Paper B9
OPPORTUNITIES AND PROSPECTS OF AGRICULTURAL WASTE FOR INDUSTRIAL APPLICATIONS IN NIGERIA: A REVIEW

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Abstract
The concept of agricultural waste utilization is one that present numerous opportunities and application in the food industrial sector because of its large proportion contribution in volume to total waste generated worldwide. The Food Processing Industry has recognized the problems connected with the treatment and disposal of wastes right from the preparation and preservation. This has made it possible for the initiation of research studies designed to create the technical factors involved in handling and disposing of liquid and solid wastes by methods that prevent waste impact such as pollution, flood, poor infiltration as well as other problems. The utilization of these waste has created job opportunities, sanitised environment and improved standard of living. Extension agencies should embark on enlightenment campaigns and trainings of farmers on various innovative ways of farm wastes utilization in order to facilitate more efficient and environmental friendly farm waste utilization initiatives in the area. Also, waste management strategies such as incineration, vermicomposting and recycling are suitable ways to tackling challenges associated to agricultural waste. Most importantly conversion of these waste into useful products and energy generation will help conserve foreign reserve on importation thereby boosting the economy.

Keywords: Agricultural waste, Prospect, Industries, Utilisation, impact

1.0 Introduction
Agricultural wastes are residues from the growing of raw agricultural products as well as processing of these raw agricultural products such as fruits, vegetables, meat, poultry, dairy products and crops. Agricultural wastes can be in the form of solid, liquid or slurries depending on the nature of agricultural activities [1]. Agricultural wastes are the non-product outputs of production and processing of agricultural products that may contain material that can benefit man but whose economic values are less than the cost of collection, transportation and processing for beneficial use. Agricultural waste also known as agro-waste comprise; animal waste, food processing waste, crop waste as well as hazardous and toxic agricultural waste. Agricultural waste is known to contribute significantly in proportion to the total waste matter in developed world [2]. However, the quantity of waste generated in Agricultural sector is less compare to other industrial settings. A pictorial display of Agricultural waste is presented in Figure 1.

Figure 1: Heap of Agricultural waste
Source:[2].

2.0 Classification and Sources of Agricultural Waste

Generally, waste generated based on Agricultural activities can be in solid, liquid or slurry form depending on the nature of the prevalent activity.

2.1 Agricultural solid waste

These are generated mainly from farming activities and other production food chain activities. Agricultural solid waste can be classified into the following;

i. **Food and crop processing waste:** wastes produced from the processing of crop and animal products for human consumption such as abattoir or slaughter houses. Hoofs, bones, feathers, banana peels are also good examples of food and meat processing agricultural solid wastes [3]. During processing of farm produce, wastes such as maize bran for maize, rice husk for rice, cassava peels for cassava, residues from crops in general are most times thrown away which in turn causes environmental pollution and illness to plants and animals as well as humans. Images of crop wastes are presented in Figure 2.

Figure 2: Groundnut and rice husk waste
Source: [1]

ii. **Chemical wastes:** Wastes generated from the use of pesticides, insecticides and herbicides on the farm or store, such as pesticide containers or bottles [4].

iii. **Horticultural production solid wastes:** Solid wastes generated from cultivation and maintenance of horticultural plants and landscape for beautification. Examples of such wastes are pruning and grass cuttings.

3.0 Impact of Agricultural Waste

Agricultural wastes that is not treated or disposed properly will create the following effect;

i. **Pollution:** Agricultural waste indiscriminately disposed, pollutes the environment which can prone humans to unhealthy living. This is because some of the disposal practice pollutes the environment [5]. This calls for increase public awareness on the benefits and potential hazards of agricultural wastes, especially in developing countries.

ii. **Flood:** One major cause of flood has been the blockage of waterways and channels. In an agricultural environment, the indiscriminate dumping of agricultural solid wastes can result in blockage of waterways that can result to flood.

iii. **Poor infiltration:** Wastes such as nylons and polythene leathers not disposed properly may obstruct the flow or infiltration of moisture into the soil.

3.1 Waste management methods

i. **Recycling:** Recycling refers to the reuse of used products and material; it is the recovery of raw materials from waste such as production of new glass from fragments, the melting of scrap iron and the production of recycled building materials from construction wastes.

ii. **Vermicomposting:** Vermicomposting is the process of using worms for the degradation of organic matter into nutrient-rich manure. Worms consume and digest the organic matter. The by-products of digestion which are excreted out by the worms make the soil nutrient-rich, thus enhancing the growth of bacteria and fungi.

iii. **Incineration:** Combustible waste from households and waste wood that are not suitable for recycling undergo thermal treatment in waste incineration plants or waste wood furnaces. The heat released in the process is used to generate electricity and heat buildings. Waste with a high calorific value and low level of pollutant contamination can be used in industrial plants such as cement plants, as an alternative to fossil fuels. Waste that is contaminated with organic pollutants undergoes separate thermal treatment in hazardous waste incineration plants.

