Technologies for Stubble Use

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Stubble Use

Farmers all over the world for centuries have grown rice/wheat and have developed various local useful applications for the use of rice/wheat straw. In the present modern civilization all along with mechanized agriculture, farmers all over the world in general and states of Punjab and Haryana in India in particular complain that rice straw has become a huge problem for them because they follow mechanized agriculture, are shortage of labour, need fast clearance of their fields for next crop etc. When rice/wheat is harvested by a combine harvester it leaves a significant length of straw on the field. Moreover, both wheat and rice are long-duration crops and with a short period available between rice harvesting and wheat plantation, increasing labour cost and non-availability of any user-friendly and cost effective technology to make the use of crop residue, burning of stubble seems the easiest and quickest way to get rid of rice straw to the farmers. In the absence of assured returns, farmers find stubble burning an economic way of managing the agro-waste.

Despite such huge amounts of rice straw generation, farmers in the country are yet to realize the potential of this agro-waste in terms of useful agriculture end-product and as a profitable raw material for various industries. With several applications, increasing demand and competitive prices, it seems farmers will have no dearth of options for managing the agro-waste in a profitable way. However, convincing them about economic viability of the options could be a challenge. Farmers will give up burning rice straw only if they receive a lucrative incentive. For this, policy makers can devise a plan to offer incentives to farmers to stop the polluting stubble burning and later credit the incentives through international carbon trading. Recognizing that future straw management options must meet both agriculture production and environmental stewardship objectives, at present, markets for rice straw are extremely limited and most growers are incorporating residue burning.

Old Methods Still Relevant for Stubble Use

In earlier times, when produce was limited, uses were more people oriented and they never use to burn it in fields. Many old methods of rice/wheat stubble use are still relevant as:

- As a fodder
- Making a large variety of artifacts for daily use
- Rice straw has been used to bind clay in built-up wall construction and in the manufacturing of fired brick. The resultant burn-out product provides lightweight material with good insulating properties. Shredded or fiberized straw may also be used in layered products such as roofing paper, insulating paper, and overlay products.
- Packaging material
- Defiberized rice straw can be used in hydroseeding (a process of planting in liquid solution along steep banks (i.e., roadsides, etc.) for erosion control.
- Rice straw has been used as bedding for livestock for many centuries, primarily to soak up the urine and provide a carrier for the dung. Used material may be composted and sold as fertilizer.
- Chopped straw litter can be used for poultry kept on a built-up litter system. The used litter has a useful fertilizer value or can be utilized as cattle feed.

But these methods have become insignificant with modernization/ mechanization and when production is more than use.

New Technologies Those are Available all around the World

But now things have changed and the main reasons for un-preferred use of rice straw are: difficulty in procurement due to light weight and occupying more volume, low energy density, more water resistance, difficult fodder to digest for animals and time taking to form compost. Therefore, suggestions like making use of rice straw as fodder, fuel, building material, compost, storing etc. do not come cache with farmers and they have to clear their fields for next crop showing and thus burn it. New environmental friendly, cost effective, less time consuming, viable & user friendly, and labour-free technologies have to be provided to the farmers in the fields to convert rice straw into useful end products. Companies can also collect the stubble from fields for further use and farmers will be happier if they have some income from this waste. Some of the new technologies applied world over for the use of rice/wheat stubble are discussed briefly as:

1. Making Use as Combustion Material

Rice straw can either be used alone or mixed with other biomass materials in direct combustion, whereby combustion boilers are used in combination with steam turbines to produce electricity and heat. Technology developed includes combustion furnaces, boilers, and superheat concepts purportedly capable of operating with high alkali fuels and having handling systems which minimize fuel preparation. The by-products are fly ash and bottom ash, which have an economic value and could be used in cement and/or brick manufacturing, construction of roads and embankments, etc. A variety of methods are employed to prepare straw for combustion. Most use automated truck unloading bridge cranes that clamp up to tens of bales at a time and stack them 4-5 bales high in covered storage. Some systems feed whole bales into the boiler. Whole bales are pushed into the combustion chamber and the straw burned off the face of the bale. However, the newer plants have moved away from whole-bale systems to shredded straw feed for higher efficiency. For pulverized coal co-firing, the straw usually needs to be ground or cut to small sizes in order to burn completely within relatively short residence times (suspension fired systems) or to feed and mix upon injection with bed media in fluidized bed systems.

