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ZERO WASTE ECONOMY: THE PROSPECTS AND CHALLENGES OF AGRO-WASTE CONVERSION IN KABBA/BUNU L. G. A. OF KOGI STATE

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Abstract

The potential benefits and challenges of agro-waste conversion and recycling in Kabba/Bunu Local Government Area was the aim of this study. The study explored the possibilities and challenges of agro-waste conversion in a zero-waste economy and investigated the level of awareness and information among farmers. The study focused on residual wastes from crops such as corn, sugarcane, rice, cotton and coffee. One hundred and fifty respondents were purposively sampled across Kabba/Bunu Local Government Area. Data were collected with the use of structured questionnaire and analyzed using descriptive statistics. The study revealed that cobs, stalks, leaves, husk and straw from corn 98% and coconut 22% were the major agricultural residue. The age bracket of farmers shows that farmers within the age of 51years and above representing 49% were predominant among the respondents. Most of the respondents showed low recognition of agro-waste conversion, its potential and environmental sustainability. To tap into the enormous potential of agro-waste conversion the state and local governments must embark on sensitization campaigns and revamping of the local agribusiness industry.

Keywords: Agro-waste, Kabba/Bunu, Kogi State, Waste Recycling, Zero Waste Economy

Introduction

Waste is currently considered as a sign of inefficiency. Yazdani and Lakzian (2023) viewed waste as a valuable resource in the context of zero waste. Zero waste is an integral paradigm towards attainment of circular economy across the globe. Diversion and aversion of waste are the two primary pathways towards attaining zero waste. The concept of zero needs a paradigm shift which is superior to improving the existing conventional waste management techniques (Shukla and Khan, 2022). Agricultural waste is the material obtained due to crop production or from plant growth (Kanjan, 2017). This is as a result of the increase in the world's population, there is increased demand for food and this has resulted in the production of large amounts of agricultural wastes, both at farmer, municipal and city levels (Sabiti *et al.*, 2005). Waste management and environmental quality is an accepted natural goal that has historically been focused on the industrial and municipal areas due to an instinctive feeling that agriculturally related environmental quality problems were minor or uncontrollable. Arora *et al.* (2022) noted that human activities generate tremendous amounts of

solid waste, and the amounts tend to increase as the demand for quality of life increases.

Only recently has more attention been given to the waste problems of agriculture across the nooks and crannies of Nigeria. According to Sabiti (2011), agricultural wastes are products of agricultural activities hence they are not primary products. They take form of crop residues (such as stalks, straw, leaves, roots, husks, shell etc.) and animal wastes such as manure etc. Wastes from agricultural production processes are readily available, virtually free and most importantly renewable. Ethanol, bio-fuel, charcoal and methanol are among the resources that could be converted from agro-waste. However due to lack of technical knowhow, and cutting edge approaches, many of the agricultural waste are left largely underutilized dumped or burnt as is prevalent in third world countries. These untreated wastes lead to accumulation of greenhouse gases. So now it is a worldwide concern to dictating the improvement of alternative cleaner and renewable bio-energy resources (Okonko *et al.,* 2009). These waste cause a serious disposal problem (Rodriguez-Couto, 2008).

Agricultural wastes are generated in huge quantities in various parts of the world, and they offer a potential substitute for fossil fuels. Agricultural wastes can be used to produce methane, hydrogen and biofuels along with various useful chemicals (Khan et al., 2023). All over the world approximately 147.2 million metric tons of fibre sources are found, whereas 709.2 and 673.3 million meter tons of wheat straw residues and rice straws were estimated, respectively, in the 1990's (Belewu and Babalola, 2009). In Nigeria for instance, the food and beverage industries produce a huge amount of waste as pulp, peels and husks all of which can be used as natural antimicrobials. This calls for more awareness campaigns to be taken to the farming settlements so as to enlighten the farmers on the benefits of proper management and utilization of organic waste for better environmental quality and economic gain. The utilization of waste is one of the factors helping to put into effect the idea of sustainability in all areas of human economic activity.

