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Rapid Risk Reduction Strategies Using Some Horticultural Plants in a Changing Atmosphere among Urban and Peri-Urban Centres of the Atlantic Coast in Nigeria

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Abstract: There are irregular global changes in climatic attributes. Nigeria is not left out in the unpredictable atmospheric variability especially in its coastlands. The situation has led to varying forms of environmental challenges, calling for rapid risk reduction responses. This paper suggested four technologies namely, vegetable intercrop production, improved fallow systems, biomass technology and night-soil technologies as efficacious in sequestering atmospheric carbon directly or indirectly. These technologies are easily adaptable in the agro ecological zone following its characteristic multifloristic structure and climatic peculiarities as well as demographic attributes. Coastland climate change adaptation and irrigation experimental stations should be established in the area to evaluate efficacy of these technologies.

Keywords: Climate Change, Risk Response, Settlement, Resilience Vulnerability

1. Introduction

Nigeria belongs among the least developed countries (LDCs) with high degree of vulnerability to climate change. Perhaps, Nigeria ranks among the least endowed in will power, resources and technology to minimize the adverse effects of global warming and climate change despite low contribution to the problem. [1] contended that location of poor and LDCs is contributory to their vulnerability to the changing atmosphere, reporting that Nigeria has a potential loss of 11% of her gross domestic product by 2060 with a 2 ^{0}C rise in temperature. It is known that LDCs contribute to climate change through land use and forestry activities. Changes in land use emitted an estimated 1.6 billion t C/Yr during 1990s [2]. Tropical deforestation for agriculture, mining, fuel wood, industrialization and urban expansion are essentially responsible for a good volume of emitted carbon dioxide in Nigeria. A substantial share of Nigerian economy is dependent on climate-sensitive natural resources [3], making Nigeria high vulnerable to risks associated with climate change [4].

Niger Delta region in Nigeria has a coastland area of about 6000 Km^2 in a country of about 8000KM^2 of total mangrove area [5]. A rise in sea level implies an inundation of the coastlands and displacement of human and other terrestrial inhabitants with consequent loss of lives, property and infrastructure. Unprecedented disasters such diseases, total loss and submergence of farms, homes, coastal landslides, etc. are recorded. In this regard, modern engineering practices have brought significant achievements via seismic building codes and flood management systems. Robust disaster risk reduction and preparedness systems have been put in place especially in advanced countries. Yet, there is general lack of awareness on how inhabitants contribute to disaster occurrence and what they can do within their resources to adapt, avoid or minimize them especially in this era of global climate change. There is a change in perception that climate change disasters are largely anthropogenic. A systematic assessment, reduction and management of a good number of risks associated with climate change can be done at communities semi peri-urban, urban and rural settings. The coastlands in Nigeria in addition to aquatic resources are endowed with timber, fuelwood, pulpwood (paper and match making), fruits (*Ratívenear Dacryodes edulis; Cola; Cola lepidota*), spices, food condiments and sweeteners (*Irvingia, Monodora, Piper guineense*), drug plants (Bitter Kola: *Garcinia kola; Neem Azadiraditha Indica*), fibre (Raphia Horticultural Crops (Bananas, Plantain), tuber crops (Yam, Cocoyam), tree crops (Oil Palms, Rubber), forest trees (Teak, Mahogany, Iroko) and cereals (Maize, Swamp Rice). Some of these agricultural resources are seasonally available, implying climate sensitivity. In addition to this, there is a decline in the agricultural resource base of the coastlands owing to increasing urbanization and conflictive land use types and practices. Seasonal availability of major fruits and vegetables are shown in Table 1 [6]

Table 1. *Seasonal availability of major fruits and vegetables in Nigeria*

Crop	Availability Period
Fruits	
Mango	March – July
Pineapple	November – March
Plantain/Banana	October – January
Citrus	September – November
Guava	November – January
Pawpaw	October – March
Vegetables	
Okra	July – October, January – April
Pepper	April – November, February – June
Amaranthus	July – November
Melon	July – November
Corchons	July to November

Adapted from Babatola (2001)

Crude oil exploration activities in the area with attendant oil spills has led to declining biodiversity, impeded farming activities and an attitudinal change where inhabitants lean towards crude oil fallouts for livelihood. The growth of urban and peri-urban towns in Nigeria is at an exponential rate, with a high tendency in crude oil-rich coastlands of the country. Since increasing urbanization implies reducing available space for agriculture and forestry spaces with attendant increase in greenhouse gases and heightened household expenditure on food items, it becomes necessary to adopt strategies that with capture emitted GHGs especially in the urban and peri-urban centres. The strategies suggested in this paper include;

- Vegetable/inter crop production
- Use of improved fallow systems
- Biomass technology
- Night soil technology

