
Green economy: Challenges and prospects for improved aquatic agricultural system (AAS) in Niger delta communities

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Abstract: There is dire need for deliberate green action plan to solve the endemic environmental crises occasioned by unsustainable utilization of natural resources and environmental degradation in the Niger Delta; a region with its characteristic terrain and eco-fragility that is highly susceptible to adverse environmental and climate change-related disasters. But, to successfully implement a green economy plan in the Niger Delta region, there has to be a well-thought out strategy with due appraisal of baseline environmental issues and concerns. The people of the delta depend, primarily, on the exploitation of the region's rich bio-resources with fishing and farming forming the major sources of livelihoods. Observations by independent and intergovernmental global environmental protection players indicate that, the creeks, lands, mangroves, forests, etc provide inestimable goods and ecological services to the region's inhabitants. Yet, they have been consistently degraded over the past four decades, mainly by industrial activities. Some identified challenges in greening the region and viable alternatives for sustainable agricultural development are, also, discussed. The authors have, therefore, proposed strategies such as consideration of complex biophysical and socio-economic factors, multi-stakeholder engagement, and a paradigm shift from the contemporary fossil energy-based agriculture to the more sustainable practices of biofuels and organic agriculture. A modelled paradigm for transforming current improved aquatic agricultural systems (AAS) to become more productive while, maintaining ecosystem services is proposed. Therefore, this paper examines current environmental issues and concerns as well as efforts variously made to address them in the Niger Delta against the backdrop of existing economic activities.

Keywords: Agro-Ecology, Ecological Services, Wetlands, Niger Delta, Livelihood

1. Introduction

The Niger Delta, which plays host to majority of the crude oil and gas facilities in Nigeria, borders the Atlantic coast of southern Nigeria where River Niger system divides into numerous tributary outlets that discharge the latter's waters into the Atlantic Ocean. The geographic Niger Delta spans over 20,000 km² and has a coastline of about 450 km. It has been described as the largest wetland in Africa and

among the three largest in the world [1]. About 2,370 km² of the Niger Delta area consists of rivers, creeks and estuaries while, stagnant swamp covers about 8,600 km². Also, the mangrove swamps of the delta span over 10,000 km² and are considered the largest mangrove swamps in Africa [2, 3]. The region falls within the tropical rainforest zone in the tropics lying between the Tropic of Cancer at

the northern boundaries (latitude 23.5° N) and the Tropic of Capricorn at the southern boundaries (latitude 23.5° S); specifically, described as moist deciduous and semi-evergreen seasonal forests. The ecosystems of the area are highly diverse with nutrient-rich alluvial soil that support numerous species of terrestrial and aquatic flora and fauna and human life [4].

1.1. Characteristics of the Natural Resource-Base of the Niger Delta

The Niger River Delta region is highly endowed with renewable and non-renewable resources. Oil and gas from the region have since become the main sources of revenue for the Nigerian state; accounting for about 97 percent of the country's total export earnings. The wetland environments of the region are the foundation pillars that support livelihood of the indigenous people who depend on their natural resources and ecology for a living [5]. As a result of man's desire to meet these social needs, the Niger Delta has remained a highly susceptible region to adverse environmental changes enhanced by its location in the coastal region and various incidental human activities. Therefore, the present paper x-rays the various environmental, social and food needs met by the region and their varying impacts.

1.2. Socioeconomic and Political Hindrances to Green Economy in the Niger Delta

The importance of agriculture in the economy of most countries, including Nigeria, cannot be over-emphasized. It constitutes the backbone for economic growth and industrial development in such countries and regions such as the Niger Delta region. Until recently, over 65 percent of the people of the delta were sustained by agriculture-related activities [6], mostly at the subsistence level. However, Government's direct agricultural production policy has resulted in the establishment of agricultural parastatals and companies such as Risonpalm Limited, Delta Rubber Company, Pabod Food Company, School-to-Land Authority (vocational institution) and the Agricultural Development Programme (ADP), and so on [6]. However, these hardly had systemic sustainability plans, and were easily overwhelmed by the desire for quick gains from the oil and gas sector resulting to manpower drain to the latter sector. The result is a continuous decline in the number of persons participating in agriculture and hence dwindling productivity.

