

Crop residue management

An approach to transforming waste into health

Raghubar Sahu^{1*}, R K Sohane² and Rakesh Kumar²

¹Bihar Agricultural University, Krishi Vigyan Kendra, Banka 813 210, Bihar

²ICAR Research Complex for Eastern Region, Patna 800 014, Bihar

Sustainable agriculture and related industries are necessary to promote human prosperity since they directly or indirectly employ 82% of the world's workforce and provide the foundation of economies in many developed and developing countries. Reducing agriculture dependence on resources is one of the most crucial strategies for ensuring sustainable food production. Resource-saving farming practices are essential to a sustainable food production system. Input-intensive farming practices usually result in a major loss of soil nutrients and increased usage of modern heavy agricultural machinery such as combine harvesters and rotavators. In the rice-wheat system and in the Indian subcontinent, the usage of combine harvesters and seed-cum-fertilizer drills has increased significantly in recent years. Crop residue production increased linearly because of contemporary input intensive farming techniques. Farmers usually burn these crop residues on-site, which is harmful to the environment. Crop residue burning poses a serious risk to the health of people and the environment. Asia burns more than one-third of its entire biomass as in-situ agricultural residue, according to research. Furthermore, burning produces particulates like PM10/PM2.5 as well as GHGs, which add to pollution in atmosphere.

Keywords: Biochar production, Happy seeder, Rice straw baler, Waste decomposer

Crop residue management (CRM) is an established strategy for controlling various soil physical, chemical, and biological processes. The amount of nutrients integrated into the soil for crop production as well as soil water movement, runoff, and infiltration are all impacted by agricultural leftovers. Effective CRM is crucial to conservation agriculture (CA) and the only way to optimize benefits of CA is through *in situ* management. Yet, the decomposition of agricultural remnants has both positive and negative effects on crop productivity. Crop yields can be increased through combination of conservation strategies related to tillage i.e., residue decomposition, soil erosion control, nutrient recycling, as well as nutrient availability to crops, weed pest control, soil management with crop leftovers. To keep an agricultural

system productive and to enable the greater nutrient mobilization within system, annual cycling of plant nutrients is critical to the plant-soil ecology. It has developed a relationship between soil, air and water that dramatically affects plant growth by releasing various inorganic nutrient components. Furthermore, carbon high in crop wastes serve as the main food source for soil bacteria and offer a biological framework for nutrient cycling. During the microbial breakdown of crop wastes, several chemicals are released into soil where they can be efficiently utilized by plants and other living creatures. Physical, chemical, and biological properties in soil have a significant impact on the ability of crop residue to supply nutrients to plants. Integrated management with fertilization and the amount of crop residue

remaining available for integration in agricultural fields impact the degree of cycling and plant availability of nutrients from crop residues. To increase soil organic matter, it is important to manage crop leftovers for improved carbon absorption and to apply crop residues at right time and place, as well as to use N fertilizer as efficiently as possible. In current article, we have concentrated on various aspects of crop residue management, including the influence of residues, use of natural resources, and strategies that can be developed for better residue management in farming systems, all of which are closely related to the current environmental aspects.

Biochar production

An important contributor to climate change is rise in atmospheric carbon dioxide which results from

burning of paddy straw and other anthropogenic and natural causes. Climate change is expected to cause a variety of environmental problems, including rising temperatures, a rise in the frequency of extreme weather events, rising sea levels, and the emergence of deserts. Global attempts have been made to capture and store carbon to reduce climate change. Creation of biochar has been hailed as a viable method for storing carbon with numerous advantages for waste management, energy generation, and soil physical, chemical and biological quality enhancement. Biochar is a solid, C-rich outcome of heating biomass in the absence of oxygen at temperatures from 500 to 700°C (pyrolysis). Producing biochar changes labile biomass into a refractory form, which allows it to store C-for a long time i.e. hundreds to thousands of years. To increase soil ability to support agricultural production, biochar is often added after production. Using biochar to immobilize the pollutants in contaminated soil may also be beneficial. Organic and inorganic pollutants produced by anthropogenic activities such as garbage disposal, mining, oil drilling and chemical processing, pose dangers to human health because they can travel through waterways (such as rivers and groundwater). The use of biochar in soil remediation has the following positive effects on the environment:

- Agricultural, industrial, and domestic wastes (food scraps, manure, crop residue) used as feedstock to make biochar, and reuse of this waste result in biochar reduced C-footprint.
- Energy required to generate biochar can be mitigated by co-products from pyrolysis as green energy.
- Improve soil resilience, water holding capacity, nutrient retention, assisting in revegetation of contaminated land or greening.
- Biochar can remain in soil for hundreds to thousands of years due to its refractory carbon content, thereby removing it

from the carbon cycle.

