

Review Article

Agrarian and Environmental Impacts of Stubble Burning

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ABSTRACT

Stubble is defined as short stalks and roots left in the field after the harvest of the stems and spikes of cereals like wheat, barley, rye, millet, maize and paddy. The stubbles constitute about 50- 75% of the total cereal biomass produced in a season. Post-harvest plant biomass, in other words, stubble is commonly burnt by the farmers, such a case is defined as stubble burning and it has several negative impacts on soil quality and fertility. Rapid and cost-free destruction, reduction of some weeds, pests and diseases, facilitation of soil tillage, time-saving in growing second crops and preparation of seedbed at low cost encourage farmers for stubble burning. However, stubble burning results in death of various living creatures, loss of organic matter in the soil, deterioration of soil structure, destruction of useful microorganisms, air pollution, fires, soil erosion and some health problems (asthma, bronchitis etc.). Instead of burning the cereal stubble which is an important feed source for livestock in barns, farmers should be encouraged to use stubbles as animal bedding, organic matter through incorporating them into the soils, as raw materials in pulp and paper industry and as a source of fuel.

Keywords

Stubble, organic matter, soil, micro organism

Introduction

Crop residue burning is a technique used by the farmers for the preparation of land for next cultivation. Through this technique the remaining of crops like straw which remains in the field as residue after harvesting is burned. It's an air pollution issue and concern for every one as this kind of practice by the farmers emits lots of harmful gases in the air. Crop residue burning practice is common in almost every states of India. Stubble burning is considered to be the cheapest methods for cleaning the field after harvesting. Though it's a cheap practice but its impact is hazardous in nature and the most important

concern for all is to stop such practice and to prevent air pollution. The smoke which is released from crop residue burning is a mixture of particles and chemicals produced by incomplete burning of carbon-containing materials and this is one of the reasons for many air born diseases like Asthma. All smoke contains carbon monoxide, carbon dioxide and particulate matter or soot which is very harmful. Even Section 19(5) of The Air (Prevention And Control Of Pollution) Act, 1981 states that "If the State Government after consultation with the State Board, is of opinion that the burning of any material (not being fuel) in any air pollution control area or part thereof may cause or is

likely to cause air pollution, it may, by notification in the Official Gazette, prohibit the burning of such material in such area or part thereof”.

India is the second highest producer of rice in the world after China. Generally there are three seasons for growing rice in India i.e. autumn Rice, Winter Rice, and summer rice. June to July is the sowing time for rice and harvesting time of it is November to December. The moment rice is harvest; the farmers have to prepare the land for next cultivation. After each harvesting, agriculture residues are produced. Million tons of agriculture residues are produced every year of which maximum percentage crop residues are produced by cereal crop like Rice, wheat etc. Now to get rid of this residue and to prepare the land for next cultivation farmers used to burn this crop residue which is known as *crop residues burning or stubble burning*.

Most of the farmers believed that stubble burning is a quick, easy and cheap method as by these methods all the unwanted husk will gets destroyed along with other unwanted grasses. Also many farmers believed that fire actually return the nutrients of the land which is a misconception or rather we can say lack of knowledge due to awareness and illiteracy. In practical, Burning of husk on ground actually destroys the nutrients value of the soil due to which soil become less fertile because the heat generated from the stubble burning penetrates into the soil, causing loss of the moisture, a useful microbe which in results affects the quality of the soil. Apart from this natural nutrients and bacteria which help in the rejuvenating of the soil were also destroyed. Not only this stubble burning also the reason for the loss of precious nutrients. Paddy straw is a major field-based residue that is produced in large amounts in Asia. In fact the total amount equaling 668 t could produce theoretically 187gallons of

bioethanol if the technology were available (Kim and Dale 2004). However, an increasing proportion of this paddy straw undergoes field burning. This waste of energy seems inapt, given the high fuel prices and the great demand for reducing greenhouse gas emissions as well as air pollution. As climate change is extensively recognized as a threat to development, there is a growing interest in alternative uses of field-based residues for energy applications.

Fire effects on soil biological activity

So far, very little information on the effects of fire on soil biological life is achieved. It has been reported that the fire gradually decreased soil organic matter and biological activity. One reason suggested for reducing the activity of micro-organisms, destroying them by fire. Add organic matter to the soil of the cultivation of plants and micro-organisms in the soil underneath again and areas of soils that have not been exposed to fire. Provided a food source for soil microbe's fire soil organic matter levels are severely reduced. Studies show that about 80% of plant residues by microbial oxidation process and the remaining 20% is converted into organic compounds joins. The cause of the microbial biomass production, or compounds that are easily degraded by microorganisms and increase soil biological activity.