3. Making Pellets

The straw fuel or biofuel of biomass pellet mill machine uses corn stalk, wheat straw, rice straw, peanut shell, cob, cotton bar, soybean rod, weeds, branches, leaves, sawdust, bark and other solid wastes as raw materials. After crushing, pressing, increasing density and forming, they become small solid pellets fuel. Biomass pellet mill machine can be used for civil heating fuel and life fuel. This kind of fuel has high efficiency and is easy to store. Biomass pellet fuel can be also used as main fuel for industrial boiler. It can replaces coal and solve environment pollution problem. Delivery and storage for biomass pellet fuel is very convenient and at the same time, its combustion performance is greatly improved. The technological process of biomass pellet mill is: collecting raw materials, crushing raw materials, pelletize raw materials and finally packaging and selling. Straw pellet fuel features: forming the pellet fuel, after more than major, small volume, high combustion, easy storage and transportation. Applications of straw pellet fuel: the finished pellet fuel is a new type biological energy. It can replace wood, coal, oil, gas, etc.

It is widely used for heating, life stove, hot water boiler, industrial furnace, biomass power plant, etc.

3. Power Generation

A small amount of paddy straw is only consumed by brick kilns and paper and packaging industry. Power production from rice straw is a promising way to meet the growing demand of energy.

If enough biomass power plants are set up locally, it will provide a new source of income to farmers and also save the environment from stubble burning. Punjab Biomass Power Ltd is the first of the nine rice straw power plants coming up in Punjab. This plant near Ghanaur village in Patiala district is functioning for the past one year. It uses rice straw for producing power. The company offered its own machinery to harvest and collect straw on time so that farmers do not get delayed for the next crop. A 12 MW rice-straw power plant typically needs 120,000 tonnes of stubble, which can be collected from about 15,000 farmers. Last year PBPL generated 12 MW while helping farmers reduce the pollution levels considerably.

Agents appointed by the company approach farmers to harvest their rice straw. The harvesting is followed by cutting, baling and transporting the bales to company depots where it is stored. The plant is based on the simple principle of combustion. It has a furnace, a boiler and a steam turbine. There are also a set of machines that cut open the bales and shred the straw into small pieces to ensure uniform combustion. The shredded straw is then fed into the boiler using a conveyor belt. A conventional steam turbine then generates electricity. An electrostatic precipitator to collect ash ensures minimal atmospheric pollution. Although there will be some emissions from combustion, the project is eco-friendly and aims to earn substantial carbon credits. Apart from combustion, there are other technologies to produce power from rice straw, such as anaerobic digestion (biogas), pyrolysis (bio-oil) and gasification (syngas). The last two are under research and development as they are not economically viable.

4. Back in Soil

Composting is the decomposition of rice straw to enable recovery of portions of its nutrients and organic components. It can be done in open wind rows or in an enclosed controlled environment. Best results are obtained when feedstock materials have a high nitrogen content to obtain a better carbon to nitrogen ratio. Factors affecting composting are oxygen availability, moisture content, pH, temperature, and the carbon/nitrogen ratio. Rice straw is slow to decompose and usually will take up to a year with moisture content of the pile remaining high.

Scientists have developed a simple and rapid composting technique to convert huge piles of rice straw into organically rich soil. It takes about 45 days to prepare this rice straw compost which helps conserve nitrogen and other nutrients contained in the straw. Use of compost in agriculture may helps to improve crop yield by 4 to 9 per cent but the problem of making compost is also found to be labour-intensive. The problem with farmers is that they want quick solutions. That is why the rice straw compost was not adopted in Punjab and Haryana. Another use of rice straw is mulching. In this method, straw is spread across the soil surface and allowed to decompose naturally into the soil by the activity of worm and other organisms. But environment-friendly agriculture asks for extra effort and time. With farming becoming less remunerative, farmers are looking for easy and quick solutions. This is perhaps the reason burning of rice straw continues unabated.

5. To Make Paper and Card Board

Straw is a competitive, alternative source of fiber for paper making to reduce the pressures on forests. Rice straw can be used not only to make paper but various paper products (i.e., newsprint, copier paper, bond paper, etc.). A new chemical pulping technology could eliminate waste by turning rice straw into paper and provide a cheap insecticide to control mosquitoes. The best method extracts cellulose from the straw to make paper and natural phenolic materials and more than 65 per cent of the rice straw is converted into pulp for use in the paper and cardboard industry.