- Potential for making biochar from rice straw is enormous. Threat of climate change brought on by GHG emissions in atmosphere is also lessened by C-sequestration in use of biochar.
- Biochar usage as soil amendment reduces GHG emissions than fossil fuel use that it replaces.
- Use of biochar in soil rehabilitation is considered as a sustainable/environmental friendly method.



Biochar production unit at KVK, Banka



Produced biochar from unit

Mushroom production

Growing mushrooms is lucrative agricultural venture that yields food from rice and wheat straw, and makes it easier to properly dispose of this byproduct in an environmentally acceptable way. Because of its quick 14-day incubation period, paddy straw mushroom is regarded as one of easiest mushrooms to grow. 5–10% of mushroom products can be produced using rice straw (50–100 kg of mushroom/tonne of dried straw). Alternatively, growing oyster mushrooms provides farm-based solution for bio-converting poor-quality straw into nutritious food items.



Water treatment for mushroom production



Bagging of oyster mushroom at Uprama, Banka

Happy seeder

Following combine harvesting, standing stubbles, which are typically 30 to 60 cm high, along with a sizable amount of loose straw stacked in windrows approximately 1 m wide make up rice residues. Loose leftovers obstruct tillage and sowing activities for wheat and other crops in next crop. After partial burning of rice residue, incorporation required more than >4-5 tillage operations, whereas after total burning, only ~25% of soil needed more than five tillage operations. There is a cost associated with delaying sowing of wheat and other crops until conventional tillage and stubble integration are finished, in addition to direct cost of cultivation with these methods. This delay is caused by time needed to prepare field as well as requirement to postpone sowing for a few weeks following incorporation to prevent issues with nitrogen tie-up by recently introduced straw. Wheat yields are significantly reduced by 1–1.5% every day if sowing date is postponed past the ideal time. Happy Seeder is a no-till planter that is driven by a tractor that sows seeds directly into rows without first preparing seedbed. It has a three-point linkage connection and is driven by tractor's PTO. It has a straw-managing cutter and a zero tillage drill that enable new crops to be sown in the leftovers of previous

crops. Straw management rotor is equipped with straight blades of flail type that are used to chop stubbles that come in touch with sowing tine. It scatters crop leftovers as mulch across the field that has been sown. In North India, it is primarily used to sow wheat after paddy harvest that enhances soil microclimate, protects soil moisture by reducing evaporation/increasing filtration. It controls temperature and helps to reduce heat/radiation extremes. As a result, rate at which organic matter decomposes and consequent loss of carbon is slowed.



Happy seeder machine at Uprama village



Wheat (HD-2967) sown by Happy Seeder machine

Happy seeder machine sows the seed without disturbance of rice residue present in the field that is selected for sowing. This technology is environmentally benign since it protects soil health, conserves water, eliminates the need to burn rice stubble before planting wheat, and lowers air pollution. Direct planting also lessens soil disturbance, allowing it to hold onto more organic matter, nutrients, and moisture saves money because field operations take less time to complete, which lowers the cost of labour and fuel.

Waste decomposer

Waste decomposer is used as a plant protection agent, to improve

health of soil, and to compost organic waste quickly. It is a collection of microorganisms that were isolated from cow dung in India. Within 21 days of application, waste decomposer affects biological/physical characteristics of all types of soil (acidic and alkaline), and in just six months, it helps to increase the population of earthworms in the soil to up to 4 lakhs in one acre of land. Take 2 kg of jaggery and mix it with 200 liters of water in a plastic storage container. Now take 1 waste decomposer vial and empty its entire contents into the plastic jaggery drum. To ensure that waste decomposer is distributed evenly in drum, stir it properly with a wooden stick. Every day, once or twice, cover drum with a piece of paper or cardboard and stir it. Drum solution becomes creamy after five days. Farmers could use above created solution to repeatedly prepare waste decomposer solution. This solution can be constantly prepared from this waste decomposer for life time by adding 20 liters of waste decomposer solution to a drum along with 2 kg of jaggery and 20 liters of water.

