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The Songhai Agroecological Sustainable Development Model: Synergy, Symbiosis, Collaboration, and Complementarity

John Tharakan

Abstract

The development across Africa has been piecemeal and uneven, sometimes actually leading to impoverishment and “underdevelopment.” Former colonizers and multilateral development agencies have often been the agents of these postcolonial development practices, which focused on facilitation of extraction of wealth, either as material resources or raw agricultural product and export, usually to former colonial era companies. The processing of those natural resources produced immense value-added wealth; however, not much wealth returned to Africa. These development models have been piecemeal, with symptomatic solutions that are Band-Aids, resulting in minimal progress in terms of actual improvement in the quality of life and well-being of citizens. To counter this, it is necessary to shift from linear, mechanistic worldviews to holistic, complex visualizations that are integrated and systemic. This transformation, in understanding and conceptualization through system lenses, makes clear that the unit of development must be ecosystems centered and represent organizational patterns that encompass the whole environment, including human, social, cultural, technological, and economic facets. This new understanding requires comprehensive ecological literacy transitioning from homo-arrogance to biomimicry. Such transformation enables comprehensive solutions that account for interaction among natural, physical, and social phenomena. This chapter describes a development approach, embodied in the Songhai model and conceptualized, developed, and successfully implemented by Godfrey Nzamujo. It captures the essence and reflects a new paradigm, whose core foundational ideas are synergy, symbiosis, collaboration, and complementarity. This new paradigm, as demonstrated by Nzamujo and Songhai, is described as a potentially transformative development model, ensuring sustainability for the future of Africa.

Keywords: symbiosis, synergy, collaboration, complementarity, supplementarity, sustainable, development, biomimicry

1. Introduction

The African continent has been endowed with immense natural and human resources. In addition, she has a huge inherent capital in terms of cultural,

economic, ecological, and natural diversity. Nevertheless, conditions of progress and development across Africa remain weak, with a current poverty rate of 43% and with 27 of the 28 poorest countries in the world in sub-Saharan Africa. In fact, poverty rates in many countries have fallen dramatically, but the story is the reverse in many African countries [1]. That this obtains despite more than six decades of development interventions by multilateral institutions like the World Bank (WB), International Monetary Fund (IMF), United Nations Development Program (UNDP), national and international development agencies such as the United States Agency for International Development (US AID), the German Development Agency (GIZ), and the United Kingdom's Department for International Development (DFID), as well as regional agencies and institutions like the African Development Bank (ADB) and the African Union (AU), speaks to the ineffectiveness and inadequacy of current development models and practices and calls for a radical rethinking of the approach.

Most African countries began to emerge from their colonial pasts, beginning in the 1950s and 1960s. At the time of independence, there was a great deal of hope and expectation for rapid improvements in the quality and condition of life in these former colonies, colonies that had been plundered and looted for material resources, natural wealth, and human capital for over three centuries. Yet, after over half a century of development assistance and intervention, the social, development, and public health indicators across Africa are lacking. Millions of African citizens, from Gambia in the west to Somalia in the east, from Tunisia in the north to South Africa in the south, remain mired in poverty and underdevelopment, with no or limited access to clean water, electricity, safe and affordable food, accessible and available healthcare, and broadband or even limited Internet connectivity, not to mention a critical shortfall in infrastructure for education, healthcare, transportation, communication, and finance. This challenging reality on the ground was the driver for the first Millennium Development Goals (MDGs), which were eight development goals set following the Millennium UN Summit of 2000 [2]. By 2015, most of these goals remained unmet, at least to the level and degree to have real impact. The MDGs later transmogrified into the United Nations sustainable development goals (SDGs). The SDGs outline and articulate what is needed across the various sectors, such as water, sanitation, and health, in terms of the development that is critical to achieve some measure of equity, justice, and sustainability across countries and the planet. The SDGs are a universal call to action to end poverty and ensure that *all* people enjoy a life of peace and prosperity, while protecting the planet and preserving its capacity to continue to support future generations of humanity.

