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A Sustainable Ways to Utilize and Manage the Agricultural Waste

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Abstract:
This paper focuses on the identification, evolution, approaches and trends referred to in the use and transformation of agricultural waste. Agricultural development is usually accompanied by wastes from the irrational application of intensive farming methods and the abuse of chemicals used in cultivation, remarkably affecting rural environments in particular and the global environment in general. Generally, agricultural wastes are generated from a number of sources notably from cultivation, livestock and aquaculture. These wastes are currently used for a number of applications through the '3R' strategy of waste management. Agricultural waste management system (AWMS) was discussed. Agro-waste is a huge environmental hazard in the current epidemic situation. The management of agro-waste and the conversion of agro-waste into a usable product through the application of biotechnological technologies in agriculture are receiving a lot of attention in today's world. Various agro-wastes such as wheat straw, barley straw, cotton stalks, sunflower Stacks, and oil cakes from various agriculture goods, as well as major horticulture wastes such as apple, mango, orange peels, and potato peels, were used to create beneficial products in this review.

Keywords: Women, Agricultural Waste, Crop Residue, Waste Management, Waste Recovery System.

INTRODUCTION:

Agricultural wastes are defined as the residues from the growing and processing of raw agricultural products such as fruits, vegetables, meat, poultry, dairy products, and crops. They 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. Their composition will depend on the system and type of agricultural activities and they can be in the form of liquids, slurries, or solids.

Agricultural waste otherwise called agro-waste is comprised of animal waste (manure, animal carcasses), food processing waste (only 20% of maize is canned and 80% is waste), crop waste (corn stalks, sugarcane bagasse, drops and culls from fruits and vegetables, pruning) and hazardous and toxic agricultural waste (pesticides, insecticides and herbicides, etc.). Estimates of agricultural waste arising are rare, but they are generally thought of as contributing a significant proportion of the total waste matter in the developed world.

Farming waste assessments are uncommon, however are for the most part considered to contribute an impressive portion of the waste material in the created world. Normally, expanding farming creation has prompted an increment in domesticated animals squander, crop deposits and agro modern side effects. Horticultural waste is required to increment essentially worldwide if non-industrial nations keep on fortifying farming frameworks. Yearly farming waste is assessed at around 998 million tons [1]. Natural waste can address up to 80 percent [2] of the general strong waste created by any homestead of which, on a wet weight premise, compost creation can reach up to 5.27 kg each day/1000 kg live weight [3].

The various initiatives taken by government, NGOs, private companies, and local public drastically increased in the past few decades. Nonetheless, land filling is still the dominant solid waste management option for the United States as well as many other countries like India around the world. It is well known that waste management policies, as they exist now, are not sustainable in the long term. Thus, waste management is undergoing drastic change to offer more options that are more sustainable. We look at these options in the hope of offering the waste management industry a more economically viable and socially acceptable solution to our current waste management dilemma. This paper outlines various advances in the area of waste management. It focuses on current practices related to waste management initiatives taken by India. It also highlights some initiatives taken by the US federal government, states and industry groups. The purpose of this paper is to gain knowledge about various initiatives in both countries and locate the scope for improvement in the management of waste.

CLASSIFICATION OF WASTE:

There may be different types of waste such as Domestic waste, Factory waste, Waste from oil factory, E-waste, Construction waste, Agricultural waste, Food processing waste, Bio-medical waste, Nuclear waste, Slaughter house waste etc. We can classify waste as follows:

- Solid waste- vegetable waste, kitchen waste, household waste etc.
- E-waste- discarded electronic devices such as computer, TV, music systems etc.
- Liquid waste- water used for different industries, tanneries, distilleries, thermal power plants
- Plastic waste- plastic bags, bottles, bucket, etc.
- Metal waste- unused metal sheet, metal scraps etc.
- Nuclear waste- unused materials from nuclear power plants

Further, we can group all these types of waste into wet waste (Biodegradable) and dry waste (Non-Biodegradable).

Wet waste (Biodegradable) includes,

- Kitchen waste including food waste of all kinds, cooked and uncooked, including eggshells and bones
- Flower and fruit waste including juice peels and houseplant waste
- Garden sweeping or yard waste consisting of green/dry leaves
- Sanitary wastes
- Green waste from vegetable & fruit vendors/shops
- Waste from food & tea stalls/shops etc.

