Malabo Declaration by African Heads of State [10]. It recognised the CBD’s emphasis on the “critical importance of biodiversity and ecosystem services in supporting economic growth, sustainable development, livelihoods and human wellbeing in Africa”. Under this Declaration, African Governments heightened the importance of the agriculture sector for its role as a driver of shared prosperity and improved livelihoods.
- The endorsement of the ambitious global development agenda for 2015–2030 UN Sustainable Development Goals (SDGs). SDGs 1, 2, 3, 5, and 10 seek to address poverty, end hunger, achieve human health and wellbeing, and reduce inequalities, all while protecting the environment.

For the most part, many African countries are yet to fulfil pledges towards these instruments. Regional and national food security policies still perpetuate a few major food crops’ continued dominance and sustain the perception that successful farming involves adopting industrialized economies’ intensive farming methods. These inconsistencies suggest some confused understanding of the region’s approach to natural capital management within agriculture.

To address the challenges of these poorly contextualised policies and programmes, African Heads of States have recently endorsed *Agenda 2063*, confirming the Malabo Declaration’s aims for the agriculture sector’s role as a driver of shared prosperity and improved livelihoods. *Agenda 2063* provides a blueprint towards the realisation of Africa’s own transformative agenda—the “*Africa We Want*”—and “seeks to craft new self-driven and Africa-centric visions for development and socio-economic transformation”. The Agenda acknowledges “Africa’s unique natural endowments”, the need to develop “the green economy”, and the need to use “science, technology, innovation and indigenous knowledge”. However, it is not clear how these goals will be achieved. The continued pursuit of “modern agriculture for increased production and productivity” seems to exclude novel approaches to farming that meet the goals, such as a role for “indigenous and traditional crops and fruit trees” in the rejuvenation of African agriculture to meet the needs of millions of ordinary Africans.

While the AU should be praised for targeting increasingly more relevant and pertinent policies for the reform of environmental, social, and economic growth, the rhetoric sadly lacks substance concerning practical and appropriate activities to support these goals. This paper offers our suggestions for much more productive and sustainable Multifunctional Agriculture delivered by intensified mixed-cropping systems that are rooted in African culture and tradition and are suitable for African ecosystems. As we explain below, this modifies failing and socially inappropriate monocultural systems alien to Africa’s ecology, with grassroots, community-based domestication of African crops. These crops diversify the farming system and local economy with locally well-known foods from traditionally important indigenous trees and familiar but underutilized orphan herbaceous species. These provide nutritious foods for domestic consumption while stimulating new homegrown businesses and trade. In addition, through innovative and novel local

industries, the under-researched biochemical composition of their products can potentially give rise to new local industries.

1.2. Africa's Overlooked Natural Capital

Africa is rich in indigenous plant species that have traditionally sustained its people's lives [11]. Many are still available and favoured in local markets for household consumption and medicines. Despite a lack of support, many smallholder farmers still use these plants, depending on them as nutritious foods that also support cultural and ecosystem services. This now overlooked biodiversity is central to many livelihood strategies [12] and could be leveraged to address food and nutrition insecurity, poverty, inequality, and environmental degradation [13]. Indeed, by sustainably cultivating its resources of indigenous species, Africa could initiate its own agricultural revolution based on the wise use of this biodiversity for wealth creation [14] and the Traditional Knowledge of its people.

We argue here that diversification with greater use of new crops from indigenous fruit/nut trees and underutilised food crops could diversify and fortify diets, generate income and employment, and enhance environmental resilience in the face of climate change [15]. This could be the focus of a new model for a much more sustainable form of smallholder agriculture in African ecosystems and cultures.

To effect a change in these underutilised crop species' use will require an integrated and holistic approach to their domestication and promotion in local industries. Without this, food and nutrition insecurity, poverty, and inequalities will persist. By linking Traditional Knowledge with policy and the implementation of new crop developments in a transdisciplinary way, this approach recognises the existence of cultural issues of importance to rural communities and African populations in terms of the use of natural resources and the traditional, cultural, medicinal, and spiritual fabric of community life. Respecting these indigenous rights, traditions, and cultures enhances the dignity, equality, and freedom of individuals while promoting social cohesion. This approach adds a missing component to the Black Lives Matter movement that is primarily focused overseas and outside Africa. This addition is especially important concerning matters that affect social and environmental justice, protecting the environment and reducing inequalities associated with human exploitation in Africa and across the world. Drawing all this together, indigenous trees and underutilised crop species offer an opportunity to convert the so-called 'inevitable trade-offs' of conventional agricultural intensification to sustainable policy 'trade-ons' [16] that capture numerous environmental, social, and economic benefits [13].

In summary, the purpose of this review is to draw the attention of decision makers to how the prejudice and discrimination imposed on subsistence farmers, especially in Africa, by inappropriate international policies and trade could be addressed by up-scaling the outputs of research to domesticate indigenous food plants as new crops. Furthermore, we emphasize that in addition to improving the lives of farming communities this model, if scaled-up adequately, could have numerous positive global benefits by rebalancing the economy, addressing the failures of the food system, and restoring natural capital for greater resilience to climate change and for the regeneration of wildlife habitat.

