Waste Management System

AGRICULTURAL WASTE

Agricultural solid wastes are produced mainly from farming activities. However, it is not limited to the production but other activities associated with farming and food chain. Every stage and phase of the agricultural-food chain can generate significant agricultural solid wastes. The broad classification of agricultural solid wastes includes the following:

1. Animal production solid wastes;
2. Food and meat processing solid wastes;
3. Crop production solid wastes;
4. On-farm medical solid wastes;
5. Horticultural production solid wastes;
6. Industrial agricultural solid wastes;
7. Chemical wastes.

1. **Animal production solid wastes**—animal production solid wastes are solid wastes generated from the production of livestock for whatever purposes. Examples of such wastes include bedding/litter, animal carcasses, damaged feeders, and water-trough, etc.
2. **Food and meat processing solid wastes**—this class of agricultural solid wastes are produced from the processing of crop or animal products for human consumption, such as abattoir or slaughterhouses. Examples of food and meat processing agricultural solid wastes include hoofs, bones, feathers, banana peels, etc.
3. **Crop production solid wastes**—crop solid wastes are associated with agricultural solid wastes typically produced from agricultural activities involving crop production. Examples of such agricultural solid wastes are crop residues, husks, etc.
4. **On-farm medical solid wastes**—on-farm medical solid wastes refer to solid wastes that are generated from the use of drugs,

insecticides or vaccines used on or animals. Examples of such wastes include vaccine wrappers or containers, disposable needles, syringes, etc.

5. **Horticultural production solid wastes**—this group of agricultural solid wastes refer to solid wastes generated from cultivation and maintenance of horticultural plants and landscape for beautification. Examples of such wastes are prunings and grass cuttings.
6. **Industrial agricultural solid wastes**—agricultural produce and livestock are not only cultivated and produced for dietary consumption. They are used for other uses and it is not unlikely that such activities result in agricultural solid wastes. Wood processing and cuttings readily come to mind as a source of agricultural solid wastes. Paper production using agricultural products as raw materials also generate some quantities of agricultural solid wastes.
7. **Chemical wastes**—chemical wastes in this context have to do with agricultural solid wastes generated from the use of pesticides, insecticides and herbicides on the farm or store, such as pesticide containers or bottles. Agricultural activities still depend on the use of pesticides, insecticides, and herbicides, being handled by many uneducated and untrained farmers in developing countries, resulting in abuse by these uneducated farmers. Some uneducated farmers mishandle pesticide containers, thereby resulting in unpredictable environmental hazards. It has been reported that about 2% of pesticides remain in the containers after use, which some ignorant and uneducated users may throw in the ponds or on the open field resulting in food poisoning, environmental and water pollution, causing death of many lives.

Agricultural solid wastes are usually generated through agricultural activities involving preparation, production, storage, processing and consumption of agricultural produce, livestock and their products. Agricultural solid wastes are produced via:

1. Farming activities
2. Poor road network

3.Poor electricity or lack of rural electrification

4.Inadequate drying technique and storage facilities

1.Farming activities—the main source of agricultural solid waste generation is agriculture. Beginning from land clearing till harvest, every phase of farming activities results in the generation of agricultural waste. From preparing the pen for the arrival of the animals to the farm, preparation of pasture/paddock till the animals are slaughtered and sold, solid wastes are generated.

2.Poor road network for transporting harvested produce from the farm to the market or storage is another avenue of generating large quantities of agricultural solid wastes. This happens largely as a result of the bad road network in some developing countries, which may result in a road accident or delay of agricultural produce from farms to markets. When road accident occurs, perishable agricultural produce result easily in wastage, and when delayed, the same result may occur. The spoilt produce is either thrown away on the road or separated to be discarded once the farmer gets to the market.

3.Poor electricity or lack of rural electrification—the epileptic power supply and lack of rural electrification in some parts of developing countries with significant agricultural activities are contributing in no small measure to the generation of agricultural solid wastes. Stable electricity could have facilitated the cold storage of the harvested produce and thereby reduce spoilage and consequently agricultural solid wastes.

4.Inadequate drying technique and storage facilities—spoilage of much agricultural produce could be prevented with adequate drying techniques. If farmers have access to adequate drying technique or moisture monitor, it would have gone a long way in militating against food spoilage and agricultural solid waste, thereby enhancing food security and reducing the impact of agricultural solid waste on human health and the environment. Many of the farmers depend largely on the unpredictable solar system to dry their produce before they are stored, as well as rely on the conventional method of moisture monitoring

which is neither effective nor accurate. Inadequate monitoring of moisture content in grain before storage has been reported to result in aflatoxin infestation. Aflatoxin is produced by *Aspergillus flavus*. Aflatoxin infestation is both a cause and a product of food spoilage and its contamination of food and livestock feed can lead to significant annual crop losses globally.

It has been estimated that about 10% of global crop harvest is destroyed by filamentous fungi through contamination of food and feed with mycotoxins. Aflatoxins have been reported to produce liver carcinogens, impair human health in developing countries, and result in the huge economic losses, in the U.S. corn alone amounting to about $280 million annually. The economic losses could be as high as 1 billion dollars if other crop-infestation such as cotton, peanuts and tree nuts are included. Aflatoxins B1 and B2 which cause preharvest and postharvest crop infestation are produced by *Aspergillus flavus*.

