Chronicle of Bioresource Management 2021, 5(2):069-076

Chronicle of Bioresource Management
An International E-magazine

June 2021 *Popular Article*

Open Access

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Citation: Jagadeeshwar et al., 2021. Role of Mechanization in Crop Residue Management in Telangana. Chronicle of Bioresource Management 5(2), 069-076.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

Keywords:
Burning, crop residues, multi crop shredder, rotary mulcher

Article History
Article ID: CBM70
Received on 27th June 2021
Received in revised form on 29th June 2021
Accepted in final form on 30th June 2021

Role of Mechanization in Crop Residue Management in Telangana

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Abstract

Huge quantity of crop residues are generated every season in India. Further, considerable amount of it is being burnt by farmers to make way for planting subsequent crops. But, it is causing environmental pollution and emitting green house gases besides loss of soil health and quality. Among many ways, mechanization was found effective in managing the residues. With the advent of various machinery for harvesting and threshing, cutting and incorporation of left over stubbles in the soil, residue management has gained momentum. Further, surplus residues can be utilized for cattle feed, soil health improvement, compost making, power generation, biofuel production and in various industries. Mechanized crop residue management plays a greater role in improving soil health in case of organic farming based crop production. In this article, we have given an overview of role of mechanization in crop residue management.

1. Introduction

Agriculture produces large quantity of crop residues every year. Crop residues refer to remnants of various crops devoid of economic product. These are obtained after harvesting the seed, pod, kapas, cane etc., According to reports of TIFAC (2018), approximately 683 million tonnes (MT) of crop residues of various crops are generated annually in India. Majority of these residues are utilized for fodder/ feed, fuel and for industrial purposes. Of this, 178 MT of crop residue is available as surplus in the country. However, about 84-141 MT of crop residue covering cereals (58%), fibres (23%), sugarcane, pulses, oilseeds and others (19%) is subjected to burning for various reasons. Similarly, in Telangana, it is estimated that nearly 291.5 lakh tonnes of crop residue is being generated annually. Of which, 92.3% (268.9 lakh tonnes) is contributed by three major crops *viz.*, rice (161.0 lakh tonnes), cotton (65.4 lakh tonnes) and maize (42.5 lakh tonnes). The remnants (straw/stubbles/haulms/pod hulls) of rice, jowar, maize, groundnut and soybean are used primarily for cattle feed. In case of cotton, small ruminants are allowed to feed on left over leaves and bolls. Further, rice, cotton and pigeonpea

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residue are burnt by the farmers. Approximately, 30-40% of rice and 90-95% of cotton residues are being burnt in Telangana. In case of pigeonpea, stalks may be used for firewood, thatching or burnt and pod hulls for feeding cattle, sheep and goat.

Different types of crop residue generated in principal crops grown in Telangana are detailed below in Table 1.

Table 1: Details of major crops and types of crop residue in Telangana

Sl. No.	Crop	Area (lakh ha)*	Type of residue	Expected crop residue (Lakh tonnes)
1	Rice	32.20	Straw and husk	161.0
2	Cotton	21.78	Stalks, leaves, locules	65.4
3	Maize	6.54	Stover, Cob husk and shank	42.5
4	Groundnut	1.05	Haulms and pod shells	3.1
5	Soybean	1.71	Straw/stubble and pod shells	3.6
6	Sugarcane	0.25	Trash (leaves) and bagasse	2.0
7	Sorghum	0.90	Stover	2.5
8	Castor	0.26	Stalks, leaves, capsule shells	0.7
9	Chickpea	1.32	Straw	3.2
10	Greengram	0.66	Stalks and leaves	1.2
11	Blackgram	0.22	Stalks and leaves	0.2
12	Pigeonpea	2.96	Stalks and leaves	5.8
13	Sesame	0.21	Stalks and leaves	0.2
14	Safflower	0.01	Stalks and leaves	0.0
15	Sunflower	0.04	Stalks and leaves	0.1
15	Others	0.19	Stalks/straw/leaves	0.0
	Total	70.3		291.5

*2019-20 (actual area of field crops only)

2. Reasons for Burning

➢ Farmers find it an easy way to burn the crop residues to clear off the field quickly inorder to take up succeeding crop due to short turn-around time between harvesting of preceding crop (s) and sowing of subsequent crop (s).