6. Packing Materials

The compaction resistance and resiliency of rice straw makes it a very good packing material. However, in many countries there has been a decrease in the use of natural products such as rice straw and an increase in the use of synthetic and manufactured materials. Increased cost of petroleum-based products is likely to reverse this trend.

7. Mixing with Plastics

A Chinese company has invented eco-friendly material - straw based plastic - made from rice and wheat stalks and can be used in 3D printing, without sacrificing price or performance. Company has developed a technology that can transfer crops straw into 3D printing material. The straw based plastic is made from dried crops straw, such as wheat straw, rice straw, corn stalk etc, mixed with plastic and plastic additives, using company's patent pending technology. The process started with shredding the straw to 1.5~2mm pieces. Then they mix the straw dust with polypropylene, adding silane coupling agent and ethylene bis (stearamide) as additives. The mixture is then extruded into granules using a twin screw extruder. After the transforming, the granules have even particle size and are more stable for further processing. The plastic granules can be heated up to 160˜180° C for injection moulding. Using special filament extruders the company has turned these plastic granules into filament for 3D printers. The 3D printed object created using the straw based filament has the color of natural wood, and the texture of plant fiber on the surface. It has also nice surface finish and high strength. Compared with traditional petroleum-based plastic, straw-based plastic has low production cost and fewer carbon emissions.

Other Uses for Rice Straw

Worm farming*:* ground rice straw can be used as a worm growing media. The most effective material is in the range of 1 to 3 millimeter (mm) particles produced by grinding through 3 mm screens.

Hydroseeding: defiberized rice straw can be used in hydroseeding (a process of planting in liquid solution along steep banks (i.e., roadsides, etc.) for erosion control.

Poultry litter: chopped straw litter can be used for poultry kept on a built-up litter system. The used litter has a useful fertilizer value or can be utilized as cattle feed.

Growing substrate: rice straw bales can be used for production of many crops such as cucumbers, tomatoes, and flower crops. The bales are soaked in water and impregnated with nitrogen in powder or other forms or with fertilizers.

Erosion control and soil stabilization: Rice straw is an effective material both in commercial erosion control practices and in rice field erosion control. Bales of rice straw can be shredded on site and blown into roadside cuts and fills to provide soil stabilization. Manual placing of the rice straw can also be practiced if the proper placement can be obtained. Rice straw used in hydroseeding activities also assists in erosion control and soil stabilization.

Frost control: *l*ayers of rice straw can be used for frost control in areas with low temperatures. These uses are usually closely allied with mulching and composting and it is difficult to determine which one of the practices is dominant.

Sewage sludge mixing: Rice straw would be a suitable bulking agent for sewage sludge composting and disposal. It would appear that chopped or fiberized straw would increase both absorbency and acceleration of decomposition.

Future Options

- Agriculture scientists should develop rice/wheat varieties with short length and fast degradable straw but having good yield for specific regions
- Farmers should be encouraged for diversification of crops
- Cost effective, environmental friendly and user friendly chemicals should be developed which can make the compost of rice/wheat stubble at a faster rate
- To design rice/wheat harvesters such that minimum residue is leftover in the field just like cutting manually
- Bales of rice straw can be used as mulch for reseeding and erosion control
- Rice straw can be used as the material in the construction of new non-concrete and environmental friendly homes. The bales of rice straw can be used as infill material in the walls of the structures where it provides excellent insulation and acoustical qualities. Straw bale houses, barns, community centers, and even commercial buildings are beginning to show up in many countries
- Future sound walls along highways could be constructed using stacked bales of straw covered with chicken wire and stucco. Whereas, concrete walls ricochet noise into the highway, a straw bale absorbs noise and is expected to match a concrete barrier in terms of noise insulation outside the highway. The use of straw bales is inexpensive, sustainable, nontoxic, and environmentally friendly. Also, the construction using straw bales is more cost effective than traditional materials.

Conclusion

In case of farmers in Punjab or Haryana the mindset and stature of the people involved in agriculture and having the excess produce of rice/wheat straw is almost same and burning of stubble is taken as an easiest and cost effective alternative. States like Punjab and Haryana can innovate in terms of either of the old and new technologies and can invite private players to set up facilities locally which could put stubble to better use. Any idea that does not provide a mechanism for transporting rice straw from the fields of farmers to the industrial units will face failure, even if it utilizes effective technology. In order for it to work, the method must provide added value to the farmers so that they stop burning rice straw in their fields.