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Rice Residue Management Options in Rice-Wheat Cropping System

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Rising pollution levels and low visibility during the winter months in north-western India have attracted the attention of all researchers as well as the government. The reason for this was the burning of paddy straw in large areas of Punjab, Haryana and Uttar Pradesh. Rice residue is produced at the rate of 6-8 tonnes ha^{-1} and its management in an efficient in-situ manner is very important, not only for reduction in pollution levels, but also for improvement in wheat productivity. Stubble burning increases the level of CO_2, CO and NO in the air by about 70, 7 and 2.1 percent respectively, causing heart and respiratory problems to humans.

Crop residues are those parts of the plant that are left in the field after harvesting and threshing or pasture grazing. Crop residues are sometimes treated as waste material that needs to be disposed of. But, now the scenario has changed and the work of the researchers has shown immense potential of residues to improve productivity and soil health. The rice-wheat cropping system is the predominant and also the most nutrient-exhausting cropping system in the Indo-Gangetic plains (IGP). Maximum amount of residue in India is produced from the rice-wheat cropping system. Highest crop residue is generated in Uttar pradesh followed by Punjab and West Bengal. Nearly about 80% of rice straw produced is being burnt annually in just 3 to 4 weeks during October-November in between the rice harvest and wheat sowing. Farmers generally prefer the practice of burning rice crop residues in their fields after combine harvesting due to mechanized agriculture, scarcity of labor for manual harvesting, short sowing window available after rice harvest, timeliness in operation and clearing of field and; control of weeds/pests in residues.

Consequences of crop productivity

- ✓ Global warming
- ✓ Loss of plant nutrients
- ✓ Loss of soil flora and fauna
- ✓ Carbon loss
- ✓ Health hazards to human, animals and birds
- ✓ Release of soot particles causing smog
- ✓ Emission of greenhouse gases (GHGs)

Management and utilization options for rice straw

Crop residue management options are evaluated on basis of productivity, profitability, environmental impact and sustainability for the cropping system. Farmers go for a new approach, when they see the benefits in the short term, they cannot wait for the long term impact. Therefore, management practices should increase productivity, profitability and environmental (pollution) clearance in the short run. With the new modifications the stability and sustainability of the cropping system can be seen only in the medium and long term (five years or more).

1. Off-farm utilization (Straw removal)

Rakes and balers are used to form compact rectangular and round bundles of 25-30 kg straw. The rake has spring tynes which picks the already-reaped straw and arrange these in neat lines at three feet distance from one another. And the balers compresses the straw simultaneously binding them with twines. For bailing of 25 quintals of straw from an acre, about 35-40 minutes are required. Straw removed from field can also be used as fodder and animal hay bedding by virtue of high silica and low lignin content in straw or can be used to generate power. Nearly about 120,000 tonne of stubble is required for a 12 MW rice straw based power plant located at Ghanaur village in Patiala district of Punjab. This much amount of stubble can solve the problem of paddy residue straw of 15000 farmers. Other uses of straw includes as packaging material, raw material for ethanol production, fuel in brick kilns, base for mushroom cultivation, paper/board making and biochar preparation. Biochar is formed by the chemical process named pyrolysis, in which material (straw) is heated in the presence of limited oxygen at very high temperature. Application of biochar in soil increase moisture retention capacity and the organic matter.

