

Straw burning

Issues and prevention strategies

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The region which was praised for bringing green revolution to India and making country self-sufficient in food grains is in news every winter. However, it is not for good reason but as a cause of severe blanket of fog over Delhi and NCR region starting from the month of November. Though this smoke is also affecting the health of farmers, women and children in villages; soil health loss etc., farmers are compelled to burn stubbles because of short window available between harvesting of rice and sowing of next crop i.e. wheat. Though many measures have suggested to curb the problem but adoption of alternatives is limited. Therefore, situation demands that the solution to this problem are economically viable, culturally accepted by farmers and driven by them.

Key words: Air quality, Climate change, Straw burning,

ALONG with car exhaust, industrial emission and construction dust, burning of straw and stubbles by the farmers from North India is the major reason identified behind the heightened pollution in NCT region. Smoke from the fire of straw from harvested paddy field rise into air, drift southeast towards NCR region and exacerbates the problem of pollution. Government and other sources claim 26 to 50% contribution of stubble burning in pollution (particularly PM 2.5) of the Delhi.

Though this practice is not new, practiced since more than two decades (ever since machines replaced practice of manual harvesting in late 1980a), recently it is more highlighted because of severe pollution problems caused by it. Punjab Preservation of Subsoil Water Act in 2009, prevented farmers sowing rice crop earlier than notified date in June (measure to save the depleting ground water). However, this legislation brought about more uniformity in sowing and harvesting of rice; delayed harvesting of rice,

leaving very less window (15-20 days) before next wheat crop.

Burning is most commonly used method across the globe to remove crop residues after harvesting. In aggregate terms, China, India, and the United States are the top burners of crop residues, followed by Brazil, Indonesia, and the Russian Federation. Different measures are adopted by countries to overcome the problem of straw/stubble burning, depending upon the socio-political setting. More emphasis is given on developing and adopting alternatives to burn farming. Major alternatives of straw burning can be grouped in four broad categories as follows.

- Incorporating the residue via chopping and non-inversion cultivation (surface/top work);
- Incorporating the residue via chopping and ploughing (full-inversion cultivation);
- Baling and removing cut straw;
- Retaining the crop residue on the soil surface and direct drilling through it.

Strategies for straw burning

revolves around these categories. Before going for strategies, it is important to know the reasons why farmers burn the straw/stubbles.

Why farmers burn the straw?

After National Green Tribunal order in December 2015, fine is imposed on farmers burning their straw based on landholding of the farmers. Small land owners having less than 2 acres of land will have to pay ₹ 2,500; medium land owners (2-5 acres) ₹ 5,000; and those owning over 5 acres will have to pay ₹ 15,000 per incident of crop burning towards environment compensation. This year supreme court of the country directed state governments to strictly enforce the NGT order, stop the straw burning and held village headman and other administrative people accountable for the incidences. This has not deterred the farmers to burn the rice straw and still straw burning is taking place. The problem of crop residue burning is more prominent in the Punjab and Haryana states, produced about 30 million tonnes of paddy straw of

which 22 million tonnes was produced in Punjab alone. The open burning of paddy straw has been decreased from 80% to less than 50% during the last year i.e. 2018-19. However still the crop residue burning is a challenging task ahead of farm scientists and many obstacles are encountered by the farmers in adopting these technologies. Some of the reason for why farmers prefer straw burning are as follows.

- a. *Time constraint*- Farmers get very less time period between rice harvesting and wheat sowing. In Punjab state water legislation prevents farmers sowing rice before notified date in June, causing delay in harvesting as well as uniformity in harvesting in state. As rice and wheat is major cropping pattern in state, farmers cannot delay sowing of wheat and are compelled to burn the straw as quick solution of the straw management in field.
- b. *Economical*- There is high opportunity cost of utilization of straw and low cost is involved in burning of straw. As per hypothesis of rational man, farmers make rational choice and choose to burn the paddy straw. The economics of using a match stick apparently seems the best to the farmers as otherwise there would be expenditure incurred in managing the crop residue using machinery. Farmers usually avoid such expenditure and burn the crop residue.
- c. *Labour*- As harvesting of crop is done around the same time, labour cannot be made available to all the farmers, leaving them no choice other than straw burning. Harvesting the paddy manually requires more labour and hence not feasible option.
- d. *Capital*- For management of straw heavy tractor mounted machineries, tractor with high horsepower (HP) are required, which costs more than simply burning the straw. Small and marginal farmers mostly face the problem of arranging this. Adequate machinery to handle large crop residue are still not available to many farmers.