Waste materials derived from various agricultural operations are defined as agricultural wastes. As per the United Nations, agricultural waste usually includes manure and other wastes from farms, poultry houses and slaughterhouses; harvest waste; fertilizer run-off from fields; pesticides that enter Water, air or soils; salt and silt drained from fields [4–6]. According to the world energy council, in addition to all above, agricultural waste can also comprise of spoiled food waste [7]. The harvest waste, which is more popularly termed as crop residue can contain both the field residues that are left in an agricultural field or orchard after the crop has been harvested and the process residues that are left after the crop is processed into a usable resource. Stalks and stubble (stems), leaves, and seedpods are some common examples for field residues. Sugarcane bagasse and molasses are some good examples for process residue [2, 4, 6].

According to the Indian Ministry of New and Renewable Energy (MNRE), India generates on an average 500 Million tons (Mt here after) of crop residue per year [7]. The same report shows that a majority of this crop residue is in fact used as fodder, fuel for other domestic and industrial purposes. However, there is still a surplus of 140 Mt out of which 92 Mt is burned each year [7].

CROP RESIDUE: COMPOSITION AND DECOMPOSING MECHANISMS:

Plant biomass is mainly comprised of cellulose, hemicellulose and lignin with smaller amounts of pectin, protein extractives, sugars, and nitrogenous material, chlorophyll and inorganic waste [8–10]. Compared to cellulose and hemicellulose, lignin provides the structural support and it is almost impermeable. Lignin resist fermentation as it is very resistant to chemical and biological degradation [11–13].

The crop residues generated due to agricultural activities are exploited by several countries in different ways. They are utilized in processed or unprocessed form, depending on the end use. The possible options include its use as animal feed, composting, production of bio-energy and deployment in other extended agricultural activities such as mushroom cultivation [14, 15]. According to Lohan et al. [16], many countries such as China, Indonesia, Nepal, Thailand, Malaysia, Japan, Nigeria and Philippines utilize their crop residues to generate bio energy and compost.

WASTE UTILIZATION METHODS:

Agricultural waste utilization technology must either use the residues rapidly, or store the residues under conditions that do not cause spoilage or render the residues unsuitable for processing to the desired product. There are a number of applications to which these wastes can be used. They include:

Fertilizer Application:

The utilization of animal manures for fertilizer has a definite impact on input energy requirements at the farm level [17]. Manure could supply 19, 38 and 61% of nitrogen, phosphorus and potassium in chemical fertilizer [18]. However, fertilizer use of manures from large confinement is associated with high-energy costs for transport, distribution, storage facility requirements, odour problems and possibility of groundwater contamination. [18] Reported that poultry manure contain high phosphorus which has positive effect on the growth and productivity of crops. It is also effective when combined with mineral phosphorus fertilizer for farm use. Adding manure to soil increases its fertility because it increases the nutrient retention capacity (or cation exchange capacity), improves the physical condition, the water holding capacity and the soil structure stability.

Anaerobic Digestion:

Methane gas can be produced from agricultural wastes particularly manures. The gas is best suited for heating purposes as in broiler operation, water heating, grain drying, etc. The anaerobic digestion of agricultural waste to form methane-rich gas is a twostep microbial fermentation. Initially, acid-forming bacteria break down the volatile solids to organic acids, which are then utilized by methanogenic organisms to yield methane-rich gas (Figure1). The composition of the typical gas produced is methane, 50-70 %; CO2 25-45 %; N2, 0.5-3%; H2, 1-10% with traces of H2S; and the heating value of the gas is in the range of 18-25 MJ/m. Some of the major disadvantages of the digestion system are the high 3 capital costs and the explosive properties of the methane gas. However, the advantages far outweigh the aforementioned disadvantages. Anaerobic digestion makes the treatment and disposal of large poultry, swine and diary waste feasible, minimizing the odours problem. It stabilizes the waste and the digestion sludge is relatively odour-free and yet retains the fertilizer value of the original waste.