➢ Proper decomposition of stubbles/straw of rice, maize and cotton incorporated *insitu* takes more time i.e. 2-3 months due to which farmers loose optimum sowing window

➢ Some of the residues are resistant to microbial attack due to it's wider C/N ratio (70-100:1)

➢ If left unattended, the residue may be attacked by termites or whitefly (castor) or blown away by wind. In case of cotton, pink bollworm may perpetuate. Unattended stalks may interfere with agronomic operations in the subsequent crop.

3. Problems with Residue Burning

➢ Collection and burning of crop residue leads to environmental pollution, emits hazardous pollutants and greenhouse gases like CO, CO_2, NOx, SOx, NH_3 and volatile organic compounds (VOCs). It affects air quality and visibility in the urban areas because of already existing pollutants due to vehicular and industrial pollution. Finally, it leads to global warming and climate change (IARI, 2012).

➢ Burning of crop residues releases about 627 kilo tonnes (Kt) of PM-10 and 4677 Kt of carbon monoxide into the atmosphere annually in India (TERI, 2019).

➢ Causes enormous effect on air quality, disruption in transportation, visibility, breathing problems for the public

➢ Further, burning stalks/straw/stubble leads to loss of valuable soil organic matter and nutrients and deterioration of soil fertility. It also leads to reduction in N and C level in the top 0-15 cm of soil profile. Thus, it affects crop productivity in the long run.

➢ Heat generated due to burning kills beneficial soil micro-organisms and eco-friendly insects

Hence, there is a dire need to manage the crop residue in a proper way to avoid ill effects of residue burning through proper policy and scientific methods.

4. Residue Management in Rice

4.1. Residue management in rice

Rice-rice is the predominant cropping system under assured irrigated conditions in Telangana. It is followed by rice-maize.

Kharif rice is generally planted during July-August depending on the duration of variety, progress of the monsoon and irrigation water availability in borewells/

tanks/canals. The crop is harvested during November. On the contrary to the yesteryears, most of the rice area in Telangana is harvested with paddy combiners which leaves the rice straw of one ft height unattended and shred rest of the straw in the field scattered. Farmers choose various options to manage this residue (Figure 1)

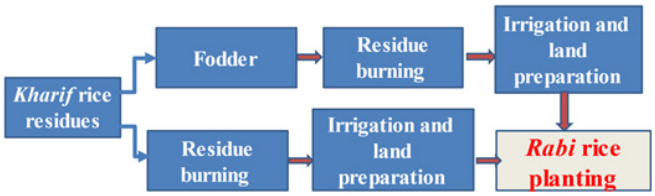

Figure 1: Farmers preferred options for manging rice crops residues

1. Collection, heaping and using for cattle feed by those having livestock and then burning the remnants followed by watering for tilling the land for taking up subsequent crop(s)

2. Collection, heaping and burning by those farmers who don't have livestock or don't need in any manner and then watering for tilling the land for taking up subsequent crop(s)

The turn around time between harvesting of *kharif* rice and sowing/planting of subsequent *rabi* crop (s) is hardly 10-15 days (ID crops) to 30 days (rice). This problem is acute for *kharif* rice than that of *rabi* rice (Figure 2).

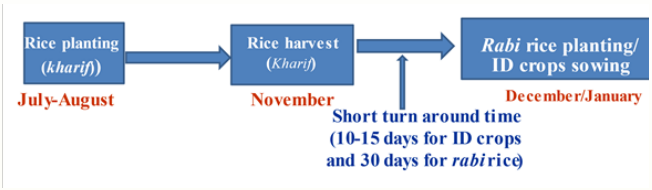

Figure 2: Short turn-around time between *kharif* rice harvest and *rabi* rice planting

Hence, managing the residue in such a short time is difficult. So, farmers are burning the same to clear off the field quickly. But, burning one tonne of rice straw leads to loss of 5.5 kg Nitrogen, 2.3 kg phosphorus, 25 kg potassium and 1.2 kg sulphur besides, organic carbon (NPMCR, 2014). It also releases 60 kg Carbon monoxide, 1460 kg Carbon dioxide, 199 kg ash and 2 kg Sulphur dioxide (Gupta et al., 2004).

Options to manage residue without burning

1. Baling the straw using tractor drawn baler and using it for cattle feed or for industrial purposes

2. Application of SSP and (or) microbial consortia for quick decomposition of straw *insitu*in 15-20 days timeand then planting rice in *rabi*

3. Running Happy seeder (without disturbing the straw in the field) for sowing ID crops in *rabi* season. Zero-till seed-cum-fertilizer drill/planters such as Happy Seeder, Turbo Seeder and rotary-disc drill or Happy seeder+super SMSmachines,can be used for direct drilling of seeds even in the presence of surface residues. Further, moisture and nutrients are conserved besides controlling weeds.