When remains are cremated remains about 60% of the amount of its immediately (carbon monoxide) becomes and the remaining 40% of this amount, 32% will be added to the soil microbial processes and their breathing to become the 8% of the organic matter is converted. Carbon in the ash cannot exist as a food source for the microorganisms and act as a support for them. Thus, the activity of micro-organisms and population declines and soil biological processes are disrupted.

During a test plant debris and ashes from the burnt remains were added to pots containing loamy soil in the laboratory and field capacity for 10 days at 24 ° C and temperature were maintained at the end of the microorganisms was evaluated in pots. Add plant remains much more than adding ash was due to microbial activity. It must be said that the plant remains in the treatment of nitrogen were added to a large amount of nitrogen in the soil due to very high carbon to nitrogen ratio (C / N) was immobile, but the ash was added in the mixture of soil available nitrogen was more due to the lack of soil microbes use of ash as a source of food. Framed population declined as a result of micro-organisms and nitrogen rather than the plant was established by soil microbes.(Einalah Hesammi *et al.*, 2014)

Fire effects on crops

Almost all sources have reported that the next crop will increase the burning remains. Burning residue that remains of nutrients and need to be released directly in the biological cycle of the plant and rotting food shop and a significant increase in the next crop to be viewed. It should be noted that this term is due to the detrimental effects that this has on soil properties described in the previous discussion in time with the decrease of product due to the accumulation will face minerals, because of the product a temporary increase In the past, farmers have shifted to operate without being aware of the devastating effects of fire, but have little today to clarify the damaging effects of this action is by arable better successor. Effects of organic inputs over time on soil physical properties (soil aggregate stability, soil bulk density, water retention etc.) was reported by several authors (Zhang and Peng, 2006; Fuentes *et al.*, 2009). The organic products additions to the soil increase aggregate stability by a factor of 1.1-10.0, and this

increase is related to the decomposition dynamics of the inputs (Abiven *et al.*, 2009).

The effect of fire on soil properties

Structure, aggregation, mechanical strength and bulk density: Fire destroyed remnants of organic matter, and this directly affects the structure and soil granulation side effects. Due to the correlation between soils organic matter disappears and low soil pore spaces. Favorable soil aggregation fires (due to reduced organic material) and disappears over time traveling machine of soil is pressed. In addition, the decrease in organic matter, soil bulk density and soil porosity increase and decrease the side effects on the growth of plants and micro-organisms, because in these Terms of air conditioning and decreases the soil Gas Exchange. It also reduces the adhesion between soil particles causes the formation of large lumps during plowing tillage that they should do more to grind that is the subject of increased soil compaction and tillage.

Major pollutants emitted during crop residue burning and its source:(Singh *et al.*, 2008)

SPM Suspended particulate matter (PM100)

Incomplete combustion of in organic material, particle on burnt Soil

FPM fine particulate matter

Condensation after combustion of gases and incomplete combustion of organic matter

CO - Incomplete combustion of organic matter

NO₂, N₂O - Oxidation of N₂ in air at high temperature

O₃ -Secondary pollutant, form due to Nitrogen Oxide and Hydrocarbon

CH₄/Benzen

Incomplete combustion of organic matter

Different technologies to manage paddy crop residues and reducing stubble burning

Due to ever growing predicaments linked with crop residue burning in the north western states of India, several proposals and techniques have been developed for its appropriate handling in the past years by different agencies were as follow:

Collection of residues for off farm uses

In some parts of India straw reaper are in practice to collect the straw from the field and is only popular in wheat straw collection instead of rice because of its economical use for feeding animals. For removal and collection of straw after combine harvesting and using the residues for off farm works; straw baler machines is very promising technology and commercially available. These balers, however, recover

Only 25–30% of potential straw yield after combining, depending upon height of plant cut by combines. Baler makes rectangular or round bales by collecting the loose straw from the ground. Thus baler provides a solution for residue management in an environmental friendly way.

Crop residue retention on surface soil

Retention of crop residue on surface soil as mulch increases the least soil temperature in winter through reducing upward heat flux from soil and declines soil temperature during summer due to shading effect. Pathak *et al.*, stated that crop residues play a

significant role in betterment of soil acidity by releasing bases during the decomposition of crop residues with higher C: N, and improves soil alkalinity through application of residues from lower C:N crops such as legumes, oil seeds and pulses. Other benefits of retention of crop residues on soil surface includes lesser weed growth which saves weedicide cost, improves physico-chemical and biological properties of soils and recycling of plant nutrients for lowering fertilizer use in the next successive crops. Mulching with crop residue also increases infiltration, reduces formation of soil crust and runoff. Resource conservation technologies (RCTs) based farm machinery provides a better promise in managing paddy residues for improving soil health, productivity, reducing pollution and achieving sustainable agriculture (Palma *et al.*, 2014).