Other predisposing factors include the interplay of plummeting fish stocks, extensive removal of mangroves (which are the key fish breeding sites) and poverty (living below the World Bank benchmark of USD \$1.25 per day) have made some unscrupulous artisanal fisher folks to adopt destructive fishing methods while, in the industrial fisheries subsector, over-capitalisation is the primary cause of over-exploitation. Inappropriate provision of subsidies contributes to widespread over-fishing and distortion of

trade in fisheries products. Industrial fishing in the tropics is, largely, characterised by huge harvests of immature fish and non-target species, which are illegally sold to bycatch traders on the high sea or simply thrown overboard as discards and thereby risking further aquatic pollution resulting from reduced dissolved oxygen in the water [7].

However, in terms of priority, most inhabitants of the Niger Delta region believe that, the major socioeconomic challenge in the region is poverty, since majority (over 60 percent) of the working class population are either unemployed or under-employed. There are reports in the literature to suggest that, there is a direct and critical link between environmental degradation and rural poverty levels [8]. For any transition to green economy to work, it must be preceded by deliberate and workable sustainable development packages that would, ultimately, result in poverty reduction by reversing the ongoing destruction of natural resources hotspots and by creating employment. As analysed by the UNDP [9], ecosystems and natural resources are vital for the survival and economic development of the inhabitants of the Niger Delta.

1.3. Natural and Man-Made Environmental Problems in the Niger Delta

1.3.1. Oil Exploration and Exploitation

Oil was first discovered in commercial quantities in Nigeria's Niger Delta region in 1956 and since the early 1970s, oil has dominated the country's economy. While the Niger Delta is, globally, heralded as the 13th largest producer of petroleum in the world on the one hand, it has and continues to suffer serious environmental damages within the same period due to the heavy exploitation of these resources causing it to be ranked as one of the five most polluted and degraded locations on planet earth [10]. Severe environmental problems resulting from oil and gas exploration and development activities have rendered majority of the lands unproductive and the water too polluted for fish (and other aquatic lives) or human use.

1.3.2. Oil Spills

Available records indicate that, the Niger Delta region of Nigeria experiences, on the average, 273 oil spills resulting to about 115,000 barrels of crude oil worth US\$5.64 million spilled annually from 1976-2001 (valid at the average prevailing rate of US\$49 per barrel within the period under review), making the region most vulnerable to oil spill than anywhere else in the world [11]. Moreover, oil spills impact significantly on farming and fisheries livelihoods and general water quality of the Niger Delta [9,12,13].

1.3.3. Gas Flaring

The flaring of gas has been ongoing in the Niger Delta region for over four decades yet, an immediate end to this daily nightmare seems not at sight. Today, there are about 123 flaring sites in the region [2]. With an estimated average of 17.2 billion m³ y⁻¹ of associated gas emitted in

the Niger Delta [14], amounting to 16 percent of global emissions. This huge volume of gas emission makes Nigeria one of the highest emitters of associated gas in the world [15]. Consequent upon this, acid rains have remained one of the effects of gas flaring, which occurs when polluting chemicals are absorbed by water droplets in the clouds. The acidity in rain water appears to be higher in the Niger Delta region and decreases further away from the region. These acidic droplets can increase the acidity of the soil and affect the chemical balance of aquatic ecosystems. Acid rains lead to loss of biodiversity, corroded roofs, destruction of forests and economic crops as well as lung diseases in mammals [16,14].

1.3.4. Pipeline Crossing

Forests and other vegetal formations are fragmented or totally removed when oil and gas pipelines are being laid. Similarly, rivers and swamps are blocked or sand filled in the process of laying the pipelines. With oil canals and network of pipelines traversing the delta land- and water-scapes, the inhabitants find it very challenging to, freely, undertake their conventional economic activities. This is because, embarking on these activities such as fishing and farming is almost impossible without standing the risk of, inadvertently, causing accidents when the pipelines are unwittingly damaged or even get damaged naturally due to loss of integrity resulting from age-related corrosion.

1.3.5. Dredging and Sandfilling

Intensive dredging activities are going on in the Niger Delta basin as a prerequisite for one project or the other. The main goal of such dredging operations has been canalization for transportation purposes, reclamation of land for construction of harbour and collection of sand for building purposes [10]. Dredging effects include destruction of spawning, breeding and feeding grounds of aquatic organisms; reduced number of benthic organisms; increased turbidity of water bodies; mobilization and bioavailability of sediment trace metals [17].

1.3.6. Waste Discharges

The water systems of the Niger Delta are used, extensively, for the disposal of various types of wastes, without conventional treatments [9]. Discharge or dumping of wastes such as sewage sludge, industrial wastes and dredged materials, municipal solid wastes and effluents and non-point pollution from agricultural and urban runoffs are common place in the region [18,19].