Rice straw baling machine

Baling of rice straw

Super SMS with Existing Combines

Sowing with Happy Seeder

4.2. Residue management in cotton

The regular practice of collection and burning cotton stubbles can be done away by running rotavator or slasher or multi crop shredder. Of all,

multi crop shredder was proved to be the best as it cuts cotton stubble and unopened bolls into tiny pieces and shred in the field. Thus, it add

✓ A crop yielding 2.0 t stalks/ha can turn back approximately 12.4-20.0 kg N, 1.6 kg P_2O_5 and 12.2-13.6 kg K_2O ha^{-1} to the soil (Ramanjaneyulu et al., 2021)
✓ Improve soil fertility and water holding capacity upon incorporation
✓ Enhances microbial activity and organic matter content
✓ Controls hibernating cotton pink boll worm
✓ Shredder also helps in collecting the chaffed stalks into a trolley and can be transported to another agricultural field for soil improvement, used as a mulch or for the manufacture of particle boards, in preparation of pulp and paper, hard boards, corrugated boards and boxes, micro-crystalline cellulose and for growing edible mushroom or in biofuel programmes

Running shredder/shredder cum mulcher is cost effective as it can save Rs. 1875 ha^{-1}as compared to manual cutting and burning of cotton stalks (Rs. 4375 ha^{-1}) (Ramanjaneyulu et al., 2021)

Multi crop shredder in Cotton

4.3. Residue management in Pigeonpea

Traditionally, Pigeonpea is harvested and threshed manually. The left over stalks are used for thatch purpose or as fire wood or burnt. The pod covers are rich in nutrients and are generally fed to cattle, sheep, goat etc., However, now a days, with the successful introduction of combiners, machine harvesting of Pigeonpea is gaining momentum. In this method, pod covers and stubbles are left in the field. These can be incorporated *insitu* in the field with rotavator or rotary mulcher instead of burning the same.

Mechanical harvesting of PigeonpeaPigeonpea stalks

4.4. Residue management in maize/jowar/groundnut

The residue of jowar, maize and groundnut crops is mostly used as fodder for cattle. Hence, residue management in these crops is not a problem.

If maize is harvested and threshed by using maize harvester, residue will be retained in the soil.

If maize cobs and jowar earheads are harvested and threshed manually and when there is no demand for cattle feed, rotavator or shrub master (slasher) or rotary mulcher or multi crop shredder can be run to cut the stover into pieces and shred in the field. It will add organic matter and enrich soil fertility upon decomposition.

Maize harvester

Multi crop shredder

Rotary mulcher

4.5. Residue management in soybean, safflower and chickpea

➢ Most of the soybean, safflower and chickpea cropped area is machine harvested, hence, the straw/stubble is automatically shred on the field surface. It can be further incorporated *insitu* by running rotavator

➢ In case of manual harvesting and threshing of soybean, the left over residue is fed to cattle

➢ In few areas, chickpea is harvested manually but threshed by machines in which case, the generated residue will be used as fuel. It has great demand in hotels in urban and peri urban areas and is being purchased @ Rs. 1500/ha residue

Mechanical harvesting of Safflower

Mechanical harvesting of Chickpea

Mechanical harvesting of Soybean

Mechanical harvesting of Soybean

4.6. Residue management in sugarcane

With the introduction of mechanized harvesting of sugarcane, the trash/residue is left on the field. The same can be incorporated *insitu* in the field. It can also be used as mulch in the ratoon crop for conserving soil moisture and controlling weeds.

Sugarcane harvester

Sugarcane harvester

Sugarcane Trash shredder

Sugarcane Ratoon manager

Trash mulching in Sugarcane

Sugarcane disc off-barrier

4.7. Residue management in castor

Castor is generally harvested manually in Telangana. After harvesting of spikes, it may be shelled manually by beating with sticks or subjected to mechanical shellers. The capsule remnants are generally thrown away by farmers. But, they can be applied to back to the soil for enriching soil fertility. Further, the left over castor stubbles in the field are generally uprooted, collected, heaped and burnt. Instead, rotavator or slasher or rotary mulcher can be run in the field in order to lodge and shred them in the field. It will add organic matter upon decomposition.