The SDGs are comprehensive and encompass all aspects of what are needed for our species to be considered peaceful, prosperous, and flourishing. Although the SDGs are numbered, there is no particular ranking, and all are considered critically important. Specifically, the SDGs call for an end to poverty and hunger and good health and high well-being for all. This includes quality education, gender equality, clean water, sanitation, affordable and clean energy, and decent work accompanied by economic growth. These are goals that can be concretely measured in terms of achievement, such as what percentage of a population has access to clean water, sanitary sewer systems, and electricity, for example. Additional SDGs are broader and more aspirational, such as building capacity in industry, innovation and infrastructure, reduction of inequalities, transformations to sustainable cities and communities, responsible production and consumption, and climate action to mitigate climate change impacts. The last four SDGs are even broader as well as much more general, speaking more to policy development perspectives, such as addressing life below water, life on land, building peace, expanding justice, and building strong institutions. The final SDG focused on building the partnerships that will

be critically necessary for our civilization and species to meet all these SDGs, especially given how far removed we are, from a global and planetary perspective, from actually addressing and meeting all the SDGs. Given the current state of global geopolitical dysfunction, with the rise of authoritarian governments and regimes that promote privatization, deregulation, and unrestricted access to capital's exploitation of natural resources, as well as the already much degraded condition of our geography and geophysical environment, *whether the SDGs are even close to being attainable remains a serious and substantive question.*

The fact that there is a continuing need for articulation of these basic development goals close to the dawn of the third decade of the twenty-first century speaks volumes about the failure of conventional development models. These models, implemented by multilateral institutions and Global North national development agencies since the end of the colonial era and the dawn of independence in Africa, Latin America, Asia, and other former island colonies, have failed to deliver. If we take 1960 as an arbitrary baseline, since many former colonies saw their independence around that time (plus or minus around 10 – 15 years) and we track development as measured by various indices forward through time, we will see that most indicators have risen slowly, some not at all, while others have changed dramatically. Clear measures of this “progress,” after more than half a century of development actions and interventions, would be the percentages of the population that live below the poverty line, have access to clean water, have access to improved and sewer-based sanitation, and have access to electricity. We can pick a country from any of the colonized continents—Asia, Africa, and Latin America—and track the change in these indicators, using that as a *prima facie* measure of the success of development and growth policies from independence forward, under the intervention of traditional aid and development agencies.

An alternate approach could be to focus on well-being, referencing development to baseline conditions necessary for societal flourishing as posited by Verharen et al. [3, 4] in their *survival ethics* model. This model articulates the critical utilities, services, and infrastructure that are essential and necessary, from moral and ethical to biogeochemical and physical perspectives, to support a society to actually flourish. At the basic physical level, we need air, water, shelter, food, and clothing. To be meaningfully sustainable, this would have to be *clean* air; *clean and safe* water; available, *accessible, and safe* food; *temperature-controlled* shelter; and *sustainably renewable* energy. One would have imagined, given the scale and overabundance of resources available in the Global North, that 50 years of interventionist development, under the direction of multilateral agencies such as the World Bank, the United Nations Development Program (UNDP), and the United States Agency for International Development (US AID), would have ensured that these minimum requirements for a healthy life would, by now, have easily been met across the planet. After all, none of these services require advanced technologies, and practically the entire population in the developed world has access to all. The story in the Global South is quite different. In the Global South, by 2015, there still are close to a billion humans—844 million—who do not have access to an improved drinking water source [5, 6]. Although the world apparently made “tremendous progress” in meeting the millennial development goal (MDG) of halving the number of people without sustainable access to safe drinking water by 2015, 5 years “ahead of schedule” in 2010, many of the “improved” drinking water sources do not consistently, reliably, and reproducibly provide safe and potable water, resulting in as many as 2 billion people not having really reliable access to clean potable water.

