International journal of advances in engineering and management (IJAEM)
Volume 3, issue 6 June 2021, pp: 1729-1735 www.ijaem.net ISSN: 2395-5252

A Review on Alternative Uses of Crop Residue

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Submitted: 01-06-2021 Revised: 14-06-2021 Accepted: 16-06-2021

ABSTRACT: India, the second largest agro-based economy with year-round cultivation of crop, generates a large amount of agricultural waste, including crop residues. In the absence of adequate sustainable management practices, approximately 92 seems a very small number of metric tons of crop waste is burned every year in India, causing excessive particulate matter emissions and lot of air pollution. Crop residue burning has become a major environmental problem causing health issues, environmental issues, economic issues as well as contributing to global warming. Composting, bio-char production and mechanization are a few effective sustainable techniques that can help to curtail the issue while retaining the nutrients present in the crop residue in the soil. The government of India has attempted to curtail this problem, through numerous measures and campaigns designed to promote sustainable management methods such as converting crop residue into energy. However, the alarming rise of air pollution levels caused by crop residue burning in the city of Delhi and other northern areas in India observed in recent years, especially in and after the year of 2015, suggest that the issues is not yet under control. The solution to crop residue burning lies in the effective implementation of sustainable management practices with Government interventions and policies. This review paper addresses the underlying technical as well as policy issues that have prevented India from achieving a long-lasting solution and also potential solutions that have been overlooked. However, effective implementation of these techniques also requires us to look at other socioeconomic aspects that had not been considered. This review paper also discusses some of the policy considerations and functionality based on the analyses and current practices.

KEYWORDS: Crop residue, Cultivation, Environment, Agriculture waste, Pollution, Production.

I. INTRODUCTION

Production in agriculture and consumption activities generates pollution and waste, and atmospheric environment can absorb pollution waste up to a limit. Agriculture is one of the important production activities and crop residue burning generates a significant amount of air pollution d harm to the environment. an Atmospheric environment can absorb this pollution in a particular geographic region given its assimilative capacity. If the burning activities remain confined within the assimilative capacity, the pollution does not create harmful effects. Therefore, in the initial stages when the production and burning activities are limited, pollution caused through these activities is not considered a problem. However, due to technological advancements in the agricultural sector, waste concentration has gone beyond the assimilative capacity of the environmental limit, thereby distorting the balance.

Burning of farm waste causes severe pollution of land and water on local as well as regional and global scales. It is estimated that burning of paddy straw results in annual nutrient losses to the tune of 3.85 million tonnes of organic carbon, 59,000 t of nitrogen, 20,000 t of phosphorus and 34,000 t of potassium at the aggregate. This also adversely affects the nutrient composition of the soil. When crop residue is burnt existing minerals present in the soil are destroyed, which adversely hampers the cultivation of the next crop. Straw carbon, nitrogen and sulphur are completely burnt and lost in the atmosphere in the process of burning. This result in the emission of smoke which when added to the gases present in the air like methane, nitrogen oxide and ammonia

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can cause severe atmospheric pollution. These gaseous emissions can pose health risks, aggravating asthma, chronic bronchitis and decreased lung function. Burning of crop residue also contributes indirectly to increased ozone pollution. The agricultural industry plays a major role in the overall economic growth of the world. However, there is limited discussion on the management of agricultural waste in the published literature. It could be related to the fact that agriculture industry is not regulated as the municipal solid waste (MSW). The MSW is mainly governed by public entities such as municipalities and hence the generation and management data are collected, recorded, and analysed in the public domain. Agricultural waste is predominantly handled by the owners of the agricultural land which is predominantly in the private sector, with little public sector involvement.

The growing demand for food in developing countries has led to tremendous increase in food production around the world. Hence, agro-based activities represent profitable businesses, both in developing as well as developed countries. The multitude of agricultural activities increases the number of agro-products produced and this has led to an overall increase in environmental pollution and waste generation. The nature of the activities deployed, and the waste generated depends on the geographical and cultural factors of a country. Large stretches of wasteland have been converted to arable lands due to developments in water management systems, modern agro-technologies and large-scale agrochemical deployment. These measures have resulted in global environmental pollution and increased complexity in the disposal of agricultural waste. However, the national agencies are continuously developing policies and possible options to manage this waste, which includes their conversion to reusable resources.