Mechanical shelling of castor

4.8. Residue management in sesame, greengram and blackgram

Sesame, greengram and blackgram are generally harvested and threshed manually for getting seed. The residues *viz.*, stalks, leaves and pod covers are the main residues in these crops which are generally thrown or burnt by the farmers. Instead, they can be applied back to the soil to improve the soil fertility.

5. Diversified Uses of Crop Residues

Crop residues can be used for various purposes such as

- Cattle feed
- Soil improvement
- Charcoal gasification
- Power generation
- As industrial raw material for production of bio-ethanol, packing material, paper/board/panel industry
- Mushroom cultivation
- Biofuel
- Biochar
- Composting and utilization in organic farming (Activated compost, ADCO compost

NADEP compost, Vermicompost, Microbial compost (microbial consortia/waste decomposer/pusa decomposer)

6. Models for Effective Utilization of Crop Residue at Village Level

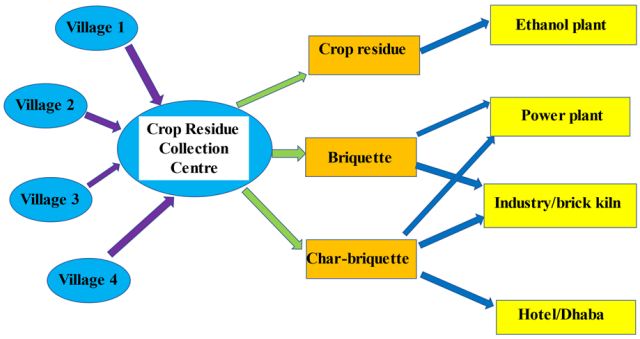

Figure 3: Village level exsitucrop residue management model (Datta et al., 2020)

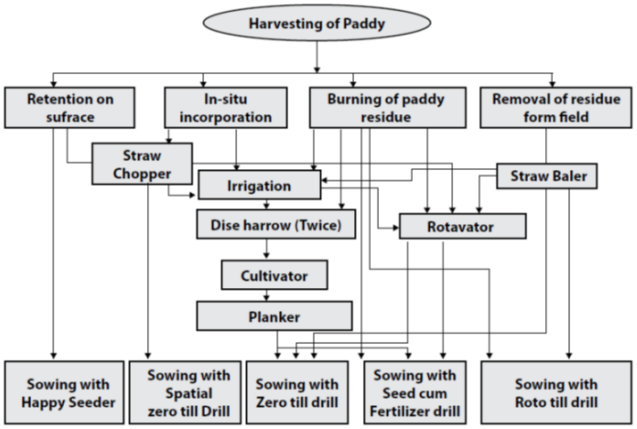

Figure 4: Rice crop residue management model (Lohan et al., 2018)

7. Law and Legislation

Section 9 sub-section of the Air (Prevention and Control) Pollution Act (1981)

- Burning of any material which is not fuel and likely to cause air pollution should be prohibited.

Chapter 3 section 7 of the Environmental Protection Act (1986)

➢ Prohibits any person to carry out activities that emit environmental pollutants in the excess of the prescribed national standard.

Environmental Protection Act (1986)

➢ Any person found to violate the act shall be deemed guilty (section 16). however, the manner of exercise of power has not been framed.

➢ The government invokes *section 144 of the civil procedure code (cpc)* to ban the burning of paddy, which is hardly implemented and little effort is made to sensitize the farmers on the same.

➢ Since agriculture falls under state subject, the state government may identify an agency or authority to implement such an order to abate, prevent and ban the practice of crop residue burning

Others

➢ The National Green Tribunal (NGT) has given directives to states for curbing burning the crop residue through recycling initiatives and awareness among the people

➢ Few states imposed fines ranging from Rs. 2500 to 15000 on farmers burning the residue

8. Conclusion

Crop residue burning continues to be a major challenge in India in general in Telangana in particular. The success stories in Punjab and Haryana must be replicated in Telangana too by upscaling and outscaling mechanization for various agronomic operations including residue management helps to control burning to a larger extent. This method further augments restoration of soil fertility and carbon sequestration. Efforts must be made to utilize crop residues for vermicompost preparation, which inturn can be utilized for Agricultural or horticultural crops.

9. Future Strategies

➢ Technology development (Conservation Agriculture, Quick decomposition methods)

➢ Establishment and organization village level Custom hiring centres for improving accessibility to machines

➢ Promoting mechanization for *insitu* incorporation or managing the residue and creation of awareness through

• Capacity building about ill effects of crop residue burning and its effective utilization and management

• Formulation and implementation of suitable law and legislative/policy measures to curb residue burning

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