Vegetables intercropped with two or more arable crops on the same piece of farmland such that the periods overlap is long enough to include vegetative stages which will absorb emitted CO_2 from the atmosphere. Vegetables intercropped with legumes will ensure optimum ground cover, optimum use of sunlight, more efficient root growth, spreads risks of crop failure over more crops due to multiple cropping and reduces effects of pests and diseases, a majority of which are crop specific. With increasing population in urban and peri-urban centres, tuber crop production leads to nutrient mining, moreso with shortened fallow periods. Future of tuber crop production (yam, cocoyam, cassava) depends on development of cropping systems that enhance soil fertility within short fallow periods. [7] noted that such cropping systems must ensure adequate nutrients content in the soil as well as promote large quantity of biomass. Total forest areas under forest cover, chemical and physical properties of some coastland have been documented by [8] and [9]. Although, staple crops such as maize (*Zea mays*), plantains (*Musa paradisiaca)*, banana (*Musa sapientum*), even fruits such as pawpaw (*Carica papaya)*, and tubers (yams: *Dioscorea spp*)are grown, urban and peri-urban populations tend to be more adapted to vegetable crop production. Vegetables grown outside urban and peri-urban centres cannot reach the market on time [10] and advantages of vegetable crop production are so many and include short shelf life [11], low transportation costs, independence from middlemen and fast access to market [12], Vegetable crop production ensures continuous production even during dry periods with simple irrigation techniques. Vegetable crop production is preferred in situations when land tenure is insecure. Urban and peri-urban small-scale farmers in Nigeria earn little or nothing from staple crops (cassava, banana, maize, yams and plantain) due to competition from rural producers [13], thereby promoting the role of vegetable production as income earner for urban dwellers.

Table 2. *Some Chemical Properties of Coastland Soils at Koko, Delta State*

Sample	pH	OC	TN	Av.P	Ca	Mg	Na	ECEC
	Water	g/kg	g/kg	mg/kg	cmol kg			
1	4.70	12.0	1.2	8.76	0.5	0.4	0.1	10.3
2	6.66	13.0	1.1	3.59	0.6	0.6	0.1	5.5
3	4.79	9.8	1.0	3.30	0.9	0.3	0.1	5.2
4	4.72	9.7	1.0	2.60	0.7	0.3	0.1	4.6
5	5.20	10.0	1.0	1.29	0.5	0.6	0.1	3.6
6	5.54	9.9	1.0	5.89	0.6	0.6	0.2	7.7
7	5.26	10.9	1.1	3.30	0.6	0.5	0.1	5.2
8	5.43	11.6	1.2	2.41	0.7	0.4	0.11	4.2
9	5.22	11.0	1.1	1.06	0.6	0.4	0.1	2.7
10	5.63	9.9	1.0	4.30	0.6	0.4	0.1	6.0
Mean	5.32	9.8	1.1	3.65	0.6	0.5	0.1	5.5

Adapted from: Imadojemu (2011)

Table 3. *Some Physical Properties of Coastland Soils at Koko, Delta State*

Sample	Sand (g/kg)	Silt (g/kg)	SCR
1	912	58	1.93
2	807	47	1.02
3	792	108	1.08
4	737	67	0.34
5	812	163	6.54
6	832	138	4.60
7	802	62	0.46
8	772	137	1.43
9	882	68	1.36
10	842	88	1.23
Mean	819	94	1.99

SCR=silt clay ratio

Table 4. *Standard Set of 25% of Total Land Area Under Forest Cover*

State	Total land area (ha)	Area of forest reserve (ha)	Standard set of the total land area (ha)	Deficiency % (ha)	% deficiency (ha)	% available (ha)
Lagos	3393900	6773	98475	91602	23.26	1.74
Ogun	1608600	275362	402150	126788	7.88	17.12
Ondo/Ekiti	2045100	305541	511275	205734	10.06	14.94
Osun	979100	91268	237275	146007	15.39	9.26
Oyo	2784800	169173	696200	527027	18.93	6.07
Southwest	7781500	848217	1945375	1097158	14.10	10.9

Source: Faleyimu et al. (2009).

Table 5. *Effect of Ash on Growth and Yield of Amaranthus*

Ash (t/ha)	Fresh mater yield/plant (g)	Seed weight per plant (g)	Root length (cm)	Root weight (g)
0	100.7	33.3	17.8	10.5
2	279.5	85.6	20.8	27.8
4	168.5	92.8	18.8	25.0
6	161.1	92.1	18.8	18.4
$LSD_{0.05}$	26.1	7.5	2.6	4.5

Adapted from Ojeniyi et al. (2001).