The situation with sanitation, the other end of the clean water spectrum, is even worse. Over two and a half billion people, practically every third person on this planet, do not have access to improved sanitation [5, 6]. Needless to say, it is

most likely that those without access to an improved water source are likely also to lack access to improved sanitation. The consequences of the unavailability of these two critical needs are evinced in numerous diverse negative ways: an estimated 801,000 children younger than 5 years of age perish from diarrhea each year, mostly in developing countries, or about 2200 children are dying everyday as a result of (preventable) diarrheal diseases [7]; worldwide, millions of people are infected with neglected tropical diseases (NTDs), many of which are water- and/or hygiene-related, such as *Guinea worm disease*, *Buruli ulcer*, *trachoma*, and *schistosomiasis*, and are found in places with unsafe drinking water and poor sanitation [8]. Clearly, the impact of clean water technologies on public health has a high rate of return, reducing morbidity from diarrhea and other water-borne diseases [9, 10].

In terms of food, close to 800 million people do not have sufficient food to lead a healthy, active life, while over a third of produced and processed food is wasted! Needless to say, the vast majority of the hungry live in developing countries, where as many as one in eight people are undernourished and hence unable to flourish. Two thirds of these are from Asia, and, while the percentage in southern Asia has reduced, an increase has also seen in recent years in western Asia, due to conflict and war. The negative impact of lack of food is profound: nearly half of deaths in children under 5, almost 3.1 million a year, are a direct result of poor nutrition. More than 100 million children in developing countries are underweight, and one in four of the world's children are stunted [11].

Over 1.6 billion people, almost one out of every four, on this planet lack adequate housing and shelter as estimated by Habitat for Humanity, while there are over 150 million people in the world who are completely homeless. India has the most homeless people in the world with almost 70 million homeless, while another 170 million are “almost homeless.” The tenuous and shaky, literally, nature of the housing of those with inadequate shelter puts these individuals and families at high risk of being added to the roll of homeless, potentially dramatically increasing the level of homelessness on our planet [12].

Nearly 1.1 billion people had no access to electricity in 2014, and more than 3 billion had no access to clean fuels and clean fuel cookstove technologies, despite the fact that these technologies have been widely researched, developed, and promulgated with numerous alternative designs developed and implemented in terms of cookstove design and fuel type being promoted by numerous development agencies and NGOs. The United Nations Sustainable Development Goal 7 recognizes that extending access to electricity and other forms of energy is fundamental to improving people's lives and communities. As recently as 2016, only 10% of the energy consumed on the planet was coming from renewable and sustainable sources such as wind and solar energy [13].

Now, in the globalized world of the twenty-first century, access to the Internet and the World Wide Web of information and communication has become a basic need that is critically necessary to build community capacity. However, only about half of the world's population is online. There are about 4.4 billion people with access to the Internet and World Wide Web, bringing the percentage of people with Internet access above the 50% mark. And as in the areas of water, sanitation, shelter, and energy, there are enormous discrepancies in terms of access, speed of connection, bandwidth, and quality of access. In the developed world, over 80% of people have broadband Internet access, while in the developing world, it is closer to half or just over 50% of people with Internet access. This does not drill down into the speed and bandwidth available. In the most connected country on earth with the highest number of Internet users, China with over 750 million users still has more than 40% of the population unconnected. In India, with almost 700 million Internet users, almost half of the population has no Internet connection [14].

For now, focusing on the very basic needs of water and sanitation, it is evident that, after 50 years of conventional interventionist development, a billion people are still left without access to reliable clean potable water, whether by way of decentralized or centralized water collection, treatment, and distribution piping systems. Even more telling, two and a half billion people are still without access to sanitation and the sanitary removal and disposal of human waste. The fact that these numbers across Africa are even lower speaks to the need for a different approach, one that will engage and empower communities and result in tangible community-centered development, capacitation, and urgent addressing of all these basic needs.

2. The Songhai approach

This is where the Songhai Center and the agroecological approach [15, 16] provide a radical rethinking of the conventional top-down, external agency-supported development practices of the twentieth century. The Songhai approach involves integrated and community-based sustainable technology research, development, implementation, transfer, and dispersion. This model forms the structural and existential fabric of the Songhai approach to development. This is where the three Rs of the twentieth century, limited to reduce, reuse, and recycle, have effectively, holistically, and successfully been expanded to a true twenty-first century model of multiple Rs, incorporating *respect* for the environment, *radical rethinking* of our approach, and an ethos of *recovery* where waste is *reconceptualized* as *resource* and a true circular economy becomes possible.