- e. Paddy straw unlike wheat straw is not preferred by animal as fodder because of less nutritional value of paddy straw.
- f. Sheer volume of the post-harvest residue (about 20 quintals per acre, as per conservative estimate) in rice crop increases the cost of collecting, piling and storage in fields.
- g. Many a times farmers are not aware or ignorant about negative externalities caused by the straw burning.
- h. Lack of market conditions and inconvenience of selling straw or product made from the straw.
- i. Weak enforcement of laws and policies because of farmers lobby as strong pressure group in state.
- j. Perceived lack of alternatives and many times farmers are not sure about the benefits of alternative methods. If they know about the alternatives they may not possess the know-how and technical knowledge of alternatives.
- k. Relatively small scale of operation-making use of machines difficult.
- l. The fibrous nature and high content of silicon dioxide (SiO_2) in rice straw delays the decay when incorporated into the soil which can also lead to a reduction in yield of the next season crop. Sometimes because of the formation of toxic gases and accompanying seedling mortality, yield of the crop decreases.
- m. Lack of collective action.
- n. Culturally produced mental models, social customs and other socio-psychological factors can play a role in perpetuating long-held practices.
- o. Psychological factors like present bias (tendency to discount future gains or losses to immediate gains) and procrastination (intend to change the practice but not implementing and keeping for next time).
- p. Perceived benefits in terms of weed management (non-chemical means of weed management) as well as disease, pest and termite management because of field burning.

Farmers decision to go for straw burning may also be influenced by

peer pressure and bandwagon effect. Identification of the reasons is the first step in finding the solutions for the problem.

Consequences/Impact of straw burning

For whatever reasons straw burning takes place, it has many consequences right from the field, villagers' health to health of people living in urban areas. Some important consequences are described here.

Quality of air

Straw burning severely affects the air quality. During burning season, sometimes air quality in Delhi deteriorates 20 times more than limit prescribed by WHO.

Human health

PM 2.5 is the key pollutant affecting human health as result of stubble burning, and associated with the various respiratory and cardiovascular diseases. Air pollution also leads to different eye and skin problems. Fine particles can also aggravate the lung and heart diseases.

Crops

Burning of biomass releases nitrogen oxide, carbon monoxide and volatile organic compounds. When these compounds react with sunlight, ozone is formed at lower level which can reduce photosynthesis and plant growth (Cassou, 2018).

Visibility

Black soot generated during burning of straw reduced visibility and increases chances of roadside accidents.

Soil health

Straw is source of nutrients like nitrogen, phosphorous etc. Burning of straw prevents it to recycle again into the soil and results in soil fertility. Most of the organic material are also lost during the process. It has been estimated that burning of one tonne of paddy straw accounts for loss of 5.5 kg nitrogen, 2.3 kg phosphorus, 2.5 kg potassium and 1.2 kg sulphur, besides organic carbon. Thus straw burning increases the need of costly fertilizers to be

added by the farmers, increasing their cost of cultivation.

Ecosystem

Burning causes loss of biodiversity in the region. Insects (friendly insects also), pests, other plant species etc. are killed during the burning causing destruction to ecosystem.

Physical infrastructure

Sulphur dioxide and nitrogen oxide released from the biomass burning may produce acid rain which can corrode urban infrastructure and soil and plants.

Climate change

Greenhouse gases (GHGs) emitted from the straw burning like carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄) affects the process of climate change.

Strategies to curb the problem of straw burning

Integration of different measures is needed like policy decisions and support of government, effective implementation and enforcement by the administration, innovative methods by start-ups, support by the corporates, effective technological solutions by research organisations, participative extension strategies, and innovations and adoptions by the farmers. Measures to curb the problem of straw burning should be taken at three key stages- harvest management, post-harvest to pre sowing (next crop) management and management at sowing. Integrated approach at these stages will give maximum benefits to all stakeholders.

Government initiatives

Ministry of Agriculture and Farmers' Welfare, Government of India has prepared the National Policy for Management of Crop Residue, 2014 (NPMCR) which mentions the policies to reduce the incidence rate of paddy residue burning. It focuses on use of satellite based remote sensing technologies to monitor crop residue management and development of appropriate and cost-effective farm machinery for collection, volume reduction, transportation and application of

residues etc. Government of India initiated a scheme in 2018 named Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi. It aims to reduce air pollution by providing subsidized machinery required for in-situ management of crop residue for the period from 2018-19 to 2019-20. Central government earmarked fund for farmers to purchase the machineries that converts stubble into mulch.

However, these legal measures always should be accompanied by non-legal measures like increasing awareness, cognitive level and environmental consciousness of the farmers.

Mechanization

As the mechanization is responsible for the problem of straw burning, further improved mechanization can be used to solve it.