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. According to the world energy council, in addition to all above, agricultural waste can also comprise of spoiled food waste. 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 of crops), leaves, and seed pods are some common examples for field residues. Sugarcane bagasse and molasses are some good examples for process residue. And other are the wheat and rice stubble.

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. 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 compares the agricultural waste generated by selected Asian countries in Mt/year. It is also interesting to note that the portion burnt as agricultural waste in India, in volume is much larger than the entire production of agricultural waste in other countries in the region.

Waste from the agricultural industry can be beneficially utilized in various agro-based applications and other industrial processing. However, the cost of collection, processing and transportation can be much higher than the revenue from the beneficial use of such waste. The classic example of how economic reasons have prevented attaining the sustainable use of agricultural waste and led to environmental chaos in India is the focus of this manuscript. This topic is important to the wider audience beyond India for two reasons: first, crop residues are an important constituent of agricultural waste that can actually be used for the benefit of the society due to its organic composition. The other important reason is that the volume of crop residue, with unsustainable management practices creates high adverse environmental impacts that go far beyond India. Specifically, India is the second largest producer of rice and wheat in the world, two crops that usually produce large volume of residue.

II. ALTERNATIVE USES OF CROP RESIDUE:

India is 4th among the top agricultural producing countries in the world after China, U.S. and Brazil, therefore as the production of crop increase, the crop residue or stubble also increases. According to some estimates, farmers in northern India burn about 23 million tonnes of paddy stubble every year due to which pollution is increasing day by day. So to minimize the impact of crop stubble burning on the nature, we have to find many alternative uses of the stubble. Some uses of crop stubble is mentioned as below:

1. Use of Rice residue as fodder for animals:

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Rice straw is a readily available, practical, and cheap source of fodder for feeding ruminants such as buffaloes, cattle, goats, and sheep. The high silica and lignin contents of straw also contribute to poor nutrient (dry matter and protein) digestibility (<50%). When used as fodder, rice straw primarily serves as bulk or filler to meet the dry matter requirement of ruminants. This contains 80% substances which are potentially degradable and a source of energy. It has high dry matter (DM) contents of 92–96% but with a low CP content ranging from 3% to 7% (Shen et al. 1998). Generally, in feeding dry cows, rice straw can be used for about 50% of the ration.

Rice residue as fodder for animals

Additional urea-molasses mineral blocks could be used as supplements to support the requirement of the dry cows. Rations with rice straw greater than 50% would result in a declining body weight of the cows.

To reduce waste and increase consumption, some producers inject molasses supplements into the bales. While the amount of supplemental nutrients from the molasses is small, it does enhance the smell and palatability of the straw. In addition, producers may provide supplemental nutrients by using liquid, tub, or block supplements. These supplements have been shown to increase performance of cattle on low-quality forages similar to rice straw, and increased intake and improved digestibility have been noted (see Weyers et al. 2001). The crude protein portion of these supplements is often partially non-protein nitrogen (NPN), which is about 50 percent efficient in these types of rations compared with natural protein sources.

2. Use of Crop residue as Bedding Material for Cattle:

The farmers of the state have been advised to use paddy straw as bedding material for cross bred cows during winters as per results of a study conducted by the Department of Livestock Production and Management, College of Veterinary Sciences, Punjab Agricultural University. It has been found that the use of paddy straw bedding during winter helped in improving the quality and quantity of milk as it contributed to animals' comfort, udder health and leg health. Paddy straw bedding helped the animals keep themselves warm and maintain reasonable rates of heat loss from the body. It also provides clean, hygienic, dry, comfortable and non-slippery environment, which prevents the chances of injury and lameness. Healthy legs and hooves ensure enhancement of milk production and reproductive efficiency of animals. The paddy straw used for bedding could be subsequently used in biogas plants. The use of paddy straw was also found to result in increased net profit of Rs. 188–971 per animal per month from the sale of additional amount of milk produced by cows provided with bedding. The PAU has been demonstrating this technology to farmers through training courses, radio/TV talks and by distributing leaflets.

