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A REVIEW

Sustainable use of agricultural waste

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Abstract : In India, which is mostly an agricultural nation, there are a lot of agricultural byproducts and wastes. The wastes and byproducts produced by agriculture are primarily organic in origin and contain nearly all of the nutrients required by plants. The biological cycle may be maintained by recycling waste and incorporating agricultural outputs into crop fields. The agricultural wastes may also be utilised as animal feed, organic manures and as a source of raw materials for ethanol and bioenergy production, among other things.

Key Words : Recycling, Waste management, Composting, Bioethanol, Landfill

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INTRODUCTION

By 2050, the population of the globe is projected to increase to 9.8 billion people (UN, 2022). The increase in population led to a rise in food demand (Brahmachari *et al.*, 2018 and Laik *et al.*, 2021). These put agriculture under a great deal of pressure (Sial *et al.*, 2021).Reduced and degraded natural resources (Zaman *et al.,* 2017) and ineffective input management (Maitra *et al.*, 1997) make crop yield more challenging under the current climate change and global warming consequence (Bhadra *et al.,* 2021). In this sense, technical advancements played a significant role by standardising a number of appropriate nutrition management systems (Pramanick *et al.*, 2020; Midya *et al.*, 2021; Mohanta *et al*., 2021). Food, feed, fuel and industrial raw materials are all primarily sourced from agriculture (Maitra *et al.*, 2001; Kumar *et al.*, 2019; Das *et al*., 2021 and Lakshmi *et al*., 2021). Industrialization and urbanisation led to a change in lifestyle, which in turn led to a shift in eating habits, favouring foods with added value and animal protein. The amount of trash and byproducts from agriculture rose as a result of this occurrence. India, an agrarian nation, produces a significant amount of trash, by-products, and crop residues (1566 million tonnes) from various agricultural and related operations.

A portion of the wastes are composted or added to crop fields and livestock feed, but a significant amount is improperly handled, harming the agroecosystem. Burning agricultural waste has recently become a problem in numerous regions of the nation. According to a policy document produced by NAAS in 2010 and based on an average price of Rs. 1500 per tonne, the projected annual value of these by-products/wastes is around Rs. 2,35,000 crores.The majority of these leftovers,

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byproducts, and wastes are currently spread to the fields as farm yard manure or utilised as cow feed or as such in the soil. Only a small amount is converted into energy by bio-gasification or bio-methanation. The energy produced might be used thermally, used for distributed power production, or both. Crop wastes are also utilised in small amounts for packing, the paper industry, and thatching in rural regions. However, over 5 million tonnes of cotton stalks are burned in Gujarat and Maharashtra, while approximately 15 million tonnes of rice straw are burned in Punjab, Haryana, and Western UP. Similar to this, modest amounts of other crop leftovers like wheat straw and resilient soybean straw are also burned. Such byproducts/wastes will provide superior economic returns, pose far less environmental and health risks, and also increase opportunities for revenue and employment if they are managed appropriately.

In order to meet the food need of the world population, agricultural and livestock diversification, which includes rice, maize, poultry, cattle, etc., and value addition of the abovementioned into ready-to-consume goods, created enormous amounts of agricultural waste. Agricultural waste products can occasionally produce harmful greenhouse gases such carbon dioxide, ammonia, methane, and nitrous oxide (USDA, 2013). Effective sewage and sludge management should also be taken into account (Sagar *et al.*, 2022 and Praharaj *et al.*, 2022). There is an urgent need for scientific management of agricultural wastes, including value addition of the so-called wastes whenever possible, to alleviate the burden of agricultural wastes.

What is agricultural waste :

Waste production occurs naturally throughout all agricultural processes. Small-scale subsistence farming typically produces more controllable, more easily disposed-of trash in smaller quantities. However, larger commercial farming operations produce enormous amounts of trash that call for proper waste management methods and management. Agricultural waste treatment errors can harm both the environment and people's health.

Types and examples of agriculture waste :

Agricultural waste may be divided into several categories.

First, trash can be categorised according to its physical state, such as solid, semi-solid, liquid, or gaseous.