Table 6. *Effect of Wood Ash on Celosia*

Ash (t/ha)	Plant height (cm)		Number of leaves	
	5WAP	6WAP	5 WAP	6 WAP
0	8.5	9.7	13.1	17.2
2	11.2	13.2	13.7	17.7
4	11.5	13.4	15.5	19.5
6	13.1	15.1	17.1	20.0
	13.3	15.3	17.3	21.3
$LSD_{0.05}$	1.6	6.2	4.2	2.5

WAP = Weeks after planting
LSD = Least significant difference
Adapted from Ojeniyi et al. (2001)

2. Assessment

Urban and peri-urban vegetable production can utilize organic urban wastes, a majority of which are burnt in incinerators, releasing CO_2 contained therein. Recycling these organic wastes by incorporating directly or after composting can be an effective and sustainable way of improving soil fertility and reducing disposal costs. Cities are known to have nutrient surpluses [14] but these wastes are dumped into water bodies. Incorporation of organic wastes in vegetable crop production builds soil macro aggregates hence aggregate stability which reduces risk of coastland and riverbank erosion while increasing water storage capacity. Farmers prefer application of municipal wastes on staple crops for fear of contaminating intensive vegetable production [15] but pre-treatment using composting, microbial decomposition and the use of water ferns before utilization [16] can improve its quality. Compost storage reduces pathogen levels (*Ascaris and Trichuris* eggs) markedly especially with increasing pH [17]. Municipal wastes are often criticized for high heavy metal load but this depends on soil and crop factors as well as source of the wastes. Consumers' exposure to heavy metals depends on choice of crop, nature of pollution and preparation method [18], compost fortification as using wood ash to increase soil pH thereby reduces solubilization and availability of heavy metals [19]. (Table 5 – 8)

Table 7. *Effect of Wood Ash on Yield Components of Okra (MH-47-4)*

Ash (t/ha)	Number of pods		pod weight (g)		Plant height (cm)		Top root length (cm)	
	1999	2000	1999	2000	1999	2000	1999	2000
0	2	3	60.3	51.9	45.9	41.1	12.4	10.2
1	4	4	82.3	67.9	54.5	53.0	13.4	13.4
2	5	4	92.9	94.4	55.5	53.8	13.0	13.8
3	5	5	96.7	101.6	59.7	59.1	14.1	14.2
4	5	5	101.5	103.1	62.7	64.7	16.3	15.0
5	6	6	101.6	109.3	70.0	64.9	14.7	14.4
$LSD_{0.05}$	1.3	1.2	25.6	32.0	8.5	8.4	NS	4.3

NS = Not significant Source: Ojeniyi et al.(2001)

Table 8. *Effect of Wood Ash on Leaf Nutrients of Vegetables*

Treatment	N	P	K	Ca	Mg
	g/kg				
Amaranthus					
Control	21	1.6	18	2.0	0.5
250kg urea	35	4.0	28	2.4	0.6
2t/ha as	30	3.5	26	3.0	0.9
2t/ha ash + 62.5 kg urea	44	3.7	25	2.8	0.7
2t/ha ash + 125 kg urea	45	3.2	25	2.9	0.8
2t/ha ash + 187.5 kg urea	36	3.0	23	2.6	0.1
$LSD_{0.05}$	0.8	0.9	0.4	0.03	0.01
Celosia					
0t/ha ash	38.8	34.2	20.9	20.8	32.1
2 t/ha ash	40.8	40.3	34.9	35.0	34.3
4 t/ha ash	48.7	43.2	33.1	34.1	35.4
6 t/ha ash	55.7	53.32	48.3	45.8	46.3
8 t/ha ash	49.6	54.2	47.3	56.8	48.3
$LSD_{0.05}$					
Okra					
0t/ha	31	1.5	14.5	4.5	16.7
1 t/ha	34	1.9	15.8	5.1	17.6
2 t/ha	41	2.1	16.1	5.8	17.9
3 t/ha	42	2.3	23.5	6.7	30.0
4 t/ha	46	2.6	24.1	7.2	21.6
5 t/ha	40	2.9	25.7	10.2	22.9
$LSD_{0.05}$					

Source:Ojeniyi et al.(2001)

Municipal solid wastes were used in reclaiming crude oil polluted soils of the Niger Delta region of Nigeria at rates equivalent to 1.2 – 3 t/ha [20]. It increases crop yield, improves soil properties [21] and increases nitrogen fertility in drastically disturbed low N soils [22]. However, application of industrial compost to agricultural soils may increase total concentrations of heavy metals without increasing their phytoavailability [23]. Raising biomass in situ using leguminous trees and/or shrubs improves soil nutrient status. Legumes such as *Leucaena leucocephata*, *Sesbania sesban* and *Gliricidia sepium* can generate abundant biomass in coastland soils of Nigeria. Their rapid and luxuriant growth will ensure soil cover and utilize CO_2 in the process of photosynthesis.