In agriculture, sustainability refers to the ability of a farm to produce food and other products indefinitely, without causing irreversible damage to the health of the ecosystem. In the case of small-scale production, this can be achieved by (among others) recycling crop waste and livestock manure and growing legume crops and forages such as peanuts or alfalfa that form symbiosis with nitrogen fixing bacteria. (Adam and Bogdan, 2009). Agro waste conversion is of great advantage both environmentally and economically. The utilization of biomass (energy crops) in energy production helps to reintroduce carbon and other nutrients back into the soil in a carbon negative renewable cycle. Utilizing biomass as an energy resource can help cut the global temperature increase by 2°C. Developing countries are the worst hit by the energy crisis. Economics of developing are volatile to energy markets due to their heavy reliance on non-renewable energy sources and their low capability to maintain a stable energy stock and expensive energy mix (Hussain, and Hassan, 2019).

Nigeria has abundant stock of untapped renewable energy resources which have several potential uses (Orisaleye *et al.,* 2018). Prof Emenike Ejiogu of the University or Nigeria Nsukka's Engineering Department recently led a team of researchers to build a Refuse Derived Fuel (RDF) gasification plant with a 100KVA electricity generating capacity. The gasification plant is run by organic waste such as agro waste like corn cobs, stalks, husks, leaves and stover. This has helped to ease the financial burden of energy supply to the campus and also stimulate the local economy by creating jobs for people who supply waste. The effect is a cleaner environment, internally generated revenue from the supply of electricity to the host communities and the prospect of a total departure from the use of diesel-powered electricity generating plants. This is a model

that government can adopt for sustainable development, greener economy and wholesome environment.

In recent times there has been a heightened global awakening to the challenges of agricultural based pollution arising from large scale agricultural practices as well as industrial wastes. These challenges have drawn the attention of scientists, governments and researchers across the world who are interested in remedial approaches. The intricacies in creating sustainability and balance between the economic gains and the adverse environmental quality problems of agricultural operation such as GHG emissions and waste disposals that cause imbalance in the natural ecological systems, eutrophication, contamination of surface water, loss of biodiversity is of utmost concern. Agricultural residue, variability, reliability and sustainability is an emerging issue if serious concern with the attendant economic and ecological implication in Sub-Saharan Africa in perspective. The lack of quality information, proper waste management and compliance with standard protocols is a huge deficit that needs to be addressed.

Agricultural waste is one of the many types of waste that has massive impact on the environment and the socioeconomic development of Nigeria, categorized as solid waste, often un-segregated and typically used for landfills or burnt leads to generation of greenhouse gases (GHG) such as Methane and CO_2. In the past, farming has always managed to achieve a balance between the production of animal waste and the demand for such waste as manure for arable cultivation. But such balance has been upset by intensive farming production and over reliance on fertilizer. Agricultural waste in Nigeria amounts to over 40million tons a year out of which only about 10 percent is reutilized as animal feed or organic manure. On the other hand, lack of effective animal waste management and recycling methods has robbed us of the environmental and economic benefits such as production of energy from animal fodder, rich nutrient filled manure for crop yield and soil fertility, water holding capacity and filtration rates. This study is predicated on the lack of requisite technology and adequate information in maximizing Agro-waste for economic purposes as well as entrenching a zero-waste system of agricultural waste management. It looks at land development activities, nature/type of waste generated, method of agro-waste storage facilities, waste dumping within the farm, availability of agro-waste recycling at the farm locations, method of agro-waste transportation as well as assessment of waste conversion awareness and profitability.

Study Area

Kabba/Bunu (Figure 1) is a local government area in Kogi state which is located within the southern Guinea Savannah ecological zone of Nigeria. It is headquartered in the town of Kabba. According to the 2006 census, Kabba/Bunu has a population of about 145,446 with a total area of 2,706km². The study area lies within 7°50'N and 6°03'E. The area has a humid tropical climate. In Kabba/Bunu, rainfall spans from April to November and peaks around July to September. It has a high temperature and its dry season is from December to March with a mean annual rainfall of 59%. The average weather in Kabba is warm, oppressive and overcast during the wet season whereas the dry season is hot, humid and partly cloudy. The major soil order within the experimental site is ultisol (Babalola, 2010). The physical characteristics of the soil indicates that it is mostly sandy, clay and silt with a mixed and loamy texture with a PH of 6.14. The source of water in the area is majorly surface water from rainfall and rivers Osse, Odogo,Oinyi, and Odonkolo as well as the groundwater supply from wells and boreholes. The groundwater potential varies from place to place due to the geological differences, the aquifers and degree of weathering.