1.3.7. Deforestation

One recent important observed feature in the region is the almost complete absence of primary forests, majorly attributable to unsustainable human activities. Such practices include uncontrolled logging, slash-and-burn farming approach, oil exploration and exploitation, urbanization and mining activities, and so on. Deforestation has since been identified as a serious problem in Nigeria, which currently has one of the highest rates (3.3 percent) of

forest erosion in the world [20], having temporal increment. Oladipo [21] estimated deforestation rate of tropical rainforest (not wetlands forest) in Nigeria as approximately 3.5 percent annually, translating to a loss of 350,000-400,000 ha of forest land per year. As forest cover declines, desertification becomes more intense, wildlife populations plummet due to poaching, habitat loss, and deepened soil erosion. There has also been a drop in the productivity of coastal and inland fisheries due to soaring mangrove losses [22]. The regeneration rate of biomass may also decline significantly affecting the amount of fuel wood available for local people. In addition, extensive mangrove loss in the Niger Delta has implications for global climate change. Though mangroves, salt marshes and seagrasses make up only less than 0.5 percent of the coastal bed, they sequester as much as 71 percent of the carbon stored by ocean sediment [23]

1.3.8. Erosion and Floods

The occurrence of coastal erosion has been reported in the Niger Delta by Okon and Egbon [24]. Most coastal regions of the world are already experiencing flooding due to rise in sea levels and extreme precipitation. The rises in sea levels have been linked to the impacts of global warming by the Inter-governmental Panel on Climate Change (IPCC). According to the report of IPCC [25], working with records over the last 100 years, a strong correlation exists between global temperature and sea level rise.

Also, Ogba and Utang [26] reported that, the predicted rises in sea levels and ocean surges will worsen the problems of coastal erosion that is already a menace in some parts of the globe, especially, the Niger Delta. The associated inundations will increase problems of sea-water intrusion into fresh water sources and ecosystems, destroying natural habitats stabilizing systems such as mangrove forests, and would affect agriculture, fisheries and general livelihoods. The salinization of groundwater will lead to shortage of freshwater, and thus have profound implications in regions occupied by wetlands and swamps such as the Niger Delta region of Nigeria where the inhabitants mostly depend on underground water through dugout wells as their main source of water supply for drinking as well as for other domestic uses.

2. Action to be Taken

For any green economic proposal to succeed, the various facets of environmental degradation in the Delta region must be addressed. This requires strategies that would integrate the complexes of biophysical and socioeconomic factors, and multi-stakeholder involvement. With the present economic situation, agricultural sector needs to be revived in order to make room for green alternatives in the area of food production, resource management, contamination and degradation of the environment and green employment.

2.1. Food Production

Reliable food supply is an essential prelude to rural economic stability. The government at local levels can expand local small-scale agriculture and support transition to organic agriculture rather than subsidizing costly agro-chemicals. This way, these subsistence farmers would have their capacities built to the extent that they would naturally graduate to become big farmers who engage in industrial food production through individual efforts or as farmers' cooperatives or organisations capable of positively utilizing available genetically modified crops. Family owned and operated farms of small to medium sizes constitute the most reliable, high quality and economical food production systems [27]. Thus, agricultural policies must be designed to make existing and emerging family farms, economically, viable. The government should encourage agricultural practices that are, economically, viable without compromising the integrity and stability of the environment [1]. Industrial agriculture is characterized by large-scale, monoculture production and high levels of external inputs such as pesticides and fertilizers and thus, reduces the positive impacts of biodiversity and ecosystems integrity. For such large-scale farming ventures, strategic environmental impact assessment might be helpful in forestalling possible negative environmental impacts of such projects.

Ecosystem restoration and conservation, sustainable agriculture and non-agricultural production practices need to be developed. There is a large amount of evidence to show that, a farmer-led approach, utilizing known and proven agricultural techniques and practices, can transform the livelihoods of farmers, increase food security and reduce malnutrition while, preserving the environment [28]. Organic agriculture utilizes the application of traditional and scientific information to decrease the usage of sprays and chemical substances in crop production. Organic agriculture, which is based on ecosystem management, is recommended for small-scale farmers in the Niger Delta, as they require minimal external inputs and use naturally available materials. The practice involves integrating crops and animals in a single farm production system, inclusion of cover and cash crops, selective breeding of locally adapted crops and livestock, production of on-farm organic fertilizers, use of inexpensive botanicals, and so on. It is, also, about the application of indigenous knowledge of the farmers themselves as a vital tool for building resilience and adaptation to climate change [29].