What we will here call the Songhai approach is self-defined and identified as a rural growth initiative rather than that is an alternative sustainable development model that promulgated by multilateral aid and development agencies which tend to be a top-down interventionist and have, at best, simply failed at achieving development targets and, at worst, resulted in actual underdevelopment and increased dependency [17]. The development focus and attention in decolonizing Africa were on the maintenance and expansion of the infrastructure that would enable newly independent African nations to grow, harvest, and transport fresh agricultural produce or extract, transport, and export raw mineral resources, the processing and value addition to both (agricultural produce and mineral resources) of which would occur in the industrialized Global North. The development that took place in the former colonies, as well as the infrastructure that was put in place, ensured that this export of raw materials and agricultural produce would be maintained and expanded. The long-term result of that focus has been the impoverishment of many African nations, brought about by the depletion of resources, the transformation to monoculture cash crops, and the wanton, unrestricted, and unregulated exploitation and extraction of resources, enabled through the corrupt and undemocratic regimes that enriched themselves at the cost of national development through these regime collusions with former colonial governments and their multinational corporate partners.

Multilateral and international aid agencies tend to view poverty as a symptom that can be treated through some directed intervention, whether that intervention is focused on providing clean water through the installation of a pump or the establishment of a rural health clinic and expecting these directed and very often uncoordinated interventions to result in fundamental change that has at its core the empowerment of communities through the integrated development of the community's capacities and capabilities. The Songhai analysis sees the succumbing of Africa to the logic of poverty and underdevelopment caused by the loss of internal, some would argue organic, capacity "...to build the appropriate institutions

and structure that will enable us to consistently unleash the appropriate creative and organizational forces to produce the social values, goods and services that correspond to our needs and desires” [15]. The loss of this capacity breeds passive consumerism and the adoption of piecemeal solutions, other people’s experiences, systems of production, as well as values as the cheaper, quicker substitute, instead of doing the hard work necessary to have indigenously and endogenously developed relevant solutions that are authentic, holistic, and sustainable.

Having correctly identified the multiple crises that face development in Africa, including food security, poverty, demographic transitions, youth unemployment, and environmental challenges, and recognizing that these are all connected and interdependent, the Songhai vision has been underscored by understanding the problem as systemic, requiring an integrated and holistic approach. The integration and holistic conceptualization was hypothesized to result in and enable synergy and sustainability. In the African rural context, where agriculture is the main and core human activity, this agroecological initiative and approach should reverse the logic of poverty in a sustainable manner.

Undergirding the Songhai approach is the development of the human capacity for authentic, holistic, and thus sustainable development. The program for human capacity development must be well-designed and coherent, integrating authentic technologies as well as enabling environments, which together would be required to guarantee sustainable, broad-based, and inclusive growth and development on the African continent. The human resource development program is designed to grow and maintain a new human resource base with a fundamentally new culture and capacities that are aligned with the socioeconomic realities of today and tomorrow. The Songhai Center’s human development program is aimed at developing socio-economic leaders who can implement and operate sustainable rural growth programs throughout Africa [15, 16]. Leading sustainable rural development programs requires an awareness of the integrated nature of rural environments involving crosscutting and interrelated dynamics among a diverse resource base, engaging polyvalent personnel and interdependent structures and organizations. Thus, the business model that is employed is essentially a call for dynamics and orientations that go broader and deeper than previous attempts at development, which means a radical shift that combines environmental, scientific, technical, social, and economic orientations. This combination must be both latitudinal, across areas of emphasis, but also longitudinal, from production to consumption; the continuum begins with resource extraction or cultivation followed by processing and transformation into value-added products and services. Given the agricultural context, the approach has to be systemic and multifunctional, which will insure food and nutrition security and health, but also increase household income, all in a sustainable manner.

Implemented in this framework, integrated agroecological rural development can become, as it were, a weapon of mass construction. Providing the relevant ecological literacy to the youth of a community can empower and capacitate them to develop and deploy appropriate technologies that are aligned with this new vision. The vision has to have a core, enabling institutional framework to foster skill development, as well as the generation and sharing of technologies that are relevant to the rural communities the youth inhabit.