In peri-urban centres, natural fallow lengths may be non-existent, suggesting the use of improved fallows which regenerate soil fertility more rapidly. Two and three year *Sesbania sesban*-based fallows have proved highly effective in soil fertility regeneration in Zambia. [24] reported that maize grain yield following a 3-year *Sesbania sesban* fallow without N-fertilizer in Chipata, Zambia were 2.27, 5.59 and 6.02 t/ha after 1, 2 and 3 years, respectively compared with control plots with 1.6, 1.2 and 1.8 t/ha, respectively.

Green manuring involving the cultivation forage or legumes with high N-content enhances soil fertility and fits into adaptation strategy for climate change. Plants like *Crotalaria juncea* (Sunn hemp) can be used, and incorporated while succulent into the soil. Greening the landscape keeps the soils under cover at all times.

Vegetable crop diversification is an adaptive strategy as it ensures existence of vegetation at all times on coastland farms in urban and peri-urban areas. Multiple cropping arrangements accommodate vegetable crops such as okra (*Abelmoschus esculentus*), fluted pumpkin (*Telfairia occidentalis*), Gnetum (*Gnetum africanum*), Amaranth (*Amaranthus caudatus/Amaranthus cruentus*), jute (*Corchorus olitorius)*, spinach (*Celoisia argentea*) Indian spinach (*Basella alba*), Bitter leaf (*Vernonia amygdalina*) waterleaf (*Talinum fruticosum*) and Moringa (*Moringa oleifera*). Under humid tropical climate, the coastland urban and peri-urban centres of Nigeria, these vegetables grow luxuriantly and vegetatively thereby increasing their capacity to use gaseous carbon (CO_2) and yield profitably thereby reducing poverty. There is mutualistic interaction between these plant types which enhance great, survivability under plant association. Engagement of farmers in multiple vegetable productions on available land space in urban centres guides against crop failure and tendency for climate – unfriendly practices.

In Southeastern Nigeria, human waste has been considered as a valuable source for soil fertility regeneration consequent upon this, heavy feeders such as plantain (*Musa paradisiaca*), banana (*Musa sapientum*), yams (*Dioscorea* spp) and the likes are planted on soils proximal to *abandoned* and old pit latrines. It becomes worthwhile to ignore the social stigma attached to its use. It is often argued that night-soil use is unhealthful. But, a look at World Health Organization (WHO) guidelines for safe use of wastewater, excreta and grey water convinces one to have a rethink. The WHO [26] states as follow:

- Where faecal matter and other organic materials are composited at ambient temperature, the end-product of such an aerobic composting process does not smell and has good properties as a soil conditioner and slow-release phosphorus fertilizer.
- To minimize health risks from using night-soil as fertilizer, WHO makes various statements and recommendations. Where it is difficult to increase the temperature of the compost heap, WHO recommends prolonged storage to ensure safety. With ambient temperatures of 2 – 20^{0}C, they note that storage times of one and a half to two years will eliminate material pathogens; will reduce viruses and parasitic protozoa below risk levels.
- In addition, WHO recommends various pre cautions to control exposure to risk. Precautions for those handling night-soil include wearing personal protection such as boots, gloves, facemasks, and using tools or equipment not used for other purposes.
- At the time of applying the night-soil compost to the field, if the quality cannot be guaranteed, it is recommended to use close to the ground application, working the material into the soil, and covering it. In addition, children should be kept away from all areas where night-soil is prepared, treated or has been applied.
- Finally, WHO notes that domestic and personal hygiene is important. Technology alone cannot stop transmission of diseases, and communities must be aware of good hygiene practices. If treatment recommendations are followed, coupled with good general community hygiene, the risks to be people who collect and use night-soil as well as those consuming fertilized products will be reduced to acceptable levels.

With declining organic matter content of tropical soils following reduction in vegetal sources via deforestation, night-soil composting becomes a reliable source to build up soil fertility. Some scholars [26]; [27] reported benefits from using night-soil. Night-soil has been found to be the best source of nutrients compared to other organic sources as it tends to give a quick response, especially when used as top dressing. In addition to this, an application of night-soil sustains the soil for over three years. It is currently a common practice in Tanzania where farmers buy contents of old toilets, and this is encouraging in this era of organic agriculture and climate change.

3. Conclusion

Climate change is obvious and its attendant problems cannot sustain ecosystem balance, food security and human health. The situation is more intractable in the fragile coastland ecosystems of Nigeria, especially in their urban and peri-urban centres. Following the peculiarities of the study area in question, the paper opined for the use of vegetable intercrop production improved fallows, biomass and night-technologies in reducing risks of atmospheric changes. It is recommended that rapid response experiments be conducted within the ecosystem for indepth knowledge on the suggested adaptive and irritigative technologies.

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