2.2. Environmental Degradation

Proper Environmental Impact Assessment (EIA) should be carried out on future developmental projects in the region while, an Environmental Evaluation Report (EER) should be conducted on impacted environment with adequate mitigation strategies put in place. Monitoring should be participatory between the relevant regulatory authority in collaboration with other stakeholders and

external development institutions working with local communities. Improvement in natural resource management and conservation should be encouraged and rewarded, especially, when efficient resource exploitation and utilization methods are practised.

2.3. Employment

In the Niger Delta region of Nigeria, agricultural employment has not kept pace with increasing population. There is a dearth of occupational farming in the Niger Delta since, most of the farmers do so on part-time basis or at best in conjunction with other perceived priority non-farm enterprises. Organic and small-scale farm based agriculture, which tends to utilise human labour, farmers expertise and community experience, could create a lot of job opportunities for the local people. Considerable hectares of land in the Niger Delta, including areas already established for oil palm, rubber and rice plantations, with improved techniques and better working conditions will reduce unemployment rate in the region. Climate change adaptations and mitigation measures, such as soil conservation, rehabilitation of degraded farm lands, afforestation and reforestation projects promise to create green employment and sustain rural livelihoods. Thus, deliberate efforts toward transition to a green economy will create demand for workers, which will require training and expertise in maintaining or restoring environmental quality and avoiding future damage to the ecosystem [30]. To this end, multinational companies, NGOs and governments should build the capacity of the local populace in green environment-related technologies and activities for a more sustainable impact of such intervention.

2.4. Social Protection

Social understanding should exist between the companies and their host communities, with the latter having a meaningful say in social and environmental matters that affect them as well as access to environmental benefit sharing and rights.

3. Maintaining Ecosystem Services for Sustainable Rural Livelihoods in Aquatic Agriculture Systems in the Niger Delta

In most riparian societies, aquatic resources play critical role in rural livelihoods and poverty reduction. The cardinal objective of agro-ecology or sustainable agriculture is to reduce production input and reliance on fossil fuel, while scaling up output and maintaining ecosystem balance and service viability for multiple livelihoods dependents [31]. It entails improved farm gate prices for rural food products, output value addition, adequate flow of market information and extension education.

The mangrove belt of the Niger Delta in Nigeria is the

largest in Africa and the fourth largest in the world [32]. According to Spalding *et al.* [3], the mangrove area of Nigeria covers 10,515 km². The broad deltaic ecological zone is home to over 21 million persons that mainly rely on mangrove ecosystem goods and services. Ronnback *et al.* [33] listed nine of such services, grouped under three broad functions of mangroves, namely: regulatory, reproductive and cultural functions.

Aquatic agricultural systems (AAS) are diverse natural resource exploitation and farming systems where dependent households cultivate a range of crops, raise livestock, farm or catch fish, gather fruits and other tree crops and harvest resources such as timber, reeds and wildlife [34]. They are systems in which the annual production dynamics of freshwater and/or coastal ecosystems contribute significantly to total household income [35]. For AAS outputs to be sustainable, it must be a system in which biodiversity and environmental conservation is an explicit objective of agriculture and rural development, and the latter are explicitly considered in shaping conservation strategies.

Hitherto, there had been segregation of agricultural areas from conservation areas. But, with expanding agricultural footprints, environmental conservation practitioners have since the beginning of the 21st century identified the need for agriculture to be integrated with biodiversity conservation at landscapes and seascape [36]. Managing and maintaining AAS for different stakeholder production outputs and increased livelihood returns by rural poor households require continuous supply of priceless environmental goods and services. This can be guaranteed

by investment in sustainable production methods, consensus building amongst the diverse stakeholders, reduction in postharvest losses and by dismantling market barriers that undermine farm gate prices of rural smallholder producers. It also entails concerted efforts aimed at protecting vulnerable and marginalised groups.

4. Connectedness of Sustainable Aquatic Production and Ecosystem Integrity: A Case Model for the Bonny River Estuary

Though there are broad elements that could be shared by different sustainable AAS, there exists no unilateral framework or approach that can solve the myriad of AAS improvement challenges globally. This applies to the Niger Delta region with different ecozones (floodplains, freshwater basins and inshore coastal water belts) and variation of socio-economic and cultural contexts [4]. Here, the Bonny River estuary is used as a representative case study of how ecosystem services can be managed and sustained for improved rural livelihoods of AAS in the Niger Delta. The Bonny estuary occupies between latitudes 4^o25' and 4^o50'N and longitudes 7^o00' and 7^o15''E [37]. It has an estimated 66,000 hectares made up of elevated beach ridges, mangrove swamps, rivers and creeks. Figure 1 shows the present production system in the Bonny River estuary.