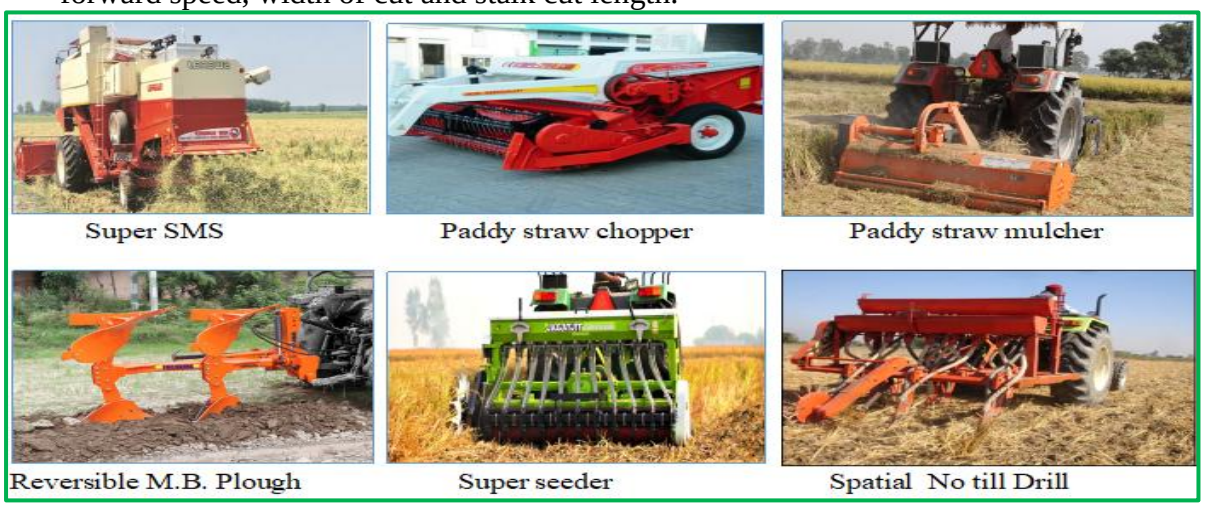
2. On- farm utilization/ In-situ management

Straw incorporation : Above ground portion of plants are chopped in small size and incorporated by power tiller. Incorporation of straw is environment friendly, helps in improving fertility and increase soil organic matter along with soil N, P and K content. The less favoring effects are more time and energy requirement which delays sowing by 2-3 weeks. Incorporation also caused temporary deficiency of nitrogen due to immobilization and require extra nitrogen.

Straw retention : All the paddy straw can be retained on soil surface as mulch and direct drilling on the mulched straw can be done with the help of Happy seeder. Mulch reduces the evapo-transpiration losses, maintain soil temperature and provide more opportunity time to rain-water preventing the run-off and soil erosion by reducing flow velocity.

Machinery used for straw management

- **Super SMS (Straw management system):** It is connected to the combine harvester and it cuts the stubble into small pieces and spreads it evenly throughout the field, which makes direct sowing of wheat possible and improve crop emergence and establishment.
- **Paddy straw chopper cum spreader:** Chopper chops the paddy straw and spreader spreads chopped straw. The chopped and spreaded straw is incorporated easily in the soil with minimum tillage efforts such as use of traditional tillage implements like disc harrow and rotavator. The field can then be irrigated and subsequent sowing of wheat is done with no-till drill. Feeding rate of the implement depends upon crop density, forward speed, width of cut and stalk cut length.



- **Paddy straw mulcher:** The function of the mulcher is to shred the remaining paddy straw and loose straw after the combine harvesting and the press wheel on the machine presses the cut straw and forms a layer of cut straw which acts as mulch for the field.
- **Reversible M.B. Plough:** It is highly useful in the cropping system following zero tillage for years. It is used for deep plowing of land to prepare the field for sowing seeds or to turn the soil and incorporate residues.
- **Super Seeder:** It removes the paddy straw and mixes it in the soil, prepares the land and also sows the seeds. It is an ultimate one pass sowing solution implement.
- **Spatial No-till Drill:** It is a modified no-till drill that has a frame with three rows of furrow openers, compared to two in a traditional no-till drill. The vertical clearance of the frame from the ground was increased from 30 cm to 60 cm by using longer shank of furrow opener. Other components of the machine like inverted T-type furrow opener, seed and fertilizer boxes etc. are similar to those as already used in conventional no-till drills.

There are many options available to the farmers, but they go for those residue management options which have high production and profit cost ratio. Short-term effects are not enough to define the sustainability of a cropping system. But, the sudden problem of environmental pollution and the increasing risk of climate change with high emissions of greenhouse gases can be reduced to the level of adopting a well-planned strategy. In view of the sustainable management of residues in the rice-wheat cropping system, their gradual impact on soil (carbon sequestration) and environmental health in long-term studies are needed.