

## **Crop Residue Management in Small Holding Farming Sector of Bihar – Its Importance and Challenges**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors BS and SS designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors DKV, MS and VBJ managed the analyses of the study. Authors TD and HO managed the literature searches. All authors read and approved the final manuscript.*

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## **ABSTRACT**

The current study paper investigates the importance and challenges of crop residue management in small holding farming sector of Bihar, India. The study covers the trends of crop system, crop cultivation patterns, after cultivation residue management systems applied, participation of small holding agriculture farms in crop residue management and challenges and future options for crop residue management including information needs. This study was focused on the management of crop residues because of their importance as ruminant livestock feeds and their role in natural resources management.

**Keywords:** *Crop residue management; Small holding agricultural farms; Burning; Bihar; India.*

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## 1. INTRODUCTION

Bihar is an agrarian state in Indian subcontinent. Small holding farming sector occupies about 70% of the total farming communities dependent directly or indirectly in agriculture. Smallholder farming systems are perceived to share certain characteristics which differentiate them from large-scale, profit-driven enterprises. These include: limited access to land, financial capital and inputs, high levels of vulnerability and low market participation [1,2]. The development of more efficient and effective residue management systems in the state for soil, water, and energy conservation is a matter of utmost national importance. Some regions in the country produce an abundance of crop residues, far in excess of that required to control erosion and maintain good soil tilth. However, in some regions, particularly in the intensively cultivated areas and with some crops, insufficient amounts of residues are produced for adequate soil protection. Crop residues are highly essential in most areas for protecting agricultural soils from erosion and loss of plant nutrients. Recent estimates of the amount of crop residues in Bangladesh that could be harvested for biomass energy conversion without negatively impacting future crop yields amount to 50% of all rice crop residues and 80% of non-rice crop residues [3,4]. Where limited quantities exist careful management methods must be devised to achieve maximum effectiveness of residues for conservation purposes. Conservation agriculture (CA) is promoted as a cropping system that has potential to alleviate poor crop yields in smallholder farming while protecting the environment. It involves maintenance of permanent soil cover, diverse crop rotations and/or interactions; and minimum soil disturbance [5].

Smallholder crop yields have remained low in Bihar and their increase has been very slow and this has been attributed to the detrimental effects of traditional ways of farming [5]. Traditional (conventional) farming involves the inversion of the soil using the mouldboard plough and this has led to enormous soil losses from arable lands hence, leading to low crop yields [6]. CA as defined by FAO (2002), is a cropping system that is based on three principles which are minimum soil disturbance, maintenance of a permanent soil cover by the use of crop residues and cover crops; and diverse plant associations (which include crop rotations). In the Indo-Gangetic Plains, principal cropping system

is rice-wheat which occupies approximately 15.8 M ha area in SSARC countries, India (12.3 M ha), Pakistan (2.2 M ha), Bangladesh (0.8 M ha), and Nepal (0.5 M ha) [7].

### 1.1 Potential Uses of Crop Residues in Agriculture

The potential uses of crop residues vary depending upon the availability of crop residues in different parts of the country as well as available technologies for utilization of such residues. Traditionally crop residues have numerous competing uses such as animal feed, fodder, fuel, roof thatching, packaging and composting [8]. The residues of cereal crops are mainly used as cattle feed. Rice straw and husk are used as domestic fuel or in boilers for parboiling rice. Farmers use crop residues either themselves or sell it to landless households or intermediaries, who further sell them to industries. The remaining residues are left unused or burnt on-farm. In states like Punjab and Haryana, where crop residues of rice are not used as cattle feed, a large amount is burnt on-farm. Sugarcane tops are either used for feeding of dairy animals or burnt on-farm for growing a ratoon crop in most parts of the country. Residues of groundnut are burnt as fuel in brick kilns and lime kilns. The residues of cotton, chilli, pulses and oilseed crops are mainly used as fuel for household needs. The shells of coconut, stalks of rapeseed and mustard, pigeon pea and jute and mesta, and sunflower are used as domestic fuel. Addition of crop residues helps in soil nutrient balances as a result of the various nutrient flows of a farming system.

### 1.2 Management Options for Crop Residues

Crop residues are retained to the soil to achieve permanent soil cover which in-turn gives benefits to the farmer. Thierfelder and Wall [9] described the retention of crop residues as the key drive in the positive realisation of the benefits of CA. Crop residues on the soil surface reduce direct raindrop impact on the soil hence reducing soil erosion [10,11]. With the advent of mechanized harvesting, farmers have been burning *in situ* large quantities of crop residues left in the field. As crop residues interfere with tillage and seeding operations for the next crop, farmers often prefer to burn the residue *in situ*, causing loss of nutrients and organic matter in the soil. Unlike removal or burning, incorporation of straw



**Fig. 1. Burning of rice residues, a prevalent practice in northwest India**

builds up soil organic matter, soil N, and increases the total and available P and K contents of the soil.

Crop residues are good sources of plant nutrients and are important components for the stability of agricultural ecosystems. About 400 million tons of crop residues are produced in India alone. In areas where mechanical harvesting is practiced, a large quantity of crop residues are left in the field, which can be recycled for nutrient supply. About 25% of nitrogen (N) and phosphorus (P), 50% of sulfur (S), and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources.

Both rice and wheat are exhaustive feeders, and the double cropping system is heavily depleting the soil of its nutrient content. A rice-wheat sequence that yields 7 tons per ha of rice and 4 tons per ha of wheat removes more than 300 kg N, 30 kg P, and 300 kg K per ha from the soil [12].

Management of rice straw, rather than wheat straw is a serious problem, because there is very little turn-around time between rice harvest and wheat sowing and due to the lack of proper technology for recycling. Among options available to farmers for the CRM (including burning), important are baling/removal for use as feed and bedding for animals, *in situ* incorporation in the soil with tillage, and complete/partial retention on the surface as

mulch using zero or reduced tillage systems. After baling CRs can also be used for paper and ethanol production, bioconversion, and engineering applications. Since rice straw has no economic value and there is a scarcity of labour, farmers hesitate to invest in cleaning the field by using a chopper. This practice also requires another operation and increases cost. Farmers of different parts of India have chosen burning as the cheapest and easiest way of removing large remnants of residues produced during harvesting of rice to sow the next crop just after rice. Therefore, farmers forces and used to burn the rice straw immediately, particularly where intensive cropping is practised by smallholder farmers in Kosi region of Bihar as well as in different parts of the country.

## **2. CONCLUSION**

The crop residues in excess of carefully determined recycling requirements can make a major difference at both the local and regional levels in producing high-quality animal and fungal protein or fiber. As crop residues have multiple functions in the soil, affecting directly and indirectly diverse ecosystem services, investments in research to better understand the impact associated with residue management are essential to define strategies for the industrial use of this raw material. A proper education and information system regarding the side effects of burning the crop residues and the scientific utilization, management of crop residues is strongly recommended.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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