In the Songhai model [17, 18], agriculture is holistically conceptualized to promote the biological processes in which investments can focus the development of environmental and biological capitals that facilitate agricultural systems to operate effectively and efficiently in a systemic and synergistic manner. At the fundamental (biomass and bioenergy) level, Songhai processes effectively manage the flows of energy and biomass within the whole system to create new and better

biological capitals. Hence, agriculture is multidimensional and multifunctional and enhances production cycles and pathways by producing food in sufficient quantities to promote health, enhancing the environment in terms of soil quality. This provides a framework for green rural communities and builds sustainability and biodiversity. The system also concurrently provides raw materials for agro-industry and feedstocks for renewables, and in so doing, the system creates employment for youth and builds household income.

3. Integrated production system: symbiosis and synergy

The holistic approach provides the rational for an integrated production system, where crop production, livestock production, and aquaculture-based production are all centered around and connected through the *bioenergy* that all three areas of production require as well as produce. This regenerative approach enables the creation of new biological capitals while breaking the cycle of poverty stemming from the scarcity that can lead to socioeconomic conflicts, through the effective recycling and management of bioenergy and biomass, now integrated into a virtuous cycle of biological capital regeneration.

This integrated production system is holistic, so that it also is embedded in the rural and peri-urban communities, linking primary production to marketing services, and the small and medium enterprises based in the community, all of which are connected through the centrality of innovative and sustainable technology contributing to all stakeholder's in the environment. Primary production includes crops, livestock, aquaculture-based fisheries, as well as specialty items that pertain to specific geographic locales and environments. Marketing and services include retail, restaurants, and food exports. Small and medium enterprises are focused on value-added processing, which could include food processing or materials processing for small-scale manufacture and construction.

At the Songhai Centers, this approach necessitated the redesign of production and development systems based on this new understanding of the integrated and interdependent nature of agriculture—engaging a broad and holistic appreciation of cyclic biomass and bioenergy flows with human ecosystems. The Center also focuses on increasing the entrepreneurial and production capacity of youth through functional training coupled with the appropriation and deployment of authentic and sustainable technologies. The Center assists youth in the incubation, seeding, and support of the development and launching of commercially viable enterprises. Across all this, the amelioration of environmental degradation and the preservation of environmental quality to ensure future generations inherit a healthier and less compromised environment than currently extant is the undergirding thematic [15, 16].

4. Organization of the Songhai Center: complementarity and supplementarity

The Songhai business model has articulated five components to deliver its mission. The model builds on a foundation of symbiosis and synergy in the ecosystem and articulates a framework based on complementarity and supplementarity. First and foremost, it is a cultural reorientation and training center where ecological literacy is foundational, and the emerging world view, concepts, and principles from modern science, combined with the implications for economic and social organizations, is inculcated into youth from the community. Second, the Center serves as a technology park, where new technologies and organizational structures

and patterns that are aligned with the new world view are elaborated, and these are developed and contextualized in collaboration with research institutions and universities. Third, the Center is an industrial park and production center, where the ideas, techniques, and organizational tools developed as part of the education and research in progress are turned into small enterprises and launched in an integrated and systemic manner [15, 16].

Fourth, it is also an incubation and training center for human resource development. Here new competencies are developed, while new visions are harnessed and new techniques and methods are developed and deployed within the technology parks. The target is the establishment of productive, effective, and efficient enterprises. The community, participating in the study, design, development, and production activities, always facilitated by mentor-practitioners, builds capacity and enhances technical, organizational, and managerial competencies, resulting in the creation of a functional entrepreneurial workforce able to add value. Since their inception, large numbers of youth have sought enrollment in the various Songhai Centers, a sign that youth are excited and attracted to new innovative agricultural initiatives that they see as bringing income and value into their and their family's lives. Fifth and finally, the Songhai Centers are also service centers, where graduates from the various training and capacity building programs are leveraged with critical services such as marketing, input procurement, hospitality services, networking, financial and loan services, as well as advisory and advocacy services and programs that create the synergies which enable the program's graduates to create synergies through initiative and cooperation.