The main economic activity in Kabba/Bunu is farming and lumbering. The study area is a trade centre for coffee, yams, cassava, maize, sorghum, Shea nuts, pea nuts, beans, cotton, and a woven cloth produced by the Yoruba, Ebira and other peoples of the surrounding area. Practices among farmers in the study area include; use of improved varieties chemical weeding, planting of cover crop, use of inorganic fertilizer, live mulch and chemical method for control of pests (T.S Babalola, 2015). The farming of arable crops, oil palm plantation, roots and tubers are very popular in the area.

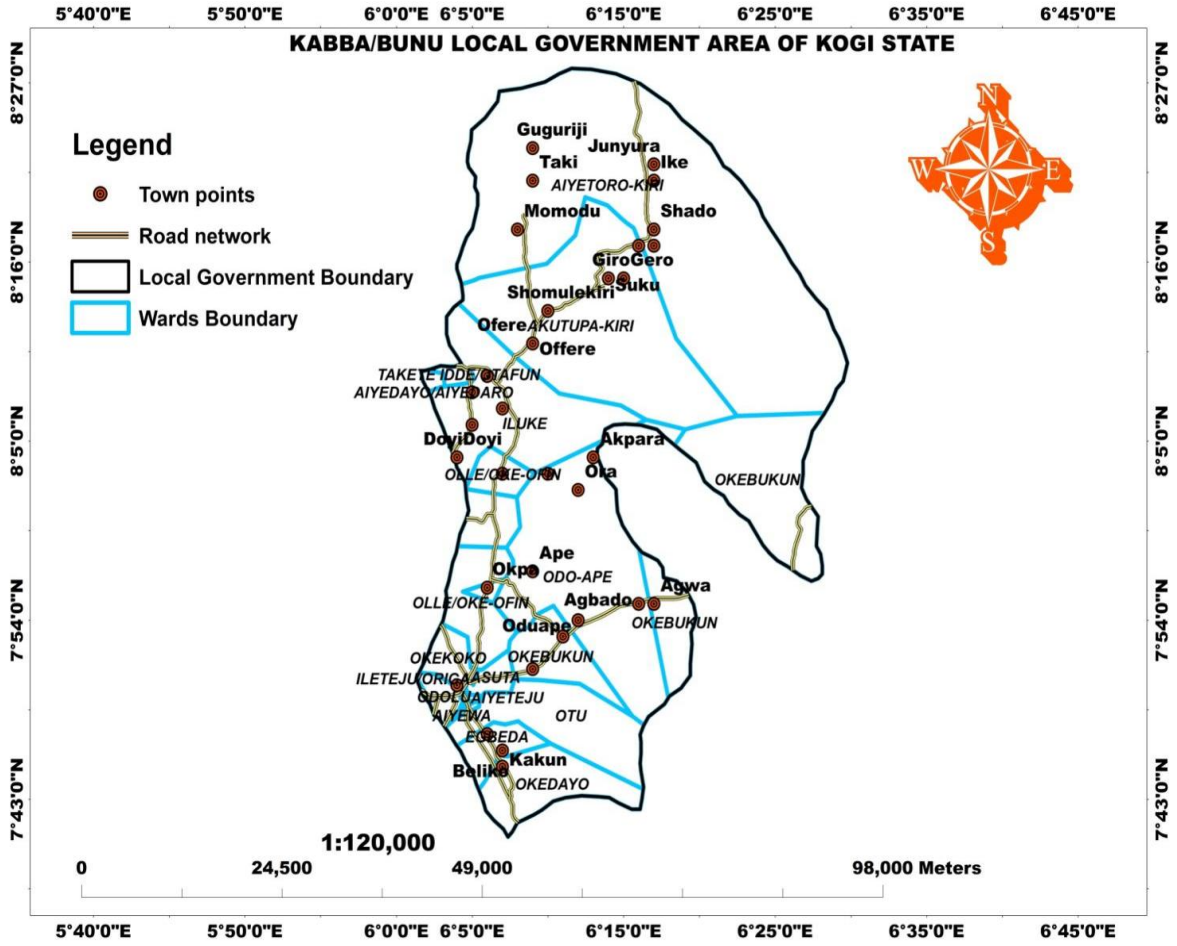


Figure 1: Map of the study area
Source: From the State Survey's Office

Methodology

Reconnaissance survey of the farms was carried out with the purpose of familiarization with the agricultural systems and the waste management practices on the farms. This study made use of both primary and secondary data types. The primary data was sourced directly from the field and this include Pictures from waste dumpsite taken with camera on the field and questionnaire administered to farmers in the area. The secondary data were sought from journals and other documented materials both online and offline. For data collection, interview and questionnaire administration were adopted. The questionnaire sought for information regarding the amount of waste generated per farm after harvest season, nature and method of agro-waste collection and their effectiveness, different types of agro-waste in Kabba/Bunu, and method of Agro waste disposal/utilization. Purposive sampling technique was employed to sample and identify 150 active farmers and questionnaire

copies administered to them. Data collected was analyzed using descriptive statistics.

Mapping the farm locations and study area

The location of the sites is as presented in Figure 1. The GPS readings for the location of the farms were presented on the Table 1

Figure 1: The GPS readings for the location of the farms.

Location	Longitude	Latitude
Okedayo	$7^0$46'34.23"N	6^0 10'31"E
Odo – ape	$7^0$56'40.09"N	6^0 13'74"E
Okebukun	$7^0$51'13.57"N	6^0 09'15"E
Aiyetoro	$7^0$58'45.82"N	5^0 59'28"E
Egbeda	$7^0$47'17.91"N	6^0 06'25"E
Kabba	$7^0$49'36.23"N	6^0 04'22"E

Results and Discussion

The socioeconomic characteristics of the respondents

Table 2: Socioeconomic characteristics of the respondents