In-situ crop residue incorporation

In-situ residue in corporation has several positive impacts on soil health such as pH, organic carbon, infiltration rate and water holding capacity (Kumar *et al.*, 2015). It increases hydraulic conductivity, cation exchange capacity (CEC), and reduces bulk density of soil by modifying soil structure and aggregate stability, surface crust formation, water evaporation from the top few inches of soil and prevents leaching of nutrients. It also increases the microbial biomass and enhances activities of enzymes such as dehydrogenase and alkaline phosphatases. Sidhu *et al.*, reveal that soil incorporated 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.

Another study (Singh, 1992) reveals that, incorporation of paddy straw in soil immobilized native as well as added fertilizer N and about half of the immobilized N was

mineralized after 90 days of straw incorporation. Straw and N application alone or in combination increased biomass carbon, phosphates and respiratory activities of the soil. Microbial biomass carbon and phosphate activities were observed maximum at 30 days of straw decomposition. In field trials, incorporation of paddy straw 3 weeks before sowing of wheat significantly increased the wheat yield at Sonapat district in a clay loam soil while no such beneficial effect was observed in a sandy loam soil at Hissar (Singh, 1992).

Use of Rice Residue as Bedding Material for Cattle(Parmodkumar *et al.*, 2015)

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.

Alternative Uses of Crop Stubble

The crop stubble produced during the harvesting of rice and wheat crops can be used for various alternative uses if it is not burnt. These include use of crop stubble as fodder for animals, use of crop stubble for the

generation of electricity, use as input in the paper/pulp industry etc. The use of rice residue as fodder for animals is relatively low in Punjab as compared to the wheat stubble.

This is because the rice residue is high in silica content which in turn is not good for animal health. However, very often the crop stubble is treated with urea before it is fed to the animals. As per Badve (1991), treating crop residues with 4 % urea and 45–50 % moisture improves the nutritive value by increasing digestibility, palatability and crude protein content.

Suggestions and recommendations for future strategies

Following suggestions and recommendations are required to halt prevalent practices leading to pollution and wastage of potential resources.(Brijesh Kumar Yadav *et al.*, 2019)

Control of burning of crop residue to prevent environmental degradation and loss of soil nutrients and minerals by promotion of in-situ management(incorporation in soil, mulching, baling/binding for use as domestic/industrial fuel, fodder) of crop residue.

Diversified use of crop residue for various purposes like charcoal gasification, power generation, as industrial raw material for production of bio-ethanol, packing material, paper/board/panel industry, composting and mushroom cultivation etc.

Anticipation of assistance (seeds, fertilizers, pesticides, electricity, diesel etc.) provided to the farmers if they persist with the defaults.

Crop residues should be categorized as recycling/amendments i.e. lime or gypsum. Their use in agriculture field should draw subsidy like any other mineral fertilizers or amendments.

Endowment of higher subsidy rate to farmers who retain their residue in the field as crop residues are a supplement to chemical fertilizers.

Free electricity should not be provided as the same policy has led to installation of high powered tube wells that are responsible for over drawing of water from deep inside the earth.

During harvesting of paddy crop, the crop stem maybe cut from the root level itself. This practice would require a suitable reaper cum harvester should be developed with cost effective using indigenous techniques.

Use of high horse-power segment of tractor for deep cutting may be facilitated to small farmers on cooperative basis.

Crop residue burning is one among the many sources of air pollution. The on field impact of burning includes removal of a large portion of the organic material, denying the soil an opportunity to enhance its organic matter and incorporate important chemicals such as nitrogen and phosphorus, as well as, loss of useful micro flora and fauna. The off-field impacts are related to human health due to general air quality degradation resulting in aggravation of respiratory (like cough, asthma, bronchitis), eye and skin diseases. Fine particles also can aggravate chronic heart and lung diseases and have been linked to premature deaths in people already suffering from these diseases. The black soot generated during burning also results in poor visibility which could lead to increased road side incidences of accident. It is thus essential to mitigate impacts due to the burning of agricultural waste in the open fields and its consequent effects on soil, ambient air and living organisms. The long- term effects of this method will be discussed in more disadvantages than advantages, it is observed

that over time the quality of the soil, and consequently the growth of the crops will greatly reduce the irreparable damages Zest and biodiversity, it is desirable to hold workshops to promote and educate the farmers with the devastating effects of the operation, supplying equipment for residue management, proper management of pests and weeds training techniques to the farmers and familiar with the rest of management remains as mulch, straw and plowing remains, effective steps to reduce the burning residue removal. This method has been proved to have adverse effects on soil quality over time, damage to soil and plant Cause and effect is devastating and destructive effects far outweigh the positive effects.

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