

Agricultural Waste to Wealth:

Way for Sustainable Agriculture Development

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Agricultural waste poses a threat to the environment and public health if it is not managed properly. India is generating huge quantity of agricultural waste every year. Several technologies are available to turn agricultural waste into wealth. Converting agricultural waste into compost, energy, and other useful products helps in doubling farmer's income besides resolving the many environmental problems. Organic manure production from agricultural waste also helps in bringing more area under certified organic production. Integrated farming system should be promoted in India, which will ensure zero waste generation and efficient utilization of input resources. In-situ recycling of agricultural waste will increase soil organic carbon content through carbon sequestration and would open the window of carbon trading in Indian agriculture.

Keywords: Agricultural waste, Clean energy, Pollution, Rice straw

WASTE is any material which is discarded after primary use. Agricultural waste is defined as unwanted material produced as a result of agricultural activities (i.e., manure, oil, silage plastics, fertilizer, pesticides and herbicides, wastes from farms, poultry houses and slaughterhouses; veterinary medicines, or horticultural plastics). Waste which is generated from both livestock and crop is known as agricultural waste. Every year India generate 350 MT of agricultural waste. Improper management of agricultural waste causes problems to

the nature and humans. Proper management of agricultural waste will ensure achieving the dream of sustainable agriculture development.

Types of agricultural waste

- Crop waste (rice straw, sorghum stalk, sugarcane trash, rotten vegetable and fruit, etc.)
- Livestock waste (cow dung, poultry litter, slaughter house waste, fish pond waste, etc.)
- Agro-industrial waste (rice husk, saw dust, molasses, pressmud, etc.)
- Pesticide waste (fertilizer run-off,

insecticide and herbicide reaching soil and water)

PROBLEM OF AGRICULTURAL WASTE

Water contamination

Both surface and groundwater pollution are common in agricultural regions where farmers use spurious fertilizers and pesticides in an indiscriminate way. Water pollution from agriculture has direct negative impacts on human health. Large quantities of agrochemicals from fertilizers and pesticides were



Fig. 1. Eutrophication due to leaching of nutrients from agricultural field and cattle shed

discharged into surface and groundwater that ends up in drinking water. For example, leaching of nitrate from nitrogenous fertilizers into drinking water of Indo-Gangetic Plains (IGP) causes blue-baby syndrome also known as Methemoglobinemia. Children affected due to nitrate toxicity in drinking water are increasing over the year in India. Similarly, increasing nitrogen and phosphorus load in lakes and pond causes eutrophication which leads to death of fishes and other aquatic animals (Fig. 1). Health diseases in humans including cancer, Parkinson, Alzheimer, birth defects, and reproductive disorders are also increasing due to increasing load of agrochemicals in drinking water.

Air pollution

Stubble burning emits fine particulate matter (PM_{2.5}), an air pollutant that is a concern for people's health when levels in the air are high; the particles can get trapped inside the lungs and increase the risk of lung cancer by 36%. Rice straw burning accounting 5% of Delhi air pollution (Fig. 2).

Emission of Greenhouse gases

Every year 130 million tonnes of paddy straw is produced in India and a significant part (35 million tonnes) of it is burnt in the field in October-November in Northwest India. Farmers of Punjab, Haryana, and Western Uttar Pradesh mainly adopted this practice due to narrow window for land preparation and sowing of wheat in rice-wheat cropping system after rice harvest. Burning of 1 tonne of crop residue emits 1460 kg CO₂.

Serve as a host for disease causing organisms

Bacteria, insects and vermin thrive from garbage that increases the risk of salmonella, which causes typhoid fever and other major illnesses.

Reduce the value of land

Waste sites affect real estate prices. Landfills reduce the real estate price by 7-10%. Similarly, waterlogging, and heavy metal contaminated area fetches very less demand. They also



Fig. 2. Rice straw burning

reduce the aesthetic value of the land and surroundings.

Loss of nutrients

As per estimates, with each tonne of rice straw burnt, 5.5 kg Nitrogen, 2.3 kg phosphorus, 25 kg potassium and 1.2 kg of Sulphur are potentially lost (FAO, 2018). The other harmful effects involve loss of soil carbon and soil organic matter.

Unpleasant senses

Presence of agricultural wastes both in the farm and cities do not give pleasing sense to human. Stench from garbage makes human uncomfortable.