Characteristics	Numbers of Respondents	Percentages
Age		
21 – 30	18	12%
31 – 40	30	20%
41 – 50	29	19%
51 above	73	49%
Marital status		
Single	26	17%
Married	80	53%
Widow	25	17%
Widower	19	13%
Family size		
2 – 4	20	13%
5 – 7	64	47%
8 – 10	48	32%
10 above	18	12%
Education		
Non – formal	46	31%
Primary	53	35%
Secondary	26	17%
Tertiary	25	17%
Occupation		
Farming	96	64%
Farming and others	54	36%

Table 2 shows the socioeconomic characteristics of the respondents in terms of age, marital status, family size, education and occupational backgrounds of the respondents.

The results on Table 2 revealed that 49% of the respondents were 51 years of age and above. It shows that younger people and singles show less interest in agriculture which has an indirect impact on the level of productivity and economic value in the area. The results also pointed out that 35% of the farmers in the area have primary school education which is higher than 17% who have either polytechnic, College or University qualifications. 31% of the respondents have no formal education while 17% of the respondents have secondary education respectively.

Land development activities

The nature and style of agricultural practices within the area as obtained from the questionnaire were shown in Table 3.

Table 3: Land development activities

Characteristics	Numbers of Respondents	Percentages
Farming activities		
Animal based	25	17%
Crop based	95	63%
Both	18	12%
Others	14	9%
Land preparation		
Traditional	56	37%
Machine (Tractor)	35	23%
Zero tillage (herbicide)	40	27%
Others	19	13%
Scale of production		
Commercial	89	59%
Subsistence	61	41%
Cultivated crops		
Roots and tubers	63	42%
Cereals	38	25%
Legumes	25	17%
Vegetables	24	16%

From Table 3, it shows that crop based agricultural activity is the major practice in the study area with 62% representing 93 of the total respondents sampled. It also revealed that 37% of the respondents were involved in traditional land preparation practices including slashing and burning. The farmers prefer this method because it is cheap

although the practice encourages soil nutrient depletion such as nitrogen (Babalola *et al.*, 2013). The majority of the respondents sampled were into commercial farming with 42% of the respondents cultivating roots and tubers whereas 25% were into cereals, 17% and 16% were into legumes and vegetable respectively.