2. New Crops for Africa

This review draws together numerous strands of a multidisciplinary approach to research and the practical implementation of its outputs aimed at finding pragmatic and appropriate solutions to the problems facing both people and the planet: solutions based on the domestication and commercialisation of indigenous and culturally important food: 'Cinderella' species which science, entrepreneurs, and politicians have overlooked. The cultivation of these species then produces Agroforestry Tree Products (AFTPs) unburdened by the legal restrictions on marketing common-property wild Non-timber Forest Products (NTFPs) [17–19]. The domestication of these species should be done within the context of respecting the African traditions of living in harmony with nature and culture and recognising indigenous rights and community integrity.

Indigenous food and medicinal species are now widely recognised as having a critical role to play in African agriculture [20], while the World Health Organization has reported that over 80% of the African population use traditional medicines. The importance of products from indigenous trees has been illustrated by the Cameroonian farmers who provided the vision for the Cameroon project described in this Section. This vision has been the catalyst for the evolution of the concept of ‘land maxing’ to reboot tropical agriculture [15]. The idea to develop techniques and strategies for domesticating traditionally important and nutritious tropical trees emerged in the 1980s [21–23] based on a strategy to make wise use of genetic resources [24]. Since then, significant progress has been made [25–27] with a focus on community-based, participatory tree domestication in Cameroon driven by the farmers themselves [28–31]. This uses simple, low-technology vegetative propagation protocols [25,32] appropriate for remote locations with poor infrastructure and community-based Rural Resource Centres to provide capacity building and community coordination [33,34]. Drawing together these principles of community engagement for the domestication of indigenous tree species has been described as the creation of Socially Modified Crops [16,35] that best capture the opportunities to close the yield gaps that underly the failures of modern agriculture to produce staple food crops [8,36]. Additional benefits of this approach arise from trying to ensure that the initiatives of farmers are not undermined by unscrupulous business interests [37] while creating great opportunities for the establishment of new local business ventures [38] based on the development of ideotypes selected to match the needs of emerging industries [39].

2.1. The Importance of Diversification

In addition to the development of new crops for the diversification of diets, markets, and the growth of the local economy to enrich and sustain livelihoods and the social/human capital of the most vulnerable and disadvantaged rural communities, the integration of new crops from indigenous food and non-food trees diversifies farming systems provides niches for colonising biodiversity above- and below-ground. This creates an agroecological succession such as that in natural ecosystems [36] and provides improved wildlife habitats. This, in turn, rehabilitates degraded land and mitigates soil erosion, land-use change and habitat fragmentation, restores soil fertility, re-establishes soil ecological health as well as biodiversity while also increasing carbon storage to mitigate global climate change and enhance community resilience. This combination of benefits to the natural, social, human, and economic capital from the integration of new tree crops in farming systems has been described as ‘land maxing’, following a highly adaptable three-step generic model [8,16]. This approach offers the opportunity to reboot tropical and sub-tropical agriculture [15] and achieve 14 of the 17 UN Sustainable Development Goals (Table 1). The difference is the localisation of the economy and the value chains derived from communities’ economic emancipation. This then reduces social dislocation caused by poverty and famine and resultant urban migration.

As crop diversity is the driver of these environmental benefits, it can also be enhanced in farming systems by integrating neglected and underutilised species (NUS, also called minor or orphan crops). Some of these are trees and shrubs recognised as ‘minor crops’, but many are herbaceous species producing grains and pulses cultivated within the lower strata of agroforestry systems to diversify farming systems [41]. Some one hundred NUS are currently identified by the African Orphan Crops Consortium (AOCC) as part of a biotechnology programme to enhance their genetic potential [42,43]. The AOCC orphan crops also include some wild indigenous food trees being domesticated by local communities through ‘social modification’ [36]. These trees typically form the upper strata in agroforestry systems.

Table 1. Contribution of described activities to UN Sustainable Development Goals: Transforming our World: the 2030 Agenda for Sustainable Development (United Nations, 2015). (Source [40]).

Goal	Purpose	Contribution (Scored 0–5)
1	End poverty in all its forms	4
2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	5
3	Ensure healthy lives and promote wellbeing for all at all ages	4
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	1
5	Achieve gender equality and empower all women and girls	4
6	Ensure availability and sustainable management of water and sanitation for all	2
7	Ensure access to affordable, reliable, sustainable, and modern energy for all	2
8	Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all	4
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	2
10	Reduce inequality within and among countries	3
11	Make cities and human settlements inclusive, safe, resilient, and sustainable	0
12	Ensure sustainable consumption and production patterns	2
13	Take urgent action to combat climate change and its impacts (under the auspices of UN Framework Convention on Climate Change)	4
14	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development	0
15	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	5
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable, and inclusive institutions at all levels	2
17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	1

Concerning the genetic diversity of the new socially-modified crops, the decentralised community-level approach to tree domestication in small individual local populations ensures the maintenance of range-wide intraspecific genetic diversity very much better than a centralised national, regional, or international system. This helps to protect the genetic diversity of the natural capital in forests and savanna ecosystems that are crucial for improving rural people's lives [44].