Adsorbents in the Elimination of Heavy Metals:
Excessive release of heavy metals into the environment due to industrialization and urbanization has posed a great problem worldwide. Unlike organic pollutants, the majority of which are susceptible to biological degradation, heavy metal ions such as copper, cadmium, mercury, zinc, chromium and lead ions do not degrade into harmless products [12]. The presence of heavy metal ions is a major concern due to their toxicity to many life forms. Studies on the treatment of effluent bearing heavy metal have revealed adsorption to be a highly effective technique for the removal of heavy metal from waste stream and activated carbon has been widely used [13]. In recent years, agricultural wastes have proven to be a low cost alternative for the treatment of effluents containing heavy metals through the adsorption process. The low cost agricultural waste such as sugarcane bagasse [14], rice husk [15], sawdust [16], coconut husk [17], oil palm shell, neem bark [18], etc., for the elimination of heavy metals from wastewater have been investigated by various researchers.

Pyrolysis:
In pyrolysis systems, agricultural waste is heated up to a temperature of 400-600°C in the absence of oxygen to vaporize a portion of the material, leaving a char behind. This is considered a higher technology procedure for the utilization of agricultural wastes. Others are hydro-gasification, and hydrolysis. They are used for the preparation of chemicals from agricultural waste as well as for energy recovery. Of particular interest to agriculture are the preparation of alcohols for fuel, ammonia for fertilizers, glucose for food and feed. Pyrolysis of agricultural waste yields oil, char and low heating value gas.

Animal feed:
In most developing countries, the problem with animal feed is in the limited availability of protein sources although great efforts are being made to find alternative supplements [19]. Crop residues have high fibre content and are low in protein, starch and fat. Therefore, the traditional method of increasing livestock production by supplementing forage and pasture with grains and protein concentrate may not meet future meat protein needs. Use of the grain and protein for human food will compete with such use for animal feed. These problems may be circumvented by utilizing residues to feed domesticated animals [20].

Direct combustion:

The simple act of burning agricultural waste as fuel is one of the oldest biomass conversion processes known to humankind. Complete combustion of agro waste "consists of the rapid chemical reaction (oxidation) of biomass and oxygen, the release of energy, and the simultaneous formation of the ultimate oxidation products of organic matter CO2 and water" [21]. The energy released is usually in the form of radiant and thermal energy provided oxidation occur at sufficient rate; the amount of which is a function of the enthalpy of combustion of the biomass. If agricultural waste is to be utilized efficiently through thermal conversion process, there is need to fabricate these biomass wastes into solid form. It is usually burnt for heating, cooking, charcoal production, and the generation of steam, mechanical and electric power applications. Of all the processes that can be used to convert agricultural waste to energy or fuels, combustion is still the dominant technology accounting for more than 95% of all biomass energy utilized today [21].

AGRICULTURE WASTE MANAGEMENT SYSTEMS

Agricultural waste management (AWM) has recently become a matter for policymakers in ecological agriculture and sustainable development [22]. The common approach to waste management in agriculture was environmental discharge with or without treatment. Wastes should be considered rather than undesirable and unwanted as potential resources in order not to contaminate air, water, land resources, and prevent dangerous material being transmitted. This will include better utilization of innovation and motivators, change in way of thinking and conduct and improved ways to deal with the administration of farming waste. Natural waste, specifically creature fertilizer, which is inappropriately overseen or left untreated may prompt critical air, soil as well as water quality corruption. Stale waste is a mode for the rearing of flies and transmission of infections. Uncontrolled natural waste deterioration produces both musty gas, and volatilization of alkali, which causes acidic downpour [23]. With animal production intensifying in a small area, there are growing concerns:

The '3R'Approach to AWM:

The concept of minimizing waste reduces the quantity and ill-effects of wast generation by reducing quantity of wastes, reusing the waste products with simple treatments and recycling the wastes by using it as resources to produce same or modified products. This is usually referred to as '3R'. Some waste products can be consumed as resources for production of different goods or the same product, meaning recycling the same resource. When wastes are reused repeatedly, it offsets harvesting of new similar or same products. This saves fresh resources exploitation and reduces waste generation. Overall, the 3Rs individually or collectively saves fresh resources exploitation, add value to the already exploited resources and very importantly minimizes the waste quantity and its ill effects. The principle of reducing waste, reusing and recycling resources and products (3Rs) aims at achieving efficient minimization of waste generation by:

- Choosing to use items with care to reduce the amount of waste generated.
- Repeated use of items or parts of items, which still have usable aspects.
- The use of waste itself as resources.