5. Songhai rural growth initiative: sustainable development

The Songhai rural growth initiative is centered in the “mother” enterprise that is an ecosystem based in the community that functions as an enterprise development, incubation, and extension space, incorporating agribusinesses, an industrial park, and a technology park with innovation and research and development spaces. Based in the community, it draws on families and the community production zone and builds capacity in terms of youth entrepreneurial zones, bringing the two together. Programs leverage the five components of the center to serve as a networking and extension space for farmers who can constantly improve and update their knowledge and skills to key into regional markets, capture export opportunities, and harness the reinvestment in agriculture while safeguarding national autonomy in development.

6. Core theories supporting Songhai

The rationale and justification for the Songhai approach center around three strategic core theories. The *first* strategic core theory postulates that a *new human resource base* is the key to addressing the development and growth challenges of the present day. The *second* strategic core theory, in the current post-modern science era, argues a *paradigm shift toward producing more and better with less* through an agroecological framework that efficiently and productively harnesses biological capital of living systems. The *third* strategic core theory is that the entire world has to move toward *true sustainable development* [17, 18].

The justification for the first strategic core theory is embedded in what has transpired in Africa in the past 50 years since many countries became independent of their former colonial masters. The world has progressed from where the socioeconomic health and well-being of a nation do not depend fundamentally or

principally on its natural resources or geographical position. The foundations of national well-being, economic prosperity, energy sufficiency, industrial capacity, public health, security, and environmental quality are all now knowledge based. Thus, knowledge and technical capacity are the principal social and capital resources in the world; nevertheless, these forms of capital are extremely unevenly distributed across the world. Sub-Saharan Africa especially suffers from a lack of access as well as availability of primary and secondary education, resulting in populations and workforces that are insufficiently capacitated in terms of education. The Songhai programs are predicated on the received understanding and wisdom that people with more knowledge and more access to knowledge and technical competence have more opportunity and are more successful than people with less knowledge and technological competence. Given this understanding, it is clear that any significant improvement on the efforts of African youth and their productivity will depend critically on the level and quality of investment in human capital development.

The Songhai metric for the performance of any of these human capital development programs is grounded in the functional value of the knowledge, skill, creativity, and humanity that is engendered through investment in such programs. This type of investment is what will provide engaged, constructive citizens of tomorrow who will be the future innovators and entrepreneurs bringing value to their communities.

The justification for the second strategic core theory locates us in a shifting paradigm where we have to produce better and more with less through an agroecological approach that efficiently harnesses and grows biological capital of living systems. Understanding the interconnected ecosystem that we inhabit is a major step in this new direction, where we will need to determine how to go about building the appropriate institutional framework and cultivate and grow the human resource base that will be empowered and capacitated to harness new opportunities that will be revealed as the new paradigm dawns on us. Framed another way, the challenge that a Songhai Center faces is how to align with the emerging world view and create an enabling institutional framework that will underpin the production of a critical mass of new human resources equipped with the right vision, values, and operational capacities to help African communities and nations navigate through this difficult and challenging period.

The paradigm shift requires that we have to change our present-day attitudes and logic. What is required is the development of new mental and operational frameworks based on what we know about how the world works. Bringing all this together, the new paradigm that is emerging has a completely new technological, organizational, and socioeconomic orientation, challenging us to learn from the basic principles of the working of our planet and human history. The new paradigm must be appropriated and deployed by a critical mass of people before we begin to see the design, creation, and invention of new organizations, industries, and economic activities that will contribute to solving our present-day problems [15].

Ultimately, the new paradigm calls for increasing the production capacity of Africans through the leapfrogging approach, which is to create innovation that jumps over older technologies and deploy and implement new and appropriate technologies that result in sustainability. That points to the third core foundational theory of the Songhai Center, which is sustainable development.

It has long been recognized that the present-day modern agro-industrial approach to food production characterized by the intensive use of fertilizers and pesticides, as well as the indiscriminate use of water, is not sustainable. It is true that this approach has resulted in tremendous grain and food surpluses in many regions, resulting in increases in per capita food consumption. This, however, has come about with severe and unsustainable costs: the depletion of soil fertility over time

and the increase in greenhouse gas emissions as well as increased water and soil pollution. More importantly, the current agro-industrial approach has not significantly reduced the numbers of chronically hungry, which is estimated at over 850 million.