3. Use of Crop residue in Paper Production:

The most important agricultural residues used in the paper industry are straw and bagasse, and for panel products bagasse and flax strives, but there are a number of other residues which are also used. The seasonal nature of the cane processing operation in most places means that extensive storage of bagasse has to be arranged to guarantee an uninterrupted supply of raw material

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to the paper or paper mill, the operation of which can neither be interrupted nor changed to use other raw materials. Any raw material in pulp and paper industry is firstly converted into fibrous mass called pulp. Pulping techniques are generally classified into mechanical, chemical and semi chemical pulping. Most of the mills rely on chemical or chemi-mechanical processes for handling out the agro based raw material during pulping. For the paperboard production, pulp from agricultural residues using either chemical or chemi-mechanical processes can be used, although technology development in both areas is needed to improve prospects for technology adoption

Paper Production from Agricultural Waste

4. In Situ Incorporation:

Though the crop stubble has various alternate uses but the area which is harvested by using combine harvester is left behind with scattered residues which farmers find difficult to remove from the fields. After combine harvesting farmers are left with only two alternatives, either in-situ incorporation of the remains of crop stubble or open burning in the field. Farmers don't prefer in-situ incorporation as the stubble takes time to decompose in the soil that may adversely affect the wheat productivity because of time loss in sowing. As per the Department of Agriculture of the Punjab government, less than 1 % of the farmers incorporate crop stubble because of more tillage operations required in the case of incorporation than of post burning.

5. Production of Bio-Oil from Straw and other Agricultural waste:

Bio-oil is a kind of liquid fuel made from biomass materials such as agricultural crops, algal biomass, municipal wastes, agricultural and forestry by-products via thermo-chemical processes. The biomass resources are abundant all over the world. The local utilization of biomass especially the residual biomass from agriculture is very low and the unused residual had been get rid of by unfriendly environmental way by burning these residual in field and produced black cloud saturated with carbon dioxide. Renewal and abundance advantages of biomass make them attractive source for renewable energy. Biomass energy "bioenergy" which are producing biofuel and energy using plant is considered a promising technique as it has a recycled array Using of fast pyrolysis to produced bio-oil depend only on wood biomass no other agriculture waste. As one kind of new inexpensive, clean and green bio energies, bio-oil is considered as an attractive option instead of conventional fuel in the aspect of reducing environmental pollution. Bio-oil produced from rice straw contains high present of light constituents (C16-C19).

6. Making Soil from Stubble:

Farming has often been considered a rural occupation, mostly practiced in the countryside. However, that's not the case for 54-year-old Poornima Savargaonkar, a resident of Gurgaon. She has always been an ardent nature lover, an urban gardener, and advocate of sustainable living. Only a few know that Poornima is also a former scientist.Till 2003, she worked at the Indian Space Research Organization (ISRO) in Ahmedabad. After quitting the organization that year to take care of her family, she took up urban farming, and eventually became an entrepreneur. There were also very few articles or videos that explained the soil variety that can be used in India's climatic conditions. She did her research, and started preparing Amrut mitti, which is a mix of compost, dried leaves, cow dung and urine, to grow these plants. To date, she does not purchase any soil, and only prepare my own. The raw material is sourced from her society, home kitchen and farmers in a

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village. To make the soil more fertile and reduce the burden on the environment, she decided to incorporate stubble waste produced in farms to make the Amrut mitti. For this, Poornima collaborates with a farmer family in a village named Behlpa, located on the outskirts of Gurgaon, to source the stubble waste, horticulture waste (dry leaves), and cow dung and urine. She decided to put her quest for zero-waste living into action. She grow her own food, and the waste that is generated goes back to growing food again. When she go out to shops, she don't purchase plastic bags. She uses items like bottles and buckets as planters. When the COVID-19 lockdown was announced, she decided to show others how they can do the same.