Why we need to manage agricultural waste?

- To safeguard natural resources (water, soil and air) for present and future generation
- To slowdown the process of climate change through minimizing the GHGs emissions.
- To generate employment and revenue
- To reduce the risk of disease breakdown and its spread
- To reduce the loss of valuable land due to landfilling
- To maintain and improve the value of land

How to manage agricultural waste

Rice straw management

In-situ recycling: Conservation

agriculture facilitates in-situ recycling of crop residue as mulch. Application of rice straw as mulch suppresses weed growth, and save irrigation water requirement through reduction of evaporation. Rice straw is rich in potassium (K). In-situ recycling of crop residue, avoid the problem of nutrient mining in rice-wheat cropping system (RWCS). Mining of potassium is the main sustainability threat to RWCS. This sustainability threat could be tackled through in-situ recycling.

Compost making: Compost is a good source of micronutrients, thus maintain soil health and save external inorganic fertilizers input. Rice straw can be used as principle composting materials in mixture with other legume crop. Compost production is one way of effectively utilizing rice straw. Application of compost results in an increase in, not only crop yield, but also soil fertility. Mechanization in mixing the materials, i.e., a compost turner, is necessary to have good aeration, increase the decomposition process, and reduce labor cost.

Pulp extraction: Rice straw is a cheap non-wood fiber material contains 18.3% lignin. Lignin extracted from rice straw is used in ceramic industry for making tiles. The extracted rice straw pulp is dried and moulded into cups and plates with the help of machines. Pulp industry is paying around ₹ 4000-5000/acre rice straw. It also reduces

the demand for non-bio degradable plastic and polythene; thereby it will reduce the plastic/polythene pollution in long run.

Mushroom production:

Mushroom cultivation is a profitable agri-business endeavour that may utilize rice straw in environmentally friendly manner. Rice straw is used as base material that can provide 50–100 kg of mushrooms per 1 tonne of dried straw. The paddy straw mushroom is one of the easiest mushrooms to cultivate because of its short incubation period of 14 days.

Biogas: Biogas is considered as an alternative green energy resource is produced through the process of degradation of rice straw by anaerobic micro-organisms in an oxygen-free environment. However, pre-treatment of rice straw before feeding into the anaerobic digester is essential since it is high in cellulose.

Fruits and vegetable waste management

Human behavioral change:

Throwing of rotten fruits and vegetables on the road side and discarding irregular shape fruits and vegetables in the market generate waste. Irregular shape fruits and vegetables are equally nutritious that of normal fruits and vegetables. Grading and packing of fruits and vegetables based on shape and size should not be promoted. It indirectly inculcates wrong message to human brain.

Use of artificial intelligence (AI): Through use of AI it is possible to forecast the demand for different crops mostly vegetables well in

advance. AI also provides information about the market demand and availability. If these informations are shared with farmers well in advance (before start of season), they can cultivate appropriate crop at right time and right quantity. It helps in increasing farmer's income and also reduces the wastage of perishable products like fruits and vegetables.

Organized collection of market and food waste: In developed countries market and food waste are collected at regular interval and used as feed for livestock mostly in piggery. Similar system can be adopted in India too. Setting of piggery unit in every municipalities and collecting market waste and food waste in the respective municipalities will generate income to government, provide employment opportunity and minimize the problem of stray cattle menace in India.

Livestock waste management

Biogas production: A large quantity of cow dung may be used to produce biogas. India is committed to generate 175 GW of energy through renewable sources like solar, wind, and biogas. Slurry from biogas plant is used for compost making.

Compost making: Organic farming – Only 2% (2.7 M ha out of 143 M ha) of our net cultivable area is under certified organic production. Only two states (Sikkim, Uttarakhand) in India is certified as 100% organic State. The scope for organic farming in India is enormous. Farmers are left with no choice other than in-organic

fertilizers, due to lack of organic source of nutrients to supplement crop nutrients demand. Increasing organic nutrients like, compost, vermi-compost could help in bringing more area under certified organic production. The increasing organic manure also brings down the burden of fertilizer subsidy to government through reduction in fertilizer demand.

Carbon trading: Organic manures are bulky in nature and that is why they are very much useful in building up soil organic matter (SOM) which eventually help in increasing the carbon content in the soil through carbon sequestration and open the window of carbon trading.