Second, it may be categorised according to the sort of agriculture that produces the waste, such as crop-growing or livestock-rearing. Each has its own risks.

Solid agricultural waste :

Solid agricultural waste from crop production consists of crop leftovers, grasses, plant stalks, and woody debris, whereas garbage from the production of meat consists of undesirable animal parts like hooves, ears, corpses and so on.

Semi-solid agricultural waste :

The term "soft" or "sludge" is occasionally used to describe semi-solid agricultural waste. This kind of trash is typically produced as a byproduct of wastewater treatment and can include significant amounts of organic material, nutrients, and metals.

Liquid agricultural waste :

Manure, wastewater, and water tainted with fertiliser and pesticides are examples of liquid agricultural waste. Blood from slaughterhouses and poultry farms is another possible source. Groundwater contamination or surface water pollution can result from improper treatment of liquid agricultural waste.

Gaseous agricultural waste :

Manure storage facilities and animal barns are the sources of gaseous agricultural waste. These chemicals have the potential to release into the air and harm the health of those who live and work nearby. The main source of greenhouse gas emissions is really agriculture.Gases including carbon dioxide, methane, and nitrate can be found in agricultural waste. Both hazardous and flammable gases are possible with these compounds.

Agricultural waste management system:

Managing and disposing of agricultural wastes in an environmentally friendly way is known as agricultural waste management. Agricultural waste management can be done in a variety of ways, and the best one depends on the kind of waste, where it is located, and the local laws and regulations. Among the popular techniques for managing agricultural waste are direct spreading, composting, fermentation, incineration, and recycling.

We adhere to three primary principles for handling agricultural waste: reduce, reuse, and recycle. Ideally, agricultural waste that cannot be recycled or repurposed

should be composted for use as fertiliser.

Another thing to keep in mind is that someone else's garbage may serve as their raw material. Waste from one agricultural operation can occasionally be used as an input for another process in vertically integrated farms.

Methods of agricultural waste management:

Composting :

A biochemical process called composting transforms the organic material in agricultural waste into a substance resembling humus. A great organic fertiliser is compost.

Incineration :

Incineration is the process of burning waste under controlled conditions to turn it into incombustible materials like ash and waste gas. The exhaust fumes from this process are treated before being released into the environment since they could be poisonous. This approach is one of the most hygienic ways to dispose of waste because it minimises the volume of waste by 90%. Occasionally, the heat produced is used to create power. However, because this process produces greenhouse gases like carbon dioxide and carbon monoxide, some people believe it is not entirely environmentally beneficial.

Landfill :

The debris that cannot be recycled or reused is filtered out during this procedure and then distributed as a thin layer in low-lying areas all across a metropolis. Each layer of trash is followed by a layer of soil. However, after this procedure is finished, the region is deemed inappropriate for building construction for the next 20 years. It can only be used as a park or a playground instead.

Soil incorporation and composting of crop residues:

The majority of residues and wastes produced by crop fields should be added to the soil either immediately or after adequate composting. Crop residue integration and the use of organic manures are crucial in conservation agriculture. The very complicated biodegradable process of composting is carried out by a variety of microorganisms that may break down both simple and complex organic materials.The growth of composting in recent years has been facilitated by the addition of chemical chemicals and biological inoculants. The ratio of carbon to nitrogen, moisture, temperature, oxygen availability in the compost pile, and the bacteria that carry out the breakdown process are the parameters that impact composting. Different composting processes have been developed, including vermicomposting, sulfo-nitro composting, microorganisms enhanced composting, and P-enriched composting, for the effective value addition of the biodegradable organic wastes. The management of farmyard manure (FYM) and compost should strive to minimise the harmful effects and maximise the beneficial effects of manure. It is important to spread awareness of scientific composting techniques and their automated handling and application. Composting quality standards must be developed and accepted.