2.2. Recent Developments

In the second and now third decades of this programme, the initiative has spread around the tropical and sub-tropical world. Currently, over 40 species are in the early stages of domestication in Africa (see citations in [45,46]). Over the last decade, a more high-tech approach with key species has also evolved to increase the genetic knowledge and understanding fundamental to the future long-term development of these new crops [43]. However, in the short term, participatory domestication of socially-modified crops within farmer-friendly, wildlife-friendly, and climate-friendly agroforestry systems can clearly make a beneficial quantum leap for the planet and African people [31]. This results from rebooting agricultural production in ways that positively enhance its interactions with the environment and the local populations, thereby avoiding the trade-offs arising from conventional approaches to agricultural intensification [38].

Interestingly, African scientists in over 400 university departments and research institutes have started to work towards the domestication and commercialization of their

indigenous species [46]. Thus, Africa is indeed embarking on a novel agroforestry approach to productive, sustainable, and environmentally appropriate agriculture. The expansion of this innovation is illustrated by the rapid growth of the scientific literature, the increase in the number of organisations involved in this research in Africa and globally, and the increasing number and disciplinarity of science journals publishing the results [47]. All this is also associated with a growing number of small emerging cottage industries (Figure 1), spawning a set of new local value chains that could become an engine of economic growth across the continent [15,47]. Prof. Ameenah Gurib-Fakim, the former President of Mauritius, has recognised this and called for Africa to capitalise on the potential of its under-exploited plants, which offer untold medical and economic promise [14]. As a fit-for-purpose new green Industrial Revolution for Africa, this outcome would bring many millions of poor people into the cash economy, helping to address our unequal world [48]. This should be based on a more holistic and integrative approach to natural resource management [49,50]. Addressing the ideals at the foundation of the economic pyramid would potentially expand the global economy, creating a ‘greener’, carbon-neutral world capable of feeding and sustainably supporting a population well above currently foreseen limits. This conforms with an emerging vision for “Afrotopia” [51] and the greater Pan-African self-reliance [52] proposed in a speech by President Akufo-Addo of Ghana (6 March 2018). The Ghanaian President has called for opinion-makers from civil society to seek a new, more autonomous and self-reliant Africa based on empowerment, better use of natural capital, greater independence from foreign aid and greater unity. These ideals are also fully compatible with the *Leaders Pledge for Nature* signed by ten countries (1 December 2020) in Africa (www.leaderspledgefornature.org); the Africa Union’s *AFR100* programme aimed at restoring 100 million hectares of degraded land in Africa (www.afr100.org) (accessed on 23 June 2012) and signed by 30 African countries (1 December 2020), and the *Global EverGreening Campaign* (www.evergreening.org/greenuptocooldown/) (accessed on 23 June 2012).



Figure 1. Indigenous fruits and nuts in Cameroon processed by the Manyu Women’s Multipurpose Cooperative Society (with permission of Magdelene Agbor).

2.3. The COVID-19 Pandemic, the Sustainable Development Goals, and Climate Change

In 2015, humanity witnessed its finest moment, when the United Nations adopted the seventeen 2030 Sustainable Development Goals (SDGs) focusing on people, planet, peace, prosperity, and partnerships to achieve improving human health and wellbeing within the planetary boundaries. Since then, additions to many national budgets have allowed the signature of ambitious treaties such as the Paris Climate Agreement and the Addis Ababa plan for financing development. Then, the COVID-19 pandemic struck, threatening the SDGs’ key assumptions: sustained economic growth and globalisation. This has had severe repercussions for both the Industrialised and the Developing Countries as the global

economy is expected to contract by at least 5% in 2020. The timeframe for its recovery is years, not months.

This severe downturn of the global economy means that overseas development aid from Industrialized Country budgets is likely to decline, so hope for future Development assistance to poorer parts of the world is becoming increasingly remote. Thus, food insecurity in Africa's most vulnerable regions is likely to become increasingly severe, with a consequent increase in disease and other vulnerabilities. Southern Africa's overdependence on maize has, for example, been implicated in the spread and progression of HIV Aids [53]. Food insecurity and its associated consequences are exacerbated by climate change impacts on rainfed crop and livestock production, such as drought and floods—an additional problem caused by unsustainable agriculture. In addition to these consequences of the misuse of natural resources, emerging evidence indicates that the breakdown of ecological functions due to deforestation and land degradation increases the risk of zoonotic diseases, such as COVID-19 [54].

Now, as the UN celebrates its 75th anniversary in 2021, the optimism ushered by the SDGs is fading, and the very foundation on which they were built is shifting dangerously. Globally, the Industrialized Countries are struggling to support their citizens and businesses, while in Developing Countries, food insecurity has taken centre stage, threatening the production of sufficient staple foods and raising the risks of malnutrition—the dual targets of SDG 2—Zero Hunger and Hidden Hunger. If the SDGs and targets that rely on the global economy are not met, then the need for 'homegrown' solutions is even more urgent now.

This paper's arguments and recommendations highlight what initiatives could be taken by African nations to address growing food insecurity by adding value to local indigenous food products grown as newly domesticated crops to address the constraints underlying hunger and malnutrition in Africa. Interestingly, many of these traditional and culturally important foods are products from indigenous plants and trees that provide a range of ecosystem services to humankind and their environments. For example, adding these products to the farming landscape can contribute to carbon sequestration and enhance organic matter in degraded soils while driving various ecological processes that enhance the farming system's sustainability. Furthermore, these crops' products could also lead to new and local food as well as pharmaceutical, nutraceutical, and cosmetic industries (Figure 2). This is because many African plant products have already shown promise as functional foods to target a range of micronutrient deficiencies and/or diseases.