Soil Made from Stubble

7. Use of Crop Residue in Bio Thermal Power Plant:

The Centre is thinking to make crop residue mandatory in thermal power plants for generating electricity and, thereby reducing air pollution from stubble burning. By the National Thermal Power Corporation, a state run power generating company has already started the process of obtaining crop residue on a large scale and same may be followed by other coal-fired thermal power stations across the country, said by official in the Ministry of Power. The NTPC has successfully done test of biomass co firing at its Dadri thermal power plant, and now the company want to extend this experiment to other plants

The stubble burning is not limited to the northern states of the country and is becoming rampant in other areas as well due to mechanized farming. To end the menace of stubble burning by farmers, the government wants all Thermal power plants to procure crop residue or agriculture waste from farmers and utilize it for generating power along with coal, said the official. Biomass co-firing has the potential to reduce emissions from coal-fuelled generation without much cost escalation, he said.

Earlier, the Ministry of Power suggested to the thermal power plants to use crop residue along with coal to generate power to ensure lower stubble burning and air pollution. The Central Electricity Authority (CEA) has issued an advisory to all public and private power generating companies to endeavor to use 5 to 10 % biomass pellets primarily made of agro residue, along with coal.

8. Use of crop residue for Mushroom cultivation:

Crop residue is of primary concern in today's world as they are rich in nutrient and their disposal without pretreatment can cause leaching in field and can cause environment pollution.

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Mushroom Cultivation from crop residue

To overcome this problem, mushroom cultivation on these agricultural wastes is the most ecofriendly method to reduce the level of nutrients at acceptable range to be used as manure. Besides overcoming this problem defined combination of agricultural wastes also gives high yield of mushroom in a cost effective manner.

Use of residues in mushroom production represents a valuable conversion of inedible crop residues into valuable food, which despite their high moisture content has two to three times as much protein as common vegetables and an amino acid composition similar to that of milk or meat. Wheat and rice straws are excellent substrates for the cultivation of Agaricus bisporus (white button mushroom) and Volvariella volvacea (straw mushroom), two of the four most commonly grown fungi. Straw for Agaricus cultivation is usually mixed with horse manure and hay and a very high conversion efficiency of the substrate into fungal bodies is possible.

9. Use of crop residue for making Biogas:

Managing the abundant supply of crop residues can be both a challenge and an opportunity. Farmers struggle to individually manage the crop residues and resort to stubble burning as an inexpensive alternative. Out of the various crop residues in India, millions of tonnes from rice, wheat and sugarcane which find limited use are majorly prone to such burning that further leads to severe environmental damage.

Generating biogas from the crop leftovers is a simpler and less cost- and energy-intensive method supporting the principles of circular economy. Biogas production from the crop residues and agricultural wastes not only offers a source of clean energy that can replace fossil fuels but also reduces methane and CO2 emissions, but these also reduce pathogen, odour and hygiene problems of these ludge and manure. Straws from various major crops like paddy, wheat, oat, barley, sorghum, grass, millet, corn stover and sugar cane crop residues have been identified as competent substrates for bioenergy production. They have been reported to bear a biogas potential ranging between 0.3 and 0.5 m3per kg vs. with a high methane content of up to 70% .This gas could be utilized as a cooking or heating fuel or converted to electrical and heat energy using a combined heat and power (CHP) unit or could even be upgraded to be injected into natural gas gridlines or used as a vehicle fuel. For Indian context, launching community programmes is recommended that would assist in equipment rentals, transportation of agricultural leftovers, linking to the biogas industries where the crop residues could be utilized as raw materials. Thinking in financial terms, the biogas sector could help farmers generate extra revenues from the energy and organic fertilizers. Further research is recommended to derive cost-effective biogas plant designs to direct economic benefits for the large number of small-scale farmers in India that resort to stubble burning. Future scopes include identifying efficient, sustainable and economically viable pre-treatment methods to encourage crop residues as favorable substrates for biogas generation.

10. Incorporation of paddy straw in soil:

The incorporation of the straw in the soil has a flattering effect on the chemical, physical and biological properties like pH, Organic carbon, water holding capacity and bulk density of the soil. It has been seen to increase the availability of zinc, copper, iron and manganese content in the soil and it also prevents the leaching of nitrates on a long-term basis. There is increase in bacteria and fungi in the soil as by increasing organic carbon it. In a rice-wheat rotation, it is observed that soil treated with crop residues held 5–10 times more aerobic bacteria and 1.5–11 times more fungi than soil from which residues were either burnt or removed. As increase in microbial population, the activity of soil enzymes responsible for conversion of unavailable to available form of nutrients also increases. The mulching with paddy straw has been shown to have a favorable effect on the yield of maize, soybean and sugarcane crops. It also results in considerable savings in irrigation and fertilizer.