Animal feed:

In India, agricultural wastes make up the majority of animal feed, with just a minor quantity of green fodder and concentrates. Poor nutrition leads to the animals' poor health and low output.Progress in the livestock development industry was projected to lead to further growth in the need for feed. In the above circumstances, using agricultural byproducts as animal feed should take precedence over all other uses, with surpluses being used only when they are not needed for animal feed.For this reason, adequate management procedures for collecting, compaction, ramparts, and scientific treatment of animal feed and fodder should be established. In order to manufacture Technically Modified Rations (TMR) for animals in the form of feed blocks that should be delivered to fodder scarcity regions and stored to be utilised when needed, animal feed factories should be established at significant locations in the producing catchments.Anhydrous ammonia can be used to treat crop leftover bales to improve the nutritional value of straw. Additionally, equipment for creating feed blocks have been invented, using which agricultural leftovers are strengthened with berseem, salt, dried green grasses, etc., and compacted into feed blocks. Crop leftovers can also be processed into low density briquettes (0.5–0.6 gm/cc), with or without fortification, that are simple to handle, transport over long distances, and store adequately enabling the creation of the idea of fodder banks in places with a shortage of fodder.

Briquetting for energy :

The agricultural leftovers are densified during the briquetting process, which also reduces moisture content, creates the ideal size and form for simple handling and fuel burning when required. Boilers, gasifiers, furnaces,

and home cook stoves employ high density briquettes. Crop/agro-processing residues have a calorific content that ranges from 3100 to 4500 kcal/kg.1–1.25 kg (Gravalos *et al.,* 2016) of these wastes can provide approximately 1 kWh of electrical energy when employed for power generating. Briquetting facilities should be constructed in productive catchments and this technique should be made more widely known. A research of briquetting,which turns excess agricultural leftovers into briquettes, demonstrates the technology's cost-effectiveness.

Biogas:

The methane and carbon dioxide gases found in biogas may be produced by processing cow dung. Anaerobic digestion, which uses no oxygen to break down organic material, produces biogas. Other agricultural wastes than manure, such as food scraps and plant materials, can also be converted into biogas using this method. Home heating systems, energy generators, and the production of ethanol and biodiesel from biogas are all possible uses.

Energy production :

The biomass might be utilised as energy for a variety of purposes depending on its properties. There have been several recent advancements in the bio-chemical conversion of agricultural wastes. More research and development effort needed to improve the technology and set up pilot plants to show their techno-economic potential for usage and commercialization in the future. Among these advancements are:

On a bench scale, solid state anaerobic conversion of wastes into compost and methane has been proven. Based on these findings, a system has been designed, along with the appropriate machinery for handling and operating it, to produce 450 to 2700 m^3 of biogas per hour, which is enough to generate 1 to 6 MW of power, or 250 to 1500 m* of natural gas-like fuel per hour (Maitra *et al.*, 2020), which can be compressed and used as home fuel or to power tractors.

– Additionally, effort is being done to uncover novel enzymes. Low cost and effective sources of enzymes for saccharifying cellulose and pentosan contents of residues to create fuel alcohol have been found.

– Additionally, technology for the bacterial production of ethyl alcohol from lingo-cellulosic materials has been created and is being improved.

– In addition, technology for producing ethyl alcohol by bacteria from lingo-cellulosic materials has been developed and is constantly being refined.

Bioethanol production:

First, remove the sugarcane trash's sand, soil, metals, etc. then take the sugarcane bagasse, often known as sugarcane sugar, out. Treat the juice made from sugarcane and filter out the contaminants. After obtaining the authorised juice, disinfect it, and then do the yeast treatment, which results in the presence of fermented gases like carbon dioxide. Following that, centrifugation process requires rectification and distillation. Vinasse, second-grade ethanol, and fusel fuel are products of distillation and correction. Anhydrous bioethanol was created following the dehydration of the second-grade ethanol.

Conclusion:

One of the pillars of operating a sustainable agriculture and agricultural production system is stopping or reducing waste, which justifies spending some time and effort working out how to do so effectively and scientifically with respect to a setting. There is plenty of room for the correct and scientific use of agricultural and crop wastes through value addition and turning waste into money.The paper described the applicability and potential of the same. For agricultural sustainability, an agrarian nation should consider the possibilities and chances for effective agricultural waste utilisation and product conversion.

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