To mention a few examples: (i) Moringa (*Moringa oleifera*) leaves are rich in vitamin C, calcium, potassium, iron, beta carotene, and protein and are being developed into a wide range of medicinal and cosmetic products, as well as teas; (ii) The leaves and fruits of Baobab (*Adansonia digitata*) are rich in vitamins and processed into many products on supermarket shelves in Europe with approval of the European Commission; (iii) All-blackia kernels (*Allanblackia* spp) have unique fatty acid profiles and have been developed as heart-smart margarine; (iv) *Sceletium tortuosum* has been tested for its tranquilising properties; (v) Hoodia (*Hoodia* spp.) and *Irvingia gabonensis* have been examined as appetite suppressors ([55,56], respectively). In addition, the fruits of Marula (*Sclerocarya birrea*) are processed into a range of alcoholic beverages, liqueurs, and snacks, while kernel oil of Shea nut (*Vitellaria paradoxa*) is processed into cosmetics. Hundreds of other African species have similar potential. In addition, there are numerous African herbs and cereals (e.g., Millet, Fonio, and Tef), which are recognised as 'orphan crops' that are essential additions to both diets and farming systems [41–43].

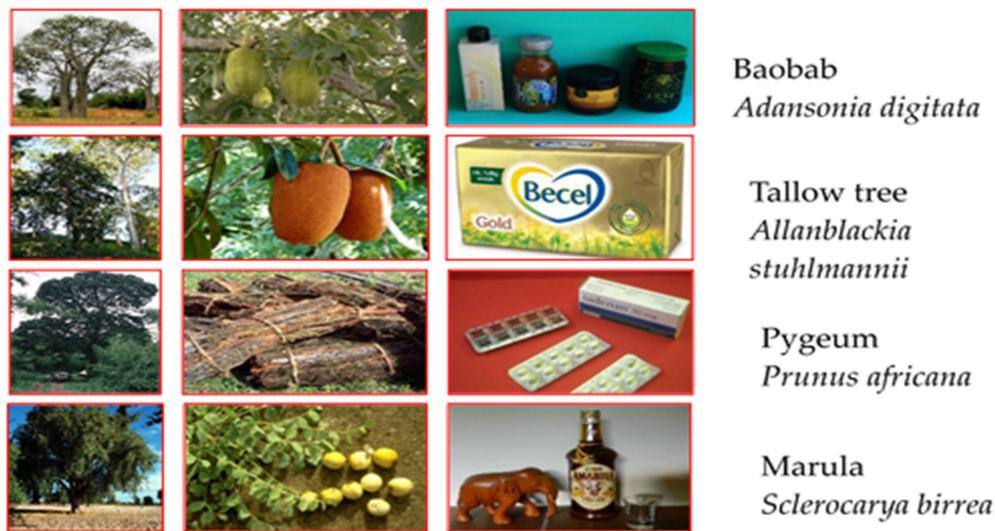


Figure 2. Examples of some indigenous fruit and nut tree species being domesticated and some processed products.

African biodiversity and African traditional knowledge remain undervalued and under-supported by recognising intellectual property rights [37]. Yet, they offer crucial solutions to address food insecurity and several other current challenges on the continent such as climate change, loss of wildlife habitats, and social injustice—especially now when we are in the throes of the COVID-19 pandemic. The uptake of indigenous crops and in-country businesses for processing and value-adding would also give a much needed boost to the local economy in ways not achieved by dependence on international commodity crops for export (Figure 3). The resulting livelihoods and social benefits would also help relieve some of the social injustice associated with conventional industrialised cropping systems.