III. CONCLUSION

Taking the fact into account that rice and wheat that usually produce the majority of crop residue being the major staples of India, the large-scale cultivation of these crops to feed the ever-increasing population has obviously led to generation of large quantities of crop residue, which the country is not able to cope up with. Increased mechanization i.e., uses of combine harvesters and unavailability of economical viable solution have compelled the farmers to burn the stubble. Crop residue burning is one among the many sources of air pollution. To avoid burning of rice (and wheat) stubble, management of agricultural waste for alternate uses is being practiced and promoted. Agricultural waste includes Paddy and wheat straw, cotton sticks, bagasse and animal waste. Keeping in view the increasing problems associated with crop stubble burning several initiatives for its proper

management have been taken up. Various departments and institutions are promoting alternative uses of straw instead of burning. These include Use of rice residue as fodder, crop residue in Bio thermal power plants and mushroom cultivation, rice residue used as bedding material for cattle, production of Bio-oil, paper production, bio-gas and in situ. Other uses include incorporation of Paddy straw in soil, energy technologies and thermal combustion.

REFERENCES

[1]. Daniel Aquino, Arnel Del Barrio, Nguyen Xuan Trach, Nguyen Thanh Hai, Duong Nguyen Khang, Nguyen Tan Toan and Nguyen Van Hung, "Rice Straw-Based Fodder for Ruminants"; Book - Sustainable Rice Straw Management

[2]. Daniel J. Drake, Glenn Nader, Larry Forero, "Feeding Rice Straw to Cattle".

[3]. http://www.fao.org/3/l2015e/l2015e03.htm#:~:text=The%20most%20important%20agricultural%20residues,residues%20which%20are%20also%20used.

[4]. [4].https://link.springer.com/chapter/10.1007/978-3-030-32373-8_7#:~:text=Rice%20straw%20is%20a%20readily,cattle%2C%20goats%2C%20and%20sheep.&text=The%20high%20silica%20and%20lignin,)%20digestibility%20(%3C50%25).

[5]. Pallavi Kisan Patil, Manoj Baliram Pohare, Sachin Ashok Bhor and Mahender Kumar, "Paperboard Production from Agricultural Residues"

[6]. Olfat AbdAllah Mohamed- Department of Chemical Engineering, Tanta University, Tanta, Egy, "Production of Bio-Oil from Agriculture Waste"

[7]. https://www.google.com/amp/s/www.thebetterindia.com/245175/isro-scientist-organic-gardening-tips-youtube-poornima-savargaonkar-stubble-soil-ros174/amp/

[8]. https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.deccanherald.com/amp/national/thermal-plants-be-told-use704751.html&ved=2ahUKEwinmOn6mO_wAhV07XMBHUqMAxMQFjABegQIBBAG&usg=AOvVaw0oLluvx1MgsLjst94KERCp&ampcf=1&cshid=1622301770814

[9]. Yongzhong Jiang, Valerii Havrysh , Oleksandr Klymchuk , Vitalii Nitsenko, Tomas Balezentis and Dalia Streimikiene, " Utilization of Crop Residue for Power Generation: The Case of Ukraine, " 2019

[10]. https://www.irri.org/rice-straw-management

[11]. https://energy.economictimes.indiatimes.com/news/oil-and-gas/government-asks-farmers-to-use-crop-residue-for-biogas-production/65776880

[12]. Dinesh Kumar Saini, Vikas Kumar Singh, Anand Kumar, "Stubble burning: either farmers to be punished or technology need to be improved?" Biomolecule Reports ISSN:2456-8759

[13]. https://www.cabi.org/news-article/fields-on-fire-new-research-reveals-alternatives-to-harmful-crop-residue-burning-in-india/

[14]. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6427124/

[15]. https://www.civilsdaily.com/mains/stubble-burning-seriously-affects-the-environment-very-badly-causing-serious-health-hazards-in-people-what-do-you-mean-by-stubble-burning-and-what-are-its-effects-on-environment-what-measures-should/