3.2 Waste Utilization Opportunities and Prospects of Agricultural Wastes in Nigeria

The concept of waste utilization can be achieved in different ways including;

i. **Residue for Animal Food:** Vegetable residuals as well as some from fruits are largely used as animal food. Residuals so used are either fed directly, converted to silage and stored for later use, or mixed with other feed materials in formulated blends. The feasibility of feeding and the method of feeding depend upon the nature of the residuals and the demand for feed stuff. In Nigeria, this procedure is mostly practiced locally where residues of plants are used as food to animals. It is scarcely practiced extensively due to lack of technical knowhow on how to use this waste to create high quality food for animal. A good example is the blood meal.

ii. **Utilization of fish residuals:** Some by-products are commonly manufactured from fish processing residuals. However, they are also the primary products into which some species of fish are processed. For example, herring, once primarily used for canned sardines, is now largely used for whole fish meal and fish oil. The equipment required to produce the products is expensive and energy intensive. Thus, a relatively continuous supply of residuals in sufficient quantity is required for economic justification [6].

iii. **Generation of hydrogen:** In Nigeria, the production of hydrogen using agricultural waste is hardly practiced; this has given room for the usage of other expensive source of hydrogen generation. Hydrogen in the form of compressed gas gives high energy yield of (142.35 kJ/g) which can also be produced from farm waste. The production of hydrogen is associated with the food waste containing higher amount of carbohydrate [7]. The production rate of 0.9 to 8.35 mol H_2/mol hexose is generated from the food waste according to recent studies. The production of this hydrogen is influenced by many factors such as process configurations, pre-treatments and the composition of food wastes [8].

iv. **Fertilizer generation:** Generated agricultural wastes can be converted into organic fertilizers known as compost manure. Compost manure development is one of the waste treatment technologies that make it possible to use organic waste as a fertilizer even in populated areas. The manure is known to improve soil fertility which in return enhances crop production [9]. The use of organic fertilizers is particularly important in most parts of Africa and Nigeria in particular where low availability of nutrients is a serious constraint for food production. Composting reduces the volume of wastes and also solves environmental problems involving disposal of large quantities of waste. It kills pathogens that may be present and decreases the germination of weeds in agricultural fields. Organic fertilizer application in Nigeria is carried out virtually by all local farmers and even modern farmers.

v. **Employment opportunity:** Wastes transformation can create job opportunities in the country. The usage of the necessary implements for the transformation of wastes to usable products needs technical knowhow and man power.

vi. **Sanitized environments:** Proper waste disposal and utilization keeps our environment clean and safe. The environment is thus protected from diseases caused by unclean surroundings. Various agricultural wastes are used for the production of different antibiotics. Studies were carried out by using agro-industrial waste to produced antibiotics. [10] used corn cobs, sawdust, and rice hulls as raw material for the production of antibiotic i.e, oxytetracycline. [11] successfully produced oxytetracycline by consuming groundnut shell as a raw material with strain of Streptomyces rimosus.

vii. **Improve standard of living:** Wastes utilization for instance, the production of bio gas (cooking gas) does not only save cost but improves the standard of living. Cooking gas compared to other sources of energy for cooking which are most likely local sources is more relevant and at such the standard of living is greatly increased.

Present day study shows the potential energy application of wastes derived from rice, cocoa, and oil palm to augment energy needs while helping to abate environmental pollution and mayhem in Nigeria. It also showed the usefulness of animal dung for energy generation and production in Nigeria. The country currently produces about 2.7 × 10 tons of rice annually, containing 0.540 × 10 tons of rice husk and a similar quantity of straw, which can be used for energy production. About 6.22 × 10 MJ of energy can be derived from the 266000 tons (which raised to 490000 tons 2015) of cocoa pods, which are currently produced and discarded annually. This could be utilized to generate process heat, either through thermal cycle or biochemical conversion. With respect to oil palm wastes, Nigeria generated about 0.344 × 10 tonnes of empty fruit bunch, 0.246 × 10 tonnes of palm shells, 0.633 × 10 tonnes of palm oil mill effluent, and 0.382 × 10 tonnes of mesocarp fibre in 2012, which are capable of producing substantial amounts of energy. Nigeria's livestock population is increasing at an annual rate of3.2%, with current dung production of 407 × 10tons/day (cow), 28 × 10 tons/day (pigs), 6.6 × 10 [12].

In Niger state Minna, the upper Niger River Basin located in Rafin Yashi Minna, based on the usage of Agricultural waste and management, have a system which processes some agricultural wastes and uses them in the generation of energy. In this region, a digester is put in place; this digester converts the wastes into gas. This gas is being channelled directly to the kitchen for immediate usage. Also a sewage storage system is made and sewages from slaughter house, livestock house, and liquid wastes from other agricultural departments are also channelled for proper utilization.

4.0 Conclusion

There is enormous waste generated from agricultural sector both in Nigeria and beyond. However, these waste present great opportunities if utilized and channelled appropriately such as useful products recreation and energy generation at very low-cost rather than dumping and landfilling. This reviewed paper has presented opportunities and some of the various utilization practices even at the industrial scale to curtail such waste.

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