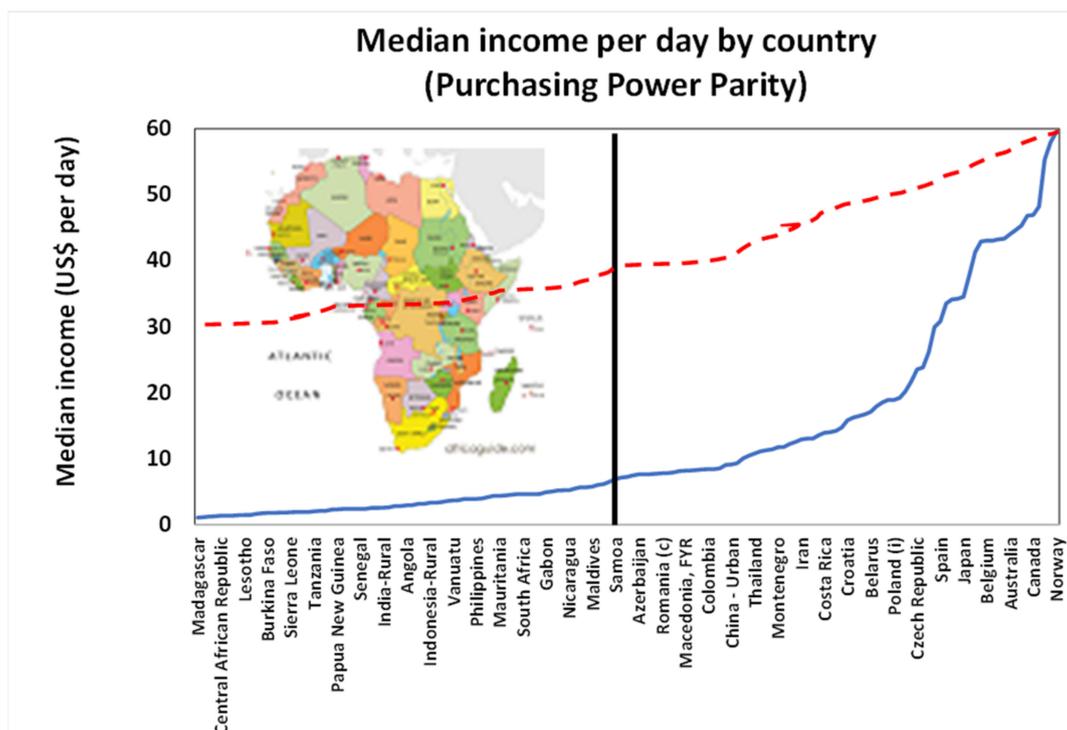


Figure 3. Conceptual impact of rebalancing the global economy by rebooting tropical and sub-tropical agriculture with new crops developed from indigenous food plants and creating new local processing industries for value addition (modified from [49]).

3. Way Forward: Actionable Recommendations

A recent study of the Global Hunger Index has identified that most Sub-Saharan African countries have experienced worsening hunger and are linked to the provision of Social Protection and the Human Development and the Global Terrorism Indices [2].

Recently, a Nature editorial [57] and a study published by Ceres2030 [58] both gave a damning report on the relevance of modern science to end hunger on smallholder farms in tropical countries, saying that more than 95% were not relevant to the needs of smallholders and their families and that 90% focused on a single issue in isolation rather than within a holistic framework. While indicating that many international agencies from think tanks, non-governmental organisations, many UN agencies, and the World Bank were partly to blame for this ‘silo thinking’, the authors also noted that holistic applied research involving work with smallholder farmers and their families does not immediately boost an academic career.

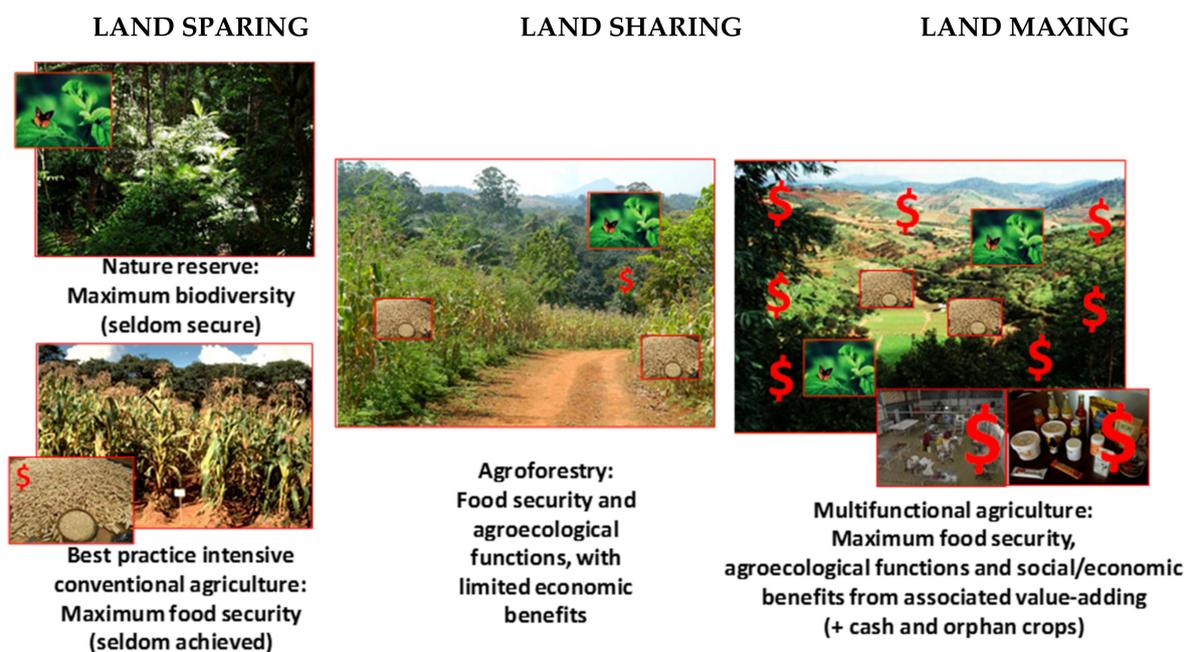
Based on the experience of a holistic approach to rural development in Cameroon, it seems clear that to address these issues, the way forwards must respect some important principles [59] underlying the following philosophy, which differs substantially from that of the current conventional wisdom of agricultural intensification as ‘one size does not fit all’. It should be based on:

1. The IAASTD concepts of multifunctional agriculture (Table 2), which seek to:
 - Understand the complexities of the interactions between the uses of natural, social, and financial capital with a new generic and highly adaptable model for sustainable intensification of subsistence farmers in tropical/sub-tropical zones.
 - Overcome the constraints to smallholder farmers’ production by helping them achieve what they want—and so getting away from telling them what they need.
 - Provide understanding, knowledge, and appropriate techniques/skills for enriched, long-term livelihood gains. This is more important than providing short-term funding for top-down projects.
 - Appreciate the need to incentivise systematic changes in farming systems and rural communities across agroecological landscapes that meet their multiple and diverse farming and household needs [61]. In this regard, Pretty et al. [62] have highlighted the importance of appropriate low-cost technologies to allow the dissemination of knowledge and new practices from farmer to farmer. This also allows households to adapt techniques to meet their own needs and circumstances.
2. A problem-based approach aimed at reversing the ‘Cycle of Land Degradation and Social Deprivation’ [8,27] to refine and build on the Green Revolution’s many achievements. This would seek to:
 - Rectify inappropriate production policies by smallholder communities living on the brink of the cash economy and in environments very different from those in Industrialised countries.
 - Foster equity at the community and population levels by promoting self-help incentives for self-sufficiency in participating households by training communities to use appropriate and straightforward technologies for remote, resource-poor communities. This should embrace aspects of education, trade, fiscal, and innovation policy priorities affecting smallholder farmers [63]. Such capacity building at village and district levels can be achieved through Rural Resource Centres and farmer-to-farmer training—in doing so decentralising the domestication process [34].
 - Implement a ‘bottom-up’ participatory approach that seeks to meet rural households’ aspirations (especially women and youths) to cultivate indigenous and traditionally/culturally important food and non-food forest species as new crops. This decentralised approach to tree domestication can protect against the loss of intraspecific genetic diversity during the domestication process.

- Apply simple, well-known horticultural domestication techniques that harness the wide intraspecific variation in qualitative traits within market-oriented ‘ideotypes’ that meet new markets’ needs based on useful and highly nutritious indigenous food species.
 - Draw on existing knowledge about the value and use of products from local food and non-food species that are typically marketed locally and sometimes regionally for domestic consumption.
 - Address the link between food insecurity and international migration from Africa [61] by recognising the potential to domesticate these new crops in ways that create new local/regional markets and local processing industries without breaching sovereign rights and intellectual property. This aims at creating employment in local businesses as a result of new on-farm initiatives. Indications are that this also reduces migration to towns and cities, contributing to social problems in urban areas [64]. This can generate new sources of farm-derived income for rural and urban dwellers.
3. Adding ‘land maxing’ to the approach of ‘land sharing’ to ensure the sustainable intensification of tropical agriculture (Figure 4). This would:
- Increase food production by restoring soil fertility and health and closing yield gaps in staple food crops (between two- to six-fold increases in average staple food yield above those currently achieved by farmers in Africa) and increasing the economic returns from the investment in the Green Revolution [65].
 - Enhance livelihoods and reduce land degradation and social deprivation that are drivers of hunger, malnutrition, poverty, climate change, and biodiversity loss. This would release degraded land for both more productive landscapes and reduce many pressures on planetary boundaries adding global to local benefits from a more sustainable agriculture approach. This is achieved by recognising the importance of harnessing multiple food production, social, economic and environmental benefits that can be derived from using the intra-specific diversity within a large set of different and useful long-lived perennial species to: (i) generate income for enhanced livelihoods, (ii) improve and diversify diets and nutrition for improved health, (iii) restore ecological health above- and below-ground in ways that enhances wildlife habitat and mitigates climate change, (iv) create business opportunities and employment in new local industries and (v) enhance social justice locally, nationally, and internationally.
 - Adopt technologies to develop new crops for mixed agroforestry production regimes that combine tree commodities in diverse production systems with locally important food trees, staple crops, vegetables and edible fungi [27].
 - Convert the environmental, social, and economic trade-offs associated with conventional approaches to agricultural intensification into new development policy objectives or trade-ons, which are cognisant of the dangers of policies that do not adequately respect traditional knowledge, local knowledge, and customary rights [66].
 - Counteract the conventional ‘silo thinking’ that overlooks the ‘whole life’ costs and benefits of farming systems and their integration into both the food system and local economic developments to relieve hunger, malnutrition, poverty, and climate change.
4. Promoting the large-scale adoption and up-scaling of new technologies for community engagement, and the enhanced stewardship of natural resources by using farmer-friendly, wildlife-friendly, environment-friendly, and climate-friendly approaches to agriculture based on the wise use of natural, social, human, and commercial capital. This would address planetary health [67] and, particularly, the critical water–food–nutrition–health nexus [68], thus improving nutrition and health of poor rural communities across the continent.

Table 2. Lessons from the historical evaluation of Agricultural Knowledge, Science and Technology by IAASTD (modified from [60]).