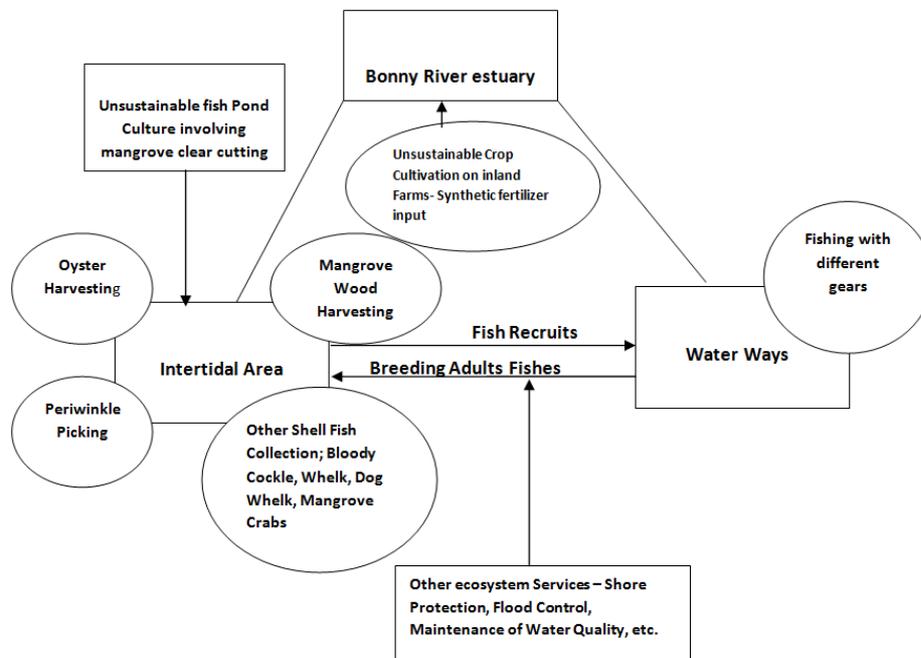


Figure 1. Flow chart showing AAS at Bonny River estuary.

The figure suggests that, the main factors undermining sustainability are clear cutting of mangrove for establishment of fish ponds and uncontrollable use of

inorganic fertilizers and pesticides to boost crop production on island farms that dot the estuary. There are also flashpoints of domestic and industrial waste dumpsite and

outfall along the community's coastal corridors, in addition to threats of oil spillage from a network of oil pipelines

traversing the river system to storage reservoirs at Bonny oil terminal.