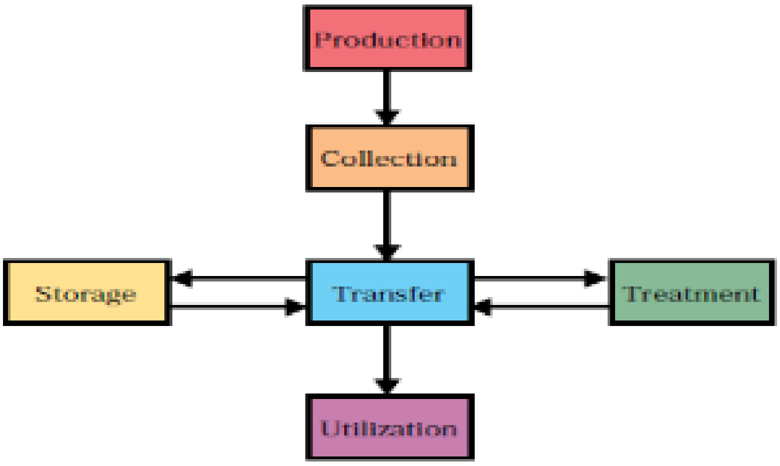

Figure 1: Agricultural Waste Management Functions

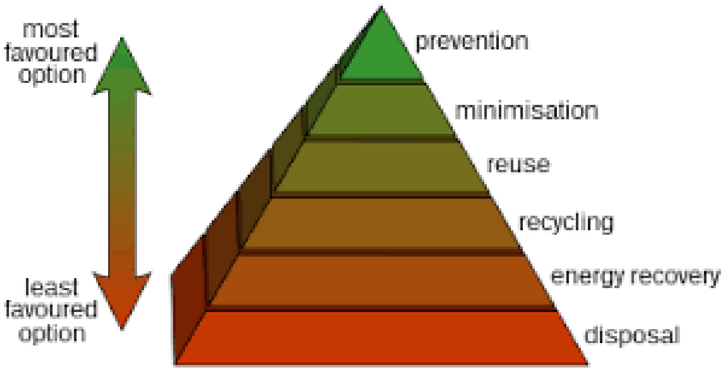

Figure 2: The 3Rs Hierarchy

The 3R Hierarchy in AWM:

Waste minimization efficiency is stated to be better achieved applying 3Rs in a hierarchical order- Reduce, Reuse and Recycle (Figure 3).The waste hierarchy refers to the "3Rs" i.e., reduce, reuse and recycle, which classify waste management strategies according to their desirability. The 3Rs are meant to be a hierarchy, in order of importance. The waste hierarchy has taken many forms over the past decade, but the basic concept has remained the foundation of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. The 3R approach is conventionally expressed through a pyramid hierarchy in which increase in environmental benefits of each approach is placed from bottom to top.

Typical Poultry Waste Management Options:

A poultry farm is used here to describe a typical waste management system showing the application of each component function of an AWMS. The poultry waste management system is as described in [21]. A holistic view of the various waste management options for poultry production in shown in Figure 3.