Nature of waste generated on the farms

The characterization and nature of agro-waste generated on the farms were shown in Table 4.

From Table 4, it was observed that the major residual properties are husk leaves; shell, nuts stalks and animal waste dusk from coffee and sugar-cane bagasse represent crops with coldest waste due to low productivity according to 8% of the total respondents sampled. Some of the crops cultivated can be seen on Plates 1 and 2.

Table 4: Character and type of agro – wastes

S/N	Waste Category	Characteristics	No		Yes	
			Frequency	%	Frequency	%
1	Coconut	Fronds, husk, shell	33	22%	117	78%
2	Coffee	Hull, husk	12	8%	138	92%
3	Corn	Cob, stoves, stalker, leaves	147	98%	3	2%
4	Rice	Hull, hustle, straw, stalks	27	18%	123	82%
5	Sugar-cane	Bagasse	12	8%	138	92%
6	Animal waste	Drug, manure	25	17%	125	83%
7	Cashew	Shell, nuts	32	21%	118	79%
8	Others	Empty pesticide containers	93	62%	57	38%



Plate 1: A maize farm in Edumo settlement Kabba
Source: Authors' field work 2022



Plate 2: A sugarcane plantation along Aiyetoro-Gbede/Egbe Road
Source: Authors' field work 2022

Method of Agro – waste collection and disposal

Table 5 to Table 9 show the methods of agro-waste collection and disposal.

Table 5 reveals that there is lack or shortage of agro-waste storage facilities across the study area. Only Kabba with 53% of the respondents representing 9 farmers had the highest positive response as regards to agro-waste facilities.

Table 5: Availability of temporary agro-waste storage facilities

Location	Yes		No	
	Frequency	%	Frequency	%
Okedayo	7	28%	18	72%
Odo – ape	7	32%	15	68%
Okebukun	9	36%	16	64%
Aiyetoro	15	45%	18	55%
Egbeda	9	32%	19	68%
Kabba	9	53%	8	47%

Table 6: Waste dumping within the farm

Location	Yes		No	
	Frequency	%	Frequency	%
Okedayo	20	80%	5	20%
Odo – ape	17	77%	5	23%
Okebukun	17	68%	8	32%
Aiyetoro	24	73%	9	27%
Egbeda	26	93%	2	7%
Kabba	13	76%	4	24%

Table 6 shows that 80% and 93% of the respondents from Okedayo and Egbeda contributed high rates of dumping in the farm after lamest with the farmers draining it increase soil fertility. Very few farmers collect waste from farm and dump elsewhere as seen by the 'No' frequency response in the Table.

Table 7: Availability of Agro – waste recycling at the farm locations

Location	Yes		No	
	Frequency	%	Frequency	%
Okedayo	0	0%	25	100%
Odo – ape	0	0%	22	100%
Okebukun	0	0%	25	100%
Aiyetoro	0	0%	33	100%
Egbeda	0	%	28	100%
Kabba	0	%	17	100%

Table 7 reveals that all the respondents from their respective locations indicate no form of agro-waste recycling in the area.

Table 8: Method of agro-waste transportation

Transportation method	Aggregate	Percentage
Wheel Barrow	21	14%
Wheeled Vehicles/Keke	82	55%
Open Trucks	47	31%

Table 8 shows that Keke and other wheeled tricycles or carriers are popular for transporting agro-waste form farms to final destination as noted by 55% of the respondents representing 82 persons of the total population. 31% were in favor of open trucks especially in the larger farms while 14% indicated wheel barrows and carts.