No.	Lessons from Historical Evaluation of Agricultural Knowledge, Science, and Technology
1	Excessive reliance on the draw-down of natural capital
2	R&D has failed to address the ‘yield gap’
3	R&D has largely ignored traditional production systems for wild resources
4	R&D has failed to fully address the needs of poor people
5	Malnutrition and associated poor human health are still widespread
6	Intensive farming is frequently promoted and implemented unsustainably
7	Agricultural governance and institutions have focused on producing individual commodities
8	Agricultural activities have been very isolated from non-agricultural activities in the rural landscape
9	Agricultural science and technology have suffered from poor linkages among its stakeholders and actors
10	For decades ‘Globalization’ has been isolated from local communities at the ‘grassroots’

**Figure 4.** Tropical agricultural land use scenarios: land sparing, land sharing and land maxing (modified from [15]).

When the above philosophical points are applied to the implementation of agroforestry research outputs, they will enhance and expand the well-recognised social, economic, environmental, and production benefits [69] across agricultural landscapes. If scaled-up, this would have a real impact on alleviating hunger, malnutrition, poverty, social injustice, biodiversity loss, climate change, etc. This is the underlying agenda behind a call to ‘reboot’ tropical agriculture ([15]; Figure 5). The remaining issue then is the lack of international political will. We urge African Governments to take this initiative for change. In this connection, it is highly relevant that the President of the African Development Bank has stated that initiatives must “play a much more proactive role in facilitating policy change that can be a scaling force multiplier” [70]. He emphasises that we owe it to ourselves and generations to come to use every opportunity at our disposal to make a giant leap in agricultural transformation a reality in Africa.

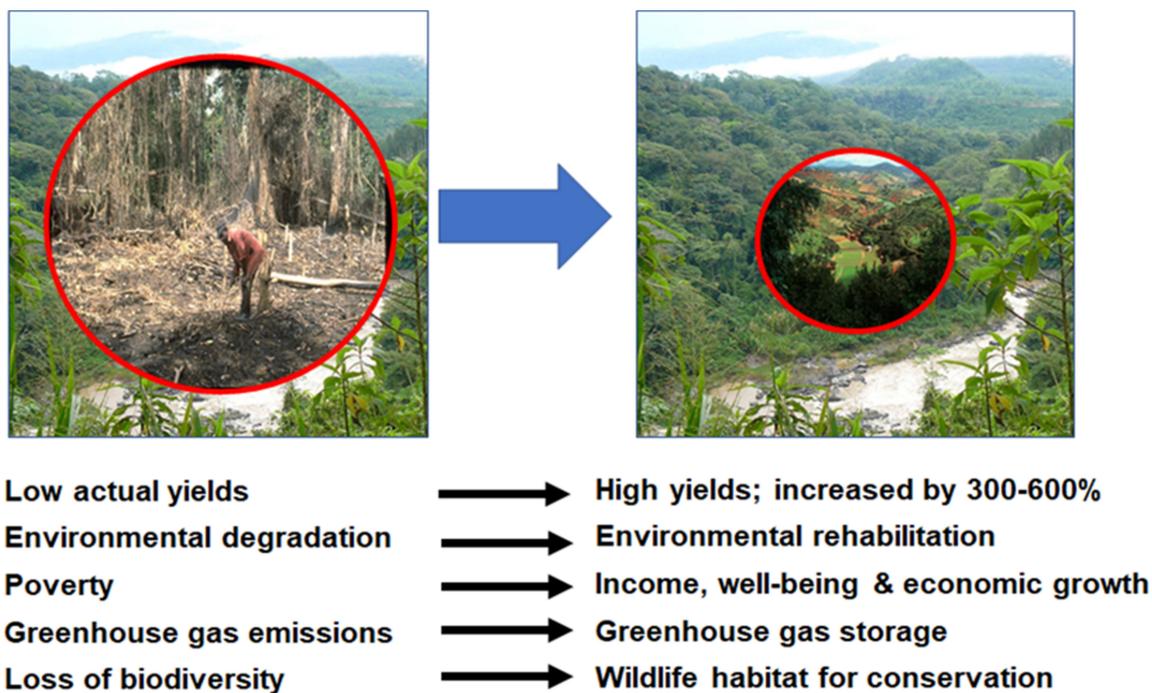


Figure 5. Rebooting the global food system: the potential is to transform agriculture in the humid and sub-humid tropics by raising productivity, using less land for staple food crops, while simultaneously reaping local social and economic benefits together with globally important environmental benefits (Source, [15]).

4. Policy Recommendations

Currently, farms neither feed the population nor provide the engine of economic growth. This outcome underpins Africa’s current relatively unproductive and environmentally damaging agricultural practice of capital intensive, large-scale, monocultural farming practices. These were developed in Industrial Economies with very different social and economic conditions and different environments. This reflects the history of the last two centuries, and poses the questions: “Do we in Africa need to think again; should we formulate our own policies to meet the needs of our people in tune with our own social, human, natural, physical and financial capital?” If the answers are ‘yes’, then what needs to change?

Policies should address:

- The under-production of staple food crops that cause food insecurity and its consequences—hunger and malnutrition—caused by the downward spiral of land degradation and social deprivation related to deforestation and loss of natural capital and traditional culture.
- The nutritional imbalance of starch-based diets from cereals and root crops and their consequences—weakness and ill-health—caused by lack of dietary diversity and loss of traditional foods.
- The lack of income-generating opportunities for smallholder farmers struggling to grow enough to feed their families, let alone to market—caused by a lack of marketable products, a lack of local rural industries, and unfair international commodity markets.