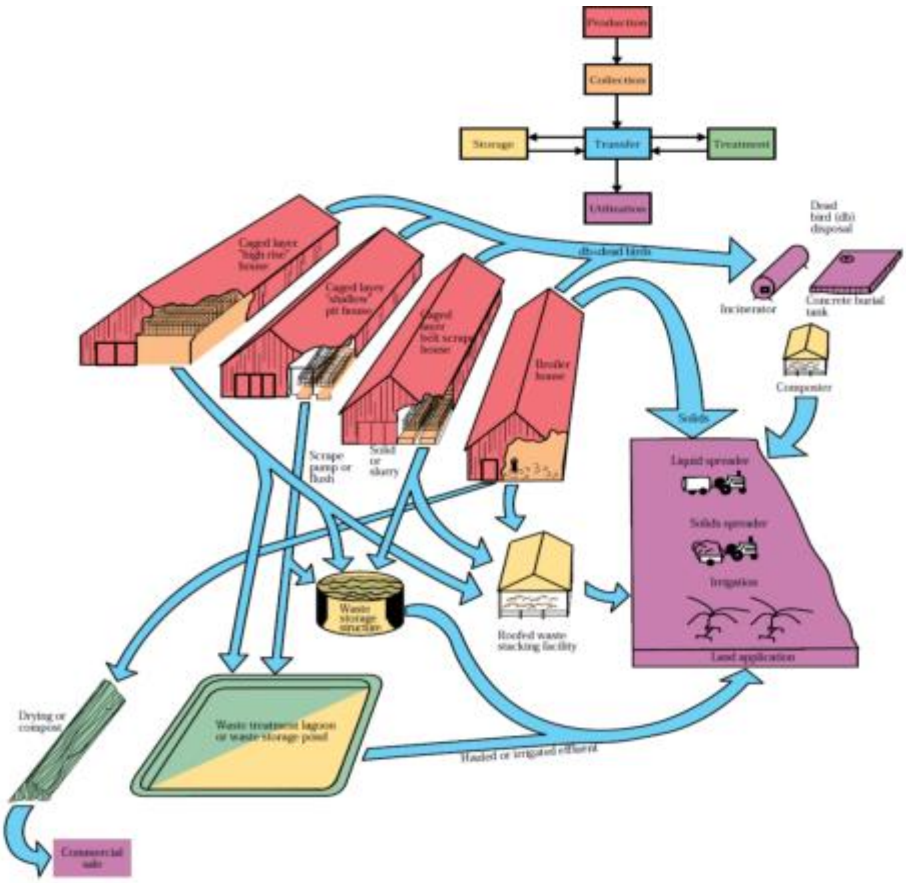

Figure 3: Poultry Waste Management Options

Production:

Wastes associated with poultry operations include manure and dead poultry. Depending upon the system, waste can also include litter, wash-flush water, and waste feed.

Collection:

The manure from poultry operations is allowed to accumulate on the floor where it is mixed with the litter. The manure litter pack forms a "cake that generally is removed between flocks. The litter pack can be removed frequently to prevent disease transfer between flocks. In layer houses, the manure that drops below the cage is collected in deep stacks or is removed frequently using a shallow pit located beneath the cages for flushing or scraping or belt scrapers positioned directly beneath the cages.

Storage:

Litter from poultry operations is stored on the floor of the housing facility or outside the housing facility. When it is removed, it can be transported directly to the field for land application. In some areas, the litter may be compacted in a pile and stored in the open for a limited time; however, it generally is better to cover the manure with a plastic or other waterproof cover until the litter can be used. However, if it is needed to be stored for a long time, the litter should be stored in a roofed facility. If the manure from layer operations is kept reasonably dry, it can be stored in a roofed facility. If it is wet, it should be stored in a structural tank or an earthen storage pond.

Treatment:
Poultry litter can be composted. This stabilizes the litter into a relatively odourless mass and helps to kill disease organisms so that the litter can be reused as bedding or supplemental feed to livestock. The litter can also be dried and burned directly as a fuel. Liquid manure may be placed into an aerobic digester to produce methane gas.

Transfer:
The method used to transfer the waste depends on the total solid content of the waste. Liquid waste can be transferred in pipes, gutters, or tank wagons, and dried litter can be scraped, loaded, hauled as a solid and transported using trucks.

Utilization:
The waste from poultry facilities can be used for agricultural land application or sold because of the high nutrient value of the litter. Furthermore, poultry waste can also be used for the production of methane gas, buried directly as a fuel, reused as bedding, or used as a feed supplement to livestock.

CONCLUSION
Agricultural wastes are residues from the growing and processing of raw agricultural products are no product outputs of production and processing and may contain material that can benefit man. These residues are generated from a number of agricultural activities and they include cultivation, livestock production and aquaculture. These wastes when managed properly through the application of the knowledge of agricultural waste management systems such as the “3Rs” can be transformed into beneficial materials for human and agricultural usage. It is important to not from the findings so far that proper waste collection, storage, treatment, transfer, and utilization is a panacea to a healthy environment. Proper waste utilization will assist in developing our agricultural sector and provide viable biofuel resources.

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