Happy Seeder- It can sow the wheat crop even in presence of rice straw residue on soil surface without any tillage. It cuts and lifts the remaining stubbles and distribute in new crop as mulch. Thus it prevents burning of straw and causes less fuel because of less tillage. A study published in Nature journal showed that no burn farming using Happy seeder raised farmers' profits (10-20% more) through higher yields and savings in labour, fuel, and machinery costs. In spite of having many advantages, its price constrained the large scale adoption by the farmers. Innovative approaches like custom hiring centers, Farmers Producers Organisations can be used to overcome the constraints. State government has established more than 4500 custom hiring centers in Punjab. From government side, subsidy in initial years can reduce the economic burden of the farmers. Around 35,000 units of Happy seeder will be required to cover entire Punjab state. Farmers are facing problems because of non-existence of uniform rate of charging by the cooperative or custom hiring centers in the area. Frequent changes

in machines confuses the farmers.

Super Straw Management System (SMS) is a machine which attaches to the rear of a combine harvester to cut and spread loose residue across the field. It helps in retaining essential nitrogen, phosphorus and potassium in the soil. It has been made mandatory to combine harvester to attached SMS before harvesting of the paddy.

Government also promoting and distributing the other farm equipment including paddy straw chopper, cutter, mulcher, reversible mould board ploughs, zero till drill, shrub cutter, rotary slasher and rotavator. In 2018, Punjab government had target to deliver 24,972 farm equipments to farmers as part of drive to reduce incidences of straw burning. However, problem with these machines is that once used after rice harvesting, they remain idle throughout the year and increases the liability of the farmers.

Biomass plant and solid fuel

Joint venture of MIT and Tata trust along with other organisations are developing a technology that can turn the agricultural waste into valuable as a solid fuel (as a charcoal or coal substitute) which also increases the income of the farmers. This will be done by mobile torrefaction reactor which are low cost and locally developed.

Pollution-free Zero Residue Technology developed by Dr T Shivakumaran of Chennai based Neway Engineering Company has come out with patent that converts straw into highly saleable carbon rich combustible and non-combustible byproducts. This product can be used in diverse industries, including cement, iron and steel, sugarcane, paper, thermal power plants etc. It is said to leave behind no residue at the end of the process, doing away with any landfill requirements and other problems.

Around seven units of biomass plant are working in Punjab state with annual capacity of one million metric tons. However total biomass generated in state is around 22 million metric tons. With the help of geospatial technology, areas where

straw burning problem is severe can be identified and biomass plants be installed in these areas.

Agronomic and cultural practices

Short duration varieties of rice would help in increasing the window between harvesting of rice and sowing of next crop, giving more time to farmers for management of straw. Incentives can be given to farmers to do away with rice wheat cropping system like other developed countries. Transfer price can be provided to the farmers when they are shifting from Paddy or wheat crop to other crops.

To convert the straw into compost, scientist at IARI New Delhi have come up with new technology to convert rice straw into compost using capsule which cost about ₹ 5 to farmers.

Use of straw as input to industries/ Start-ups

Rice bio parks concepts propounded by Dr. M S Swaminathan, where industries will produce paper, board and animal feed from rice straw. Swedish furniture retailing giant IKEA, world's largest furniture retailer announced that it will collect rice straw from farmers in North India as raw material for their products. Ethanol production from the cellulose of rice straw is prominent technology, but require support of government. Start up like Agri2Power started using straw to produce the product that act as input for energy industries. Kriya lab is using rice straw to develop disposable plates and other material from it. These start-ups are also giving nominal money to farmers for taking the straw from the field. Of course, these are start-ups and may require some help from government during initial years of business.

Straw for other uses

It can be used as raw material for mushroom cultivation by the farmers. It can also be used as bedding material for the animals.

Community based enforcement

Considering the influence of community and religious leaders on

farming community in Punjab and Haryana, message can be spread about the disadvantages of straw burning through them.

Behavioural change

Stopping straw burning and adopting alternative methods involves behavioural change among the farmers. Behavioural change can be brought about using the nudge techniques suggested in Nudge theory. It is based on notion that traditional methods of direct instruction, enforcement, punishment may not be much effective to change the behaviour of the individual but focus on designing choices for people which encourage positive helpful decisions; for the people choosing, and ideally for the wider interests of society and environment; based on indirect encouragement and enablement. Rather than recommending farmers to use happy seeder, making it available to farmers in their locality is likely to change the behaviour of farmers and farmers start using machines rather than burning the straw.

Japan's principal of extension teaches us that when we need to change the behaviour of people, we need to go there and be part of their system. In same way our extension advisory needs to be oriented in such a way that farmers are not feeling alienation from it. To change the behavior of the farmers following extension strategies are useful to avoid the straw burning.

Extension and advisory strategies

Awareness

In Punjab and Haryana all the stakeholder viz. Department of Agriculture, State Agriculture Universities (PAU, Ludhiana and HAU, Hisar) have launched a massive campaign for awareness