These three policy recommendations can be combined to create a generic model which is highly adaptable to different environmental and social situations, to reverse the “Cycle of Land Degradation and Social Deprivation” that drives the downward spiral in food production and livelihood outcomes in African agriculture [16]. The cumulative effects of implementing these policies would be substantially improved staple food crop yields: a new location-specific set of highly nutritious indigenous food crops for integration into

diversified farming systems that promote (i) agroecological sustainability; (ii) the market expansion and diversification of local business opportunities and employment; and (iii) rural development based on community growth and greater access to farm inputs and physical infrastructure. When scaled up, these economic benefits would allow a suite of livelihood outcomes from new local markets, trade, and industries [15]. Furthermore, by diversifying and rebalancing agroecosystems, these actions would, in the longer term, reduce the risk of new zoonotic diseases.

Diversification to include new crops from indigenous food trees has gained momentum in recent years [45,46]; in addition to diversifying diets, it aligns with the importance of prioritising interventions based on poverty prevalence, absolute numbers of the poor, and inequality measures. Furthermore, increasing perennial biomass and agrobiodiversity is central to climate change adaptation and mitigation and is relevant to existing African policy instruments on food and nutrition security and poverty reduction. It also aligns with existing global and regional programmes under the United Nations Framework Convention on Climate Change, the Convention of Biodiversity, and the International Treaty on Plant Genetic Resources for Food and Agriculture. However, there is still a lack of political will to enact a paradigm shift on the scale needed at a national level. Thus, policy makers, scientists and agricultural practitioners need to be further informed about the benefits of indigenous biodiversity and traditional knowledge systems.

Showcased examples suggest that rural livelihoods can be markedly improved at sub-regional and national levels if Africa undertakes its own agricultural revolution. More attention is needed to create an enabling environment vis à vis the ‘ecological politics of development’. Smallholder farmers are often regarded as static and standardised rather than dynamic and context-sensitive within development models. Because of this challenge, the use of participatory domestication of socially modified crops within farmer-friendly, wildlife-friendly, and climate-friendly agroforestry systems has the added advantage of formulating content and context-specific interventions. Policy to support socially modified crops will require transdisciplinary participation, incorporating smallholders and policy makers into the process at all stages. There is also a need to develop an agricultural research agenda that focuses on achieving sustainable impacts embedded within intensification.

We recommend that African countries should take a series of measures to reform institutional arrangements, integrating production and markets appropriately to support and speed up crop diversification within agricultural landscapes. The immediate actions include creating a conducive environment for trade, ensuring markets, developing roads, creating appropriate infrastructure, and encouraging private sector participation to add value and process indigenous food products. Direct policy intervention is needed to increase institutional credit access to promote innovative, low-cost technologies suited to supporting new cottage industries that expand the value chain of indigenous food products within a green circular economy, leveraging the significant social and natural capital that exists within Africa. This requires an explicit pan-African acknowledgement of the role of Africa’s agrobiodiversity in modern agriculture. If Africa adopts the above initiatives based on her biodiversity and people, it could launch a fit-for-purpose African Green Revolution for Africans and led by African farmers, researchers, and policy makers.

5. Conclusions

It is time for action to address (i) the discrimination against African farmers, which has led to them being locked in social injustice, hunger, malnutrition, and poverty, and (ii) environmental degradation on a planetary scale. Over the last 30 years, progress has been made towards finding ways to address the failures of African agriculture and its consequent hunger, malnutrition, and environmental degradation, which are intertwined with abject poverty, societal marginalisation, injustice, and social conflict. The time is now ripe for a socially and environmentally meaningful adoption of a new approach led by African farmers, researchers, and policy makers to reverse the processes driving land degradation and social deprivation. The solution needs to be driven at a localised level,

addressing decolonization and neo-colonialism by leveraging the geographic advantage of Africa's natural and social capital on behalf of Africa's people. The outcome should focus on empowering African rural communities and indigenous peoples' rights to improved livelihoods, well-being, and justice. The positive impacts of this would then extend to enhanced resilience to environmental pressures on a planetary scale.

The more holistic and sustainable approach to tropical and subtropical agriculture outlined above repairs the special relationship between nature and human beings. Importantly, it specifically offers an appropriate way forwards for Africa, and indeed the wider global population: one that addresses the main constraints to agricultural production facing subsistence smallholder producers, as well as the *Ecocide* underlying planetary health. Fundamentally, this approach draws on the decentralised domestication, diversified cultivation, and localised commercialization of a much wider set of indigenous and locally important food and non-food crops within diversified and rebooted farming systems that maximise the returns/profits from the natural, social, human, and commercial capital, while becoming an engine of economic growth that rebalances the global economy (Figure 3). This is needed in Africa as, currently, the benefits flow mainly to those in Industrialized Countries in this age of scientific discovery. This has been the case in agriculture, where millions of African farmers still do not have access to the advances in soil fertility management, pest control, irrigation, etc., of the 1950s–1970s. However, to achieve this economic, social, and environmental rebalancing, and address the UN Sustainable Development Goals ([65]; Table 1), it will require accepting a very different mindset by international policy and decision-makers in Africa and the rest of the world. This diagnosis has been recognized by Dembitzer [71], who stated that any economic analysis of global economic growth and development must acknowledge that there is not one “central, unifying economic engine of growth”.

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