Agro-industrial waste management

The juice industries produced a huge amount of waste as peels, the coffee industry produced coffee pulp as a waste, and cereal industries produced husks. These organic residues can be utilized for different energy sources. Agro-industrial wastes are used for manufacturing of biofuels, enzymes, vitamins, antioxidants, animal feed, antibiotics, and other chemicals through solid state fermentation (SSF).

Sugar industry: Every year in India 8 million tonnes of pressmud is generated as a byproduct from sugar industry. It contains 1.5-2.5% N, 2-3% P, 1-2% K, 11% Ca, 0.3% S. Thus, it has a great potential to use as manure in agricultural field. Due to its high Ca content it can also be used as an amendment for reclaiming acidic soils, since, 17.9 M ha land is affected by acidic soils in India. Waste



Fig. 3. Pressmud compost



Fig. 4. Sawdust

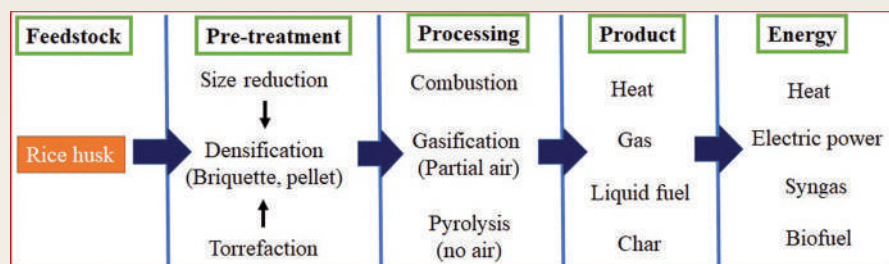


Fig. 5. Flow chart of rice husk to energy

water generated in sugar industry is also used in the process of converting pressmud into compost (Fig. 3). So through this way we achieve zero waste generation from sugar industry. Application of pressmud also helps in soil carbon sequestration and improves soil fertility.

Sawdust (wood) industry: Huge quantity of sawdust (approximately 2.2 million tonnes) is produced in timber industry during wood processing every year (Fig. 4). In many developed countries wood pellets (sawdust) is gaining attention as a viable and promising renewable energy source replacing coal. Sawdust, known for generating low emission and high power offers great advantages over burning fossil fuels. High amount of bio-oil can be produced from sawdust through pyrolysis process and it can be utilized in multiple applications such as furnaces, diesel engines, boilers, gas-turbines, etc. Result from the pyrolysis experiment showed feeding sawdust @ 17 kg/hr, residence time 30 minutes at 450 °C produced 45.69% bio-oil, 24.82% bio-char and 29.49% pyro-gas.

Rice husk: India generates 23-25 million tonnes of rice husks every

year. Rice husk has around 30–50% organic carbon and high heat value (13–16 MJ per kg). It can be used to generate fuel, heat, or electricity through thermal, chemical, or bioprocesses. The energy production processes from rice husk are presented in Fig. 5. National grid expansion project is not efficient and economical to reach every nook and corner of the country. This technology is very useful to electrify the remotes location of our country.

Pesticide contamination management

Improper disposal of pesticide waste causes groundwater and surface water contamination. Following action *viz.* waste avoidance, waste reduction, waste recycling, waste treatment, and waste disposal should be taken to manage pesticide waste management. Pesticide should be applied at the right place with the right dose and right time through right method. Adaption of early pest management will reduce the quantity of pesticide use. Wastewater that is generated during equipment rinsing can be recycled by spraying it onto cropland, thus, avoiding a soil contamination problem. Chemical and biological degradation is useful

method in managing contaminated soils. Composting, bio-remediation/ bio-augmentation/ bio-stimulation/ bio-accumulation should be used in combination to manage the contaminated soil rapidly. These methods are suitable for small farmers without any extra investment.

SUMMARY

In our Country, agricultural wastes are not managed efficiently, although many technologies are available to recycle and reuse agricultural waste. Efforts should be encouraged to reuse and recycle as much as we can. Farmers should be trained with modern technologies to utilize agricultural waste efficiently. Technology transfer programme related to agricultural waste management should be encouraged since it generates huge quantity of agricultural waste every year. Turning agricultural waste into wealth will helps in achieving sustainable agricultural development, also doubling farmer's incomes besides making our Country cleaner and environment friendly.

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