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MANAGEMENT OF WASTE

There are options on how agricultural solid wastes could be handled. This chapter is necessary because of the need to focus people's attention on efficient ways of managing these wastes. Traditionally, shafts from palm oil processing could be used as fuel in fuel wood for cooking and heating. In the recent time, some of these wastes are put into better uses. Some of these agricultural solid wastes could be used as additives in cement mixes, water glass manufacturing, paper making, ethanol production, animal feed, electricity and biogas generation, heavy metal removal, mulching, organic fertilizers, and compost. An effective means of managing agricultural solid wastes is to recycle them to produce useful products. This can be achieved through:

1. Compositing/organic manure
2. Substrates for edible fungi cultivation
3. Nonconventional feed ingredient
4. Traditional soap making
5. Alternative energy sources and bio-fuel production
6. Production of silica

1. **Compositing**: kitchen wastes, largely agricultural solid waste from food wastage could be used as an animal feed via sterilization, fertilizer via composting and bioenergy via anaerobic digestion. These wastes are important candidates for compositing owing to their high organic matter content and nutrients, although their high salt, moisture content and oil may impair composting.
2. **Substrates for mushroom cultivation**: mushroom has been grown on different agricultural solid wastes as substrates .
3. **Nonconventional feed ingredient**. Several attempts have been made to feed agricultural solid wastes to livestock as a means of recycling as well as a cheap source of feed for raising animal-source protein. A nonconventional feed ingredient, *mycomeat* has also been produced from agricultural solid wastes. The wastes served as substrate and a mixture of the

substrates and the cultivated fungi (mushroom) was feed to broiler chicks, as a nonconventional feed ingredient, *mycomeat* fed some agricultural solid wastes to albino rats and recommended processing of the wastes in order to obtain a better result. Adebiyi et al.recommended the combination of 40% cassava peel +40% concentrate +20% watermelon wastes for feeding grower pigs. Poultry feathers could be used for several products instead of being indiscriminately discarded or burnt. Traditional, feathers are used for decoration, pillows and could be converted as nonconventional feed ingredients to feed livestock.

Feathers are a group of agricultural solid wastes that are generated in large quantities annually as a by-product of poultry processing . It may account for about 6% of the total live weight of a mature chicken. They are rich in a keratinous protein, which is a fibrous and insoluble protein .Adejumo et al.reported protein content of between 84 and 87% for feather meal, hence, effective use of feather meal as livestock feed ingredient may payoff than its use as other produce. Feathers can be used in erosion control, for diaper filling, as biodegradable composites, in the greenhouse industry, animal feeds, upholstery, artwork, paper alternatives, light-weight structural materials, water filtration fibers, fabric, aircraft, and automotive industries and thermal insulation .The major limitation to the use of feathers as a livestock feed ingredient is the insoluble keratinous protein, but recent studies are suggesting ways of overcoming the limitation It has been documented that about 80% of kitchen wastes, largely food wastage are fed to pigs in China, although direct feeding of kitchen waste has not been without restriction in China, arising from the concern of foot and mouth disease Processing of agricultural solid wastes could enhance their value for feeding pigs . The effect of dried sweet orange (*Citrus sinensis*) peel has been tested on humoral immune response of broiler chickens as well as maize replacement and its effect evaluated on growth performance and carcass qualities of broiler chickens , instead of allowing them to accumulate and constitute a nuisance as agricultural solid wastes.

3.Traditional soap making: traditional technology exists in Africa decades ago for turning some of the agricultural solid wastes into useful products. Cocoa pods which could turn agricultural solid wastes are usually either allowed to naturally decompose and enrich the soil or are used to make black soap, which may be used for washing dishes or bathing.

4.Alternative energy source and bio-fuel production: agricultural solid wastes can be converted to green energy through anaerobic digestion High protein and fat contents of these wastes may impair anaerobic digestion stability, as well as unavailability of efficient technology required for disposal of biogas residues . However, pre-treatment techniques such as mechanical (sonication), chemical addition (acid or alkali), oxidative (ozone), biological (enzyme addition), thermal ad osmotic (freezing and sodium chloride treatment) may improve the physical and chemical properties of the wastes, thereby enhancing their solubilization of organic particles, sterilization effect as well as the promotion of their subsequent recycling (biogas production). Despite many challenges confronting its production, bio-fuel and bio-energy attract many hopes as a sustainable renewable energy source, which tend to promote rural and regional development, reduction of CO_2 emission, creation of job opportunity as well as replacing the energy from nonrenewable fossil fuel with green energy. Agricultural solid wastes (rich in cellulose, hemicellulose, starch, lipids and proteins) which are produced in large tons and burnt in open-field or allowed to accumulate in some developing countries may be channeled toward bio-fuel generation . Key players and political leaders, particularly in developing countries should team up with researchers to scale up the conversion of biomass to alternative energy sources or bio-fuel generation. This is expected not only to reduce the health menace arising from open-field agricultural solid wastes burning or dumping but to improve energy production and reduce economic losses of waste disposal as well.

5.Production of silica: Production of silica: Silicon, the 2nd most abundant nonmetallic element in the earth crust with an atomic weight of 28 forms silica and silicates. It is rarely found in its elemental state owing to its affinity for oxygen . It has been reported as a beneficial

trace element, widely distributed in foods. Its health benefits include improvement of the structural integrity of nail, hair, skin, immunity, bone mineralization, bone calcification and reduces the occurrence of atherosclerosis . In the presence of hydrochloric acid and other gastric fluids in the GIT, silicon compounds are degraded into bioavailable forms of silicic acid (ortho, meta, di, and tri-silicates) and are diffused into different organs of the body . Silicon quantity decreases with age and tends to be more in plants than animal-sources, although dietary sources are low in silicon and may need to be supplemented in diets through other means It does not bond with plasma proteins, hence, about 75% of plasma silicon is excreted within a few hours after ingestion . Agricultural solid wastes are potential sources of silica. Silica has been produced from agricultural solid wastes such as corn cob, rice husk, bagasse and rice straw using chemical, thermal, and microbial methods.