Thus, what is needed is a new approach, one that the Songhai Centers have been developing and improving over the past 30 years, since the first Songhai site was established on 1 hectare of poor agricultural land in Benin. The approach must be predicated upon the holistic appreciation of the ecosystem we inhabit and take an agroecological stance that appropriately values biological and environmental capitals. This new developmental trajectory is centered around harnessing environmental capitals to produce more and better quality food with less inputs for a growing population and to do this not only for protecting, but enhancing, environmental quality and capital. This Songhai approach of regenerative agriculture promotes the real “greening” of agriculture because it is an ecosystem’s approach that draws upon nature’s contributions to crop and animal growth in all its multifaceted and interlinked mechanisms, including soil organic matter, soil microorganisms, rainfall, pollination, biocontrol, integrated pest management, and eco-services including water, shade, and landscape. Hence, the space-time can be filled up quicker and more efficiently if we harness life cycles of different sizes that occupy different space-times, which in essence means we must mimic the biodiverse ecosystems in nature and be able to build into our interconnected efforts the reciprocal, the symbiotic, the complementarity, and the supplementarity that will result in the required synergies to go forward.

7. Implementing sustainable development

The resulting synergy is what will result in the enhancement of all, and this is what will make innovative technologies and sustainable development possible. The biggest technological and commercial opportunities in the future will have these as their underlying theme and *raison d’être*, and they will all emanate from these efforts. Sustainable development technologies will enable the African agricultural sectors to produce more and better with less and with less adverse environmental impact. Integration of these principles and values into our technology design and development thinking will enable the creation of products and services that dramatically increase productivity, nutritional value, and quality while eliminating waste and pollution [17].

The Songhai initiative seeks to harness these principles to imagine and construct new and appropriate technological and developmental models and trajectories. It is an integrated development system that organically creates both forward and backward linkages and synergy between agriculture, industry, and services and within reach for each subset as well. Thus, Songhai develops and promotes processes that strive to harness the regenerative forces and elements in nature to develop agriculture that is multidimensional and multifunctional and also enhances the benevolent cycles and pathways within an ecosystem.

Hence, the underlying core themes and efforts are production of sufficient food in terms of quantity and quality to promote healthy living, aging, and disease prevention, enhancement of the environment in terms of soil quality, building of sustainability and biodiversity, provision of raw materials for agro-industry, provision of feed stocks for renewable energy, and creation of employment opportunities, especially for youth and women.

The merits of such a development approach and strategy, grounded firmly in an agroecological model of sustainable agriculture, are safe, affordable, of high yield and high quality, and sustainable; at the same time, this approach also addresses problems of degraded environments and unemployment, in both rural and urban areas, and builds a strong base for a broad and inclusive economy [19].

8. Conclusion

The core of the design approach is reciprocity, symbiosis, complementarity, and supplementarity, all focused on elucidating and exploiting the synergies that abound in a “designed” natural and integrated farming system based on low-cost inputs through recycling by-products, reclaiming “wastes” as resources through the deployment of new biotechnologies based on microorganisms. These synergies and amplifications have been ignored by conventional industrial agriculture and have resulted in the degradation of soil environments to such a degree that without intensive inputs of fertilizers and pesticides, agro-industry cannot deliver. Hence, an added and critical advantage of the synergistic agroecological approach to development is the creation of a probiotic environment that empowers the regenerative agents of nature. It should be clear that this agriculture *will not* be a chemical intensive and interventionist process, like conventional agriculture. Instead, it will harness fundamental biological and microbiological processes, where the full range of biological and environmental capitals is completely engaged and harnessed. This will require the (re)learning of the processes whereby our environmental capital can be harnessed, providing the impetus and undergirding the transformation of the rural economy to become productive, efficient, and remunerative. The effects of this broad-based approach should result in the creation of diverse and meaningful employment that should eventually support a reversal of the exodus from the villages to the cities and provide a pathway to a diverse, viable, and inclusive economy that will provide the strong and stable foundation for sustainable development.

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