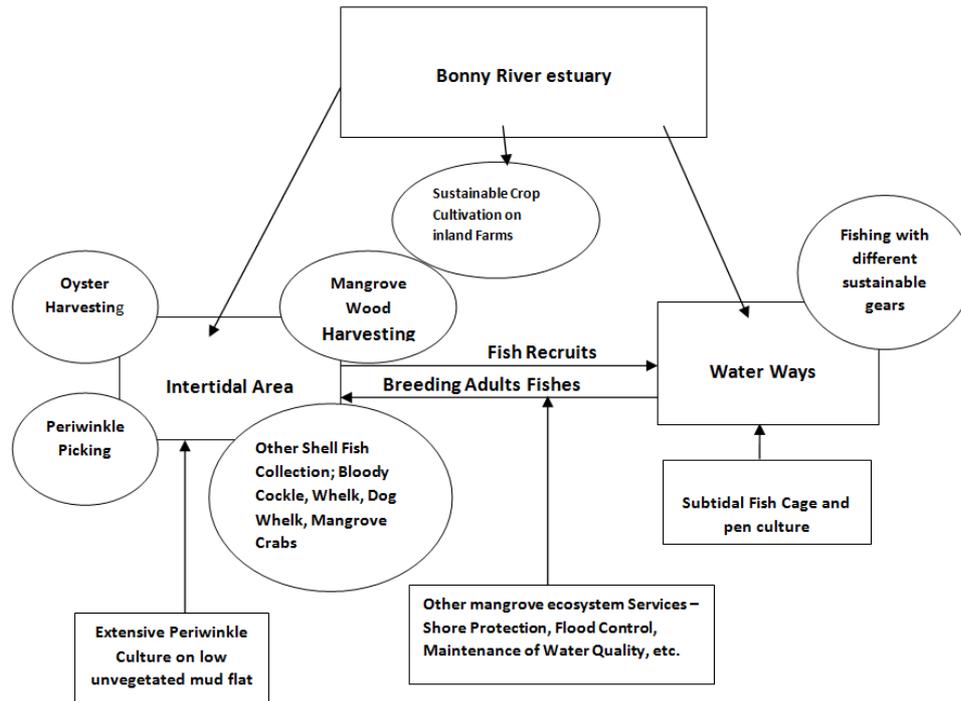


Figure 2. Model of sustainable AAS for the Bonny River estuary.

Given the above identified potential and real threats, the model below (Figure 2) is proposed as a sustainable paradigm for managing and maintaining ecosystem services for the Bonny River estuary AAS. Fish pen and cage culture in the subtidal waterways is suggested instead of earthen fishpond culture in the intertidal area; the latter requires removal of mangrove cover and excavation of mangrove peaty sediment to create ponds and for building embankments. The former will protect the integrity of mangroves to continue to deploy their inherent services for the overall maintenance and productivity of the seascape. Improving oil pipeline integrity and maintenance regime, followed by the entrenchment of a robust and proactive contingency response strategy will reduce the incidence of oil spills and environmental impact on ecosystem quality, biodiversity and livelihoods.

To improve the livelihood of women, an extensive system of periwinkle farming on low unvegetated intertidal mudflats is recommended. Here, the farmers can use low level (in terms of tidal heights) submersible, water-permeable lateral separators to demarcate periwinkle culture beds from the mangrove margin of the mid-intertidal to the low water tidal mark of the subtidal creek. This is more or less a semi natural flow-through system as both the outer and inner edges of the rearing compartments would be opened for normal tidal communication at high tide between the permanently submerged waterways and the upper intertidal area. Overtime, exploitation of the cultured stocks will reduce harvest pressure on the wild populations. The periwinkles will grow to attain

reproductive age, thereby acting as recruitment brood stock, and the recruits would, in turn, act as buffer stocks for the entire system. In addition, the enhanced size quality of farmed periwinkles will assure high farm gate pricing, thereby increasing the income of the rural operators.

While there are functional fishermen associations in the Bonny River estuary catchment, women periwinkle pickers are not organised into unions. This lack of networking and representative platform, together with customary barriers, make women participation in AAS governance and involvement in decision making next to nothing. Meanwhile, good governance regime is critical for direct resource user groups and other stakeholders to build capacities to manage resilience [34].

4.1. How to Integrate AAS and Ecosystem Services for Rural Livelihood Improvement: A General Summary

1. Strengthening co-benefits of ecosystem livelihood dependents,
2. Detailed consideration of specific socio-cultural and economic contexts through multi-stakeholder engagement and analysis,
3. Mainstreaming gender equality and transforming traditional and social norms that create gender inequality,
4. Strengthening governance across various user groups,
5. By encouraging targeted investment to improve productivity for smallholder farmers – such as the diversification of income earning sources for traditional periwinkle scavengers,

6. Research and education on improved approaches and protection of vulnerable and marginalised groups, particularly women,
7. Integrating conservation into the fabrics of AAS productive and management mechanisms, and
8. Investment in methods that will minimize postharvest losses.

5. Conclusions

It would appear that the challenges of transition to green economy in the Niger Delta are more formidable than the opportunities are promising. However, some of the environmental challenges can be transformed to opportunities and livelihood gains. For any green economy project to work, environmental protection, restoration of degraded environment and careful management of natural resources are required while, investing a higher proportion of the national budget (minimum of 10% as recommended by the Comprehensive Africa Agriculture Development Programme; CAADP) in the agricultural sector. Much of this will depend on governments making the right policies and setting up requisite institutional frameworks from national to the local levels, which will link agricultural production to the requirements for conservation of the environment and biodiversity. The productive outputs of AAS dependent households can be enhanced and secured through deliberate efforts at maintaining ecosystem services by conserving environmental integrity, and by closing gender and poverty gaps between men and women in riparian rural communities. Understanding local environmental dynamics, stakeholder spatio-temporal resource use, gender mainstreaming, research, networking and community-level management framework are the basics for achieving sustainable agro-ecological resource exploitation and farming in wetlands, freshwater and marine coastal rural poor areas of the Niger Delta – for increased production outputs and poverty reduction.

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