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Bio Waste Management through Mushroom Cultivation and Beneficial Microbes

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Abstract
Bio waste can be easily converted into wealth with creation of only awareness. Issues of burning agro waste and proper management of industrial waste, plastic waste and other wastes are creating lot of environmental pollution as a result there is an increase in the amount of greenhouse gases and pollution to the land, soil, water and air. Proper management of bio-waste can thus retain the organic carbon back to the soil and reduce nutrient requirements also. The central and state governments are seriously thinking of addressing these problems of burning of enormous quantity of wheat/paddy straw. Recycling of wheat/rice straw can improve yield and soil fertility and reduce atmospheric pollution. Burning of rice straw is a common practice in northwest India, where rice–wheat cropping system is extensively followed. This practice results in loss of nutrients, atmospheric pollution and emission of greenhouse gases. All the treatments with rice straw incorporation had larger soil organic C. These wastes can either be converted into compost making use of suitable microbes (*Trichoderma* spp.) which may be recycled for better crop growth or recycling of waste using fungal technology into healthier and nutritious wealthy foods like mushroom which can provide livelihood option and quality food to the mankind. Mushrooms are a unique group of fungi through which we can pilot a non-green revolution in less developed countries, and in the world at large. Mushroom mycelia can produce a group of complex extracellular enzymes which can degrade and utilize the lignocelluloses wastes in order to reduce pollution. They biosynthesize their own food from agricultural crop residues and spent composts/substrates can further be used as animal feed, biofertilizers and biogas. It has been revealed recently that mushroom mycelia can play a significant role in the restoration of damaged environments.

Introduction
The amount of crop residues produced every year in India exceeds 620 million tons (Singh and Sidhu, 2014). Agro-waste includes crop waste, animal waste (manure) and food processing wastes. A total of 50% of agricultural residues are produced by rice, wheat and oilseed crops (Singh and Prabha, 2017). India produces approximately 130 million tonnes of paddy straw of which only about half is used for fodder and 50 million tonnes of cane trash. During rice and wheat harvesting and milling, three types of residues are formed viz., straw, husk, and bran, which are used as a cattle feed, packing material, heating, cooking fuel and cooking oil. Direct incorporation of paddy straw increases methane emission from the irrigated fields and impact global warming. In the past, the entire paddy and wheat straw was burnt by the Indian farmers but now a days, it is being converted as a bio-renewable source.

Production of bio waste and mushroom

A large quantity of agricultural and horticultural wastes are generated every year from agricultural activities in India. As per Agricultural waste management' Policy paper 49, about 947 million tons of bio-wastes was produced in the year 2010 apart from 204 tons of road side/ forestry/ social forestry waste totalling 1151 million ton. Out of these wastes, cereal wastes including wheat straw and paddy straw forms the major part of bio wastes. Wheat straw production is about 160.5 million tons while paddy straw is about 130 million tons in the year 2019-20 totalling around 290.5 million tons. These cereal strawsare largely burnt by the farmers, which causes air pollution to distant places including Delhi metro city. However, these raw materials can actually be used for the cultivation of mushrooms in a small to commercial scale. This kind of bioconversion exercise can greatly reduce environmental pollution. Mushroom cultivation is a labour intensive activity and will serve as a means of generating employment, particularly for rural women and youths in order to raise their social status. It will also provide additional work for the farmers during winter months when the farming schedule is light. It provides vegetable of high quality, and enrich the diet with high quality proteins, minerals and vitamins which can be of direct benefit to the human health and fitness. The extractable bioactive compounds from medicinal mushrooms enhanced human's immune systems and improve their quality of life. Mushroom cultivation is a cash crop and can be sold in local markets for additional family income or exported for an important source of foreign exchange that will definitely improve the economic standards of the people. Some warm mushrooms, e.g. Volvariella volvacea (Straw mushrooms) and Pleurotus sajor-caju (Oyster mushrooms) are relatively fast growing organisms.

Methods

Spent Mushroom Substrates (SMS) The compost/substrate, obtained after mushroom crop harvest possesses all essential attributes of an organic manure which further gets enriched during its recomposting by natural weathering or any other process. The spent substrate from different mushrooms varies in its physical, chemical and biological properties and each one has its own specific utility (Ahlawat, 2011. Studies have revealed that SMS being rich in organic matter adds nutrients to the soils (Barman et al. 2018), helps in neutralizing acidic soils, facilitates plant growth in barren areas and in some cases, it improves water quality along with bioremediation of contaminated soils/industrial sites. It is capable of supporting further biological activities, e.g., the growth of another species of edible mushroom, can be used as fodder for livestock, as a soil conditioner and fertiliser also. Innovative way for collection of straw after harvesting through combine harvester Paddy harvesting and threshing has now become very common practice through combined harvester but the difficulty with this machine is that, it leaves aside the paddy straw sprinkled in the entire field. Paddy straw collection manually requires 3-4 hrs per ha with four workers. Hence, farmers usually destroy that straw by burning at field itself, which creates air pollution, destroy beneficial soil microorganisms as well as made unavailable straw to milch animals. To overcome this problem, an innovative attachment of wire mesh of 8 x 1.1 feet was made and arranged in tractor drawn cultivator which collected combined harvested paddy straw within 35- 40 minutes per ha and saves about Rs 7620 per ha as well as saving of energy (Fig. 1-3). The cost of this innovative method is just Rs 150.00. Thus, this method can be widely used by the farmers in collecting the paddy straw from the field left after combine harvester at one place and made use of this straw the way they liked to use it. Role of mushroom fungi in crop waste management Mushrooms are environmentally very friendly. Mushroom mycelia can produce a group of complex extracellular enzymes which can degrade and utilize the lignocellulosic wastes in order to reduce pollution. Their spent composts/substrates can be used in various ways. It has been revealed recently that mushroom mycelia can play a

significant role in the restoration of damaged environments. Saprotrophic, endophytic, mycorrhizal, and even parasitic fungi/mushrooms can be used in mycorestoration, which can be performed in four different ways: mycofiltration (using mycelia to filter water), mycoforestry (using mycelia to restore forests), mycoremediation (using mycelia to eliminate toxic waste), and mycopesticides (using mycelia to control insect pests).

Recycling of bio waste using mushroom

Fungi Mushroom farming has become one of the most proven income generating enterprise in different parts of the country to double or triple the farmers income within a year. It is the important source of food, nutrition, income and employment security in rural sector of the society particularly in Chhattisgarh state which is predominated by tribal community. Mushroom cultivation in Chhattisgarh has been promoted by ICAR-AICRP on Mushroom at IGKV, Raipur, Krishi Vigyan Kendras (KVKs) and Constituents Colleges of the university by establishing, 14 Mushroom Spawn Laboratory and 14 Mushroom Crop Production units in 14 KVKs (Bastar, Dantewada, Bijapur, Kanker, Dhamtari, Mahasamund, Rajnandgaon, Kawardha, Janjgir, Korba, Korea, Ambikapur, Raigarh, Bilaspur), Governmentsindeveloping countries including India are focusing on taking several initiativeslike • SkillIndia,Stand up India • SwachhaBharat Abhiyan, • Startups/Incubators, • doublingof farmers income by 2022etc. • to facilitate theyouths/young entrepreneurs in rural, urban and peri urbanareasto involve them in the cultivation,production and processing activities There are different varieties of edible and medicinal mushrooms which are cultivated in India. The most predominant mushroom grown in our country is white button mushroom followed by oyster mushroom, paddy straw mushroom, milky mushroom and shiitake mushroom.

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