Rice straw baler

Throughout rice straw supply chain, collecting rice straw continues to be a significant challenge. Bundles of rice straw need to be compacted into bales after being collected from field in order to lower cost of transportation. Rice straw collection has gotten tougher and more expensive with introduction of combine harvesters, which often leave rice straw on field. Three primary steps in collection of rice straw are collecting up raw materials, compacting them into



Production of waste decomposer at KVK, Banka

bales, transporting them to storage or processing place. A gathering device known as a baler serves as the primary compacting unit in these operations (baling). Other two processes, gathering up straw and carrying baled material, can be added to a baler depending on operating conditions and objectives.



Spraying of waste decomper on crop residue

With a stationary baler that only has a compaction machine; straw that paddy threshers have rejected can be collected efficiently. On the other hand, a mobile baler can be used to gather rice straw that combine harvesters leave in the field (which can be either self-propelled or pulled by a tractor). Compacting unit operating mechanism distinguishes two primary categories of balers. Roller-type is used to create round bales, while piston-type is used to create square bales. Research revealed that collection devices has an operational capacity of 0.87 to 2.47 tonne/hr. At a moisture level of 12%, straw bales that balers collected had a specific weight of 73–104 kg per cubic meter. Total energy used to convey one tonne of straw to field bund varied from 351 to 588 MJ per tonne of straw gathered. This energy use resulted in GHGE of 60 to 165 kg carbon dioxide equivalent. Amount of digestible energy and vital nutrients in raw, supplemented rice straw is insufficient for developing cattle. In comparison to leaves, which have greater silica content and are thought to be poor fodder for animals, stems of rice straw are more digestible. The rice harvest should be cut as close to the ground as possible if straw is to be given to cattle. As urea is safer and easier to use than anhydrous or aqueous ammonia,



Bale making at Village-Lilatari, Banka



Bale Making at KVK, Banka

rice straw is routinely treated with it for nitrogen amendment. Urea turns into a source of nitrogen (also known as crude protein), which rice straw lacks. Rice straw can also be treated with sodium hydroxide and ammonia to increase the cellulose's digestibility.

Way forward

Crop wastes are important resources because they improve the quality of the soil, water, and air. They also provide nutrients to succeeding crops, boosting agricultural output. Effective techniques for CRM require a thorough understanding of the factors influencing residue decomposition and their deliberate use within a specific crop

production system. By preserving and managing crop wastes, crop production can benefit society more than just a few farmers financially. Better residue management, reduced tillage methods, and increased soil production are all beneficial and ought to be encouraged. Carbon sequestration in soil helps to achieve these benefits and can also greatly lessen the effects of global warming.

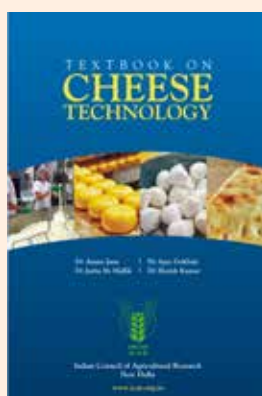
SUMMARY

Crop residue management techniques based on conservation agriculture are becoming a crucial tool for preserving SOM levels, boosting soil productivity, and increasing crop yield. Two major advantages of surface-residue

management, are enhanced nitrogen cycling and retention, and increased SOM in soil surface. A rise in biomass and microbial activity at the soil's surface stores nutrients necessary for crop growth and enhances structural stability to permit greater infiltration. Along with changing nutrient distribution throughout the soil profile, changes occur to the chemical and physical properties of the soil. One doable way to lessen environmental impact is to combine enhanced CRM with increased carbon sequestration in soil.

*Corresponding author email: raghubar.bhu@gmail.com

TEXTBOOK ON CHEESE TECHNOLOGY



"Textbook on Cheese Technology" is an excellent compilation of the basics of cheese technology, incorporating the advances that are taking place in the modern cheese industry in order to tackle issues such as cheese manufacturing, quality, mechanization, safety, cost, environment etc.

This textbook is written with a view to cater to the evolving needs of the rapidly growing cheese industry and highly suited for the Dairy and Food Science Colleges of the globe.

TECHNICAL ASPECTS

Pages: v + 369; Price: ₹ 600.00, US\$ 90.00; Postage: ₹50
ISBN No.: 978-81-7164-273-1

For obtaining copies, please contact:

Business Unit

ICAR-Directorate of Knowledge Management in Agriculture
Krishi Anusandhan Bhawan – I, Pusa, New Delhi 110012
Tel: 011-25843657; email: bmicar@icar.org.in, businessuniticar@gmail.com
website: www.icar.gov.in

SCAN QR Code to
Purchase Online