Table 9: Final destination of agro – waste

	Okedayo		Odo – ape		Okebukun		Aiyetoro		Egbeda		Kabba	
	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%	Frq.	%
Open dump site	18	72%	15	68%	20	80%	19	58%	18	64%	12	70%
Landfills	5	20%	7	32%	5	20%	8	24%	8	29%	7	30%
Buried	2	8%	-	-	-	-	6	18%	2	7%	-	-

Table 9 shows that open dump sites were the predominant final destination of agricultural waste according to 72%, 68%, 80%, 58%, 64% and 70% of respondents from Okedayo, Odo ape, Okebukun, Aiyetoro, Egbeda and Kabba respectively. Landfill was another popular choice for although less famed.

The assessment of waste conversion awareness and profitability

From Table 10, 100% of the respondents from the selected areas indicated that the level of awareness on agricultural waste conversion is low. The level of commitment to adopting techniques of waste management was rather ordinary due to the lack of awareness, most of the farmers just have an ordinary or fair understanding of recycling agricultural residual. Almost all the farmers lacked information regarding technological advancement in agricultural waste as seen in the Table above. The Table further shows that there is no consultative representation policy framework or strategy for harnessing the potentialities or agro-waste. The results above show that so far, the level of profitability economic wise is fair.

Tab**le 10:** Assessment of waste conversion awareness

Measure	Okedayo	Odo – ape	Okebukun	Aiyetoro	Egbeda	Kabba
Level of awareness of farmed on agro waste conversion	Low	Low	Low	Low	Low	Low
Level of commitment of farmers to adopting waste management techniques	Ordinary	Ordinary	Ordinary	High	Low	High
Level of information of technological advancement and modern approaches	Low	Low	Low	Low	Low	Ordinary
Availability of consultative and policy representatives	X	X	X	X	X	X
Availability of policy frame work or strategy for agro-waste management	X	X	X	X	X	X
Level of profit from agro-waste	Fair	Fair	Fair	Fair	Fair	Fair

Discussion of Results

The current economic decline owing to unstable debt/GDP dynamics shows that there is need for action and strategic planning towards an effective diversification of our local economy from being oil dependent. Although agriculture and food security has been on the front burner of discussions in many international forums and the (FAO) of the United Nations; agriculture will not just defeat hunger but can also reduce poverty. Thus, the economic potential of agricultural waste is of immense benefit to the prosperity of the state, therefore the agricultural sector needs to be prioritized in terms of investments from government and non-governmental organizations like the case when a Dutch firm invested ₦144 Billion Naira in Kogi State a few years ago.

From this study, it is worthy of note that very little is known about agro-waste conversion, the processes and economic benefits. This is in agreement with Blenkinsopp *et al*, (2013) who opined that lack of awareness about the technology, its associated benefits as well as incentives provided by the government was one of the reasons for low usage of biogas as the primary fuel for cooking. It is without question that most of the people in the area do not understand the nexus between safe agricultural practices, sustainable development and the environment. In fact, very little is known about the potentialities of agricultural residue in boosting an economy in terms of energy and power generation and manufacturing. The respondents across the locations revealed lack of technical know-how as per the economic benefits of agricultural waste partly due to their educational background and also lack of awareness and policy frameworks.

Albeit, some farmers demonstrated zest and interest in agribusiness and agro-waste conversion but expressed low financial motivation and lack of enabling environment. However, although cashew nut seems to be an export business around the area, there is still more to be desired. The Cashew Shell Nut Liquid (CSNL) asides from the kernel, and fuel wood production can be rewarding economically. It is sad that not too many of the farmers are properly informed about the CSNL as against the findings of Agbongiarhuoyi *et al.* (2008) who stated that 95 percent were aware that wine is produced from cashew apple as well as CNSL being made from cashew shell. The discordance noted is that their sample size of 60 was rather low and most of the respondents belonged to the cashew association and cooperative societies making it a more targeted work in comparison to the generic approach in this research. This present research also discovers that there is some form of exclusiveness in the cashew nut business and information is not widely circulated among farmers generally.

However, the prospects of a cashew shell nut liquid processing industry in the area will definitely be a welcome development as it will make kabba/Bunu and Kogi state an export region with the oil used internationally for the production of brake and clutch linings, insecticides and fungicides amongst others.

This study showed that farming in the area was a venture for older adults representing 88% or respondents in contrast to 12% under the age of 30. Furthermore, the study revealed the main waste or farm residue to be stalks, stoves, cobs, leaves from corn, shell, husk and hull from cashew, coffee as well as manure form animal waste. The study shows that there is a high amount of abandoned waste which could have been utilized for energy production, construction or recycled as fertilizer amongst others. These wastes produce great biomass that could be converted to briquettes and used as fuel for cooking since most of the farm areas are rural. This could provide jobs for the vendors as much as saving the environment. Briquettes doesn't have smoke and a great alternative to kerosene and charcoal which causes health hazards when inhaled. This will limit the rate of tree falling for fuel in the area thereby conserving the natural reserves in the area. Despite the many challenges confronting its production, biofuel and bio-energy attracts many hopes as a sustainable renewable energy source which tends to promote rural and regional development, reduction in CO_2 emissions, creation of job opportunities as well as replacing the energy from non-renewable fossil fuel with green energy (Elghal *et al.*, 2007).

Kabba/Bunu area is blessed in terms of agriculture and can harness the potential of agricultural waste by producing briquettes as a viable option for fuel wood. It can be deduced that the state of things agro – economic wise in Kabba/Bunu is a reflection of lack of cutting edge initiatives as far as agro-waste conversion is concerned. This calls for policy frameworks, financial investments, awareness, remediation and optimization plans in order to maximize yield from a highly blessed agrarian area such as Kabba/Bunu Local Government. From the study, one can see that inadequacies in technical know-how and training as well as lack of expertise and agricultural management strategy deficit contributes to the unharnessed economic benefits from agro-waste. Umeugochukwu (2019) opined that ignorance to the opportunities for biodegradable agricultural wastes, and the often limited or total lack of government incentives, impel many farmers prefer not to manage this waste. Furthermore, the large amounts of agro-wastes which emerge from crop production in the area is left untapped which is a deficit in terms of the industrial potentials of the renewable resources generated, the fibers, sugars, proteins and minerals which are of economic benefit. Ayo et al. (2015) concluded that the appropriate application of principles of agro industrial waste conversion: composting, anaerobic digestion, solid state fermentation and delignification will create raw materials for secondary industries and will also greatly improve the recovery of some of the potentials that are normally lost and also prevent the generation of contaminants in the environment causing bad health.

The study also revealed that there is lack of regulations or policy framework to enforce the conversion of waste for environmental protection as well as economic yield. Although there is a fair level of profit making especially in the area of converting waste to animal feed or manure, there is still more to be desired. This is in tune with the findings from the study which shows a number of critical areas that need to be addressed in order to harness the potentialities of agro-waste conversion in Kabba/Bunu and indeed across Nigeria.

Conclusion

This study examined the prospects and challenges of agro-waste conversion in Kabba/Bunu L. G. A. of Kogi State by assessing the nature/type of waste generated in the study area, land

development activities, method of agro-waste storage facilities, assessment of waste conversion awareness, availability of agro-waste recycling at the farm locations, among others. The following can also be deduced:

i. There is low awareness of agricultural waste economic potentials and the environmental challenges it poses.
ii. Cashew shell nut is one of the hugely economical agricultural yielding crops due to its high export value.
iii. The rate at which the younger generation run away from agricultural based ventures is alarming.
iv. Agro – based technology information is very low within the study area.

Recommendations

From the research findings, the following recommendations were made:

i. Policy frameworks on agro – circular economics and waste conversion should be reviewed for more productivity.
ii. Financial aids and grants should be awarded to private companies or individuals interested in agricultural waste conversion schemes.
iii. Awareness campaigns should be organized and sponsored by the State as a way of boosting local IGR Agro based fertilizer production plant.
iv. Building of standard anaerobic digester facilities that can process cassava peels, corn cobs, as a source of renewable energy and fertilizer**.**
v. Building of cashew shell liquid plant and or briquette processing plant in Kabba/Bunu area**.**
vi. Investing in power generation plants solely based on agricultural biomass.
vii. Organization of training workshops for farmers on the benefits of agro-waste conversion and training.
viii. Kogi State Ministry of Agriculture and Agricultural Development Programme (ADP) should have a roadmap on how to develop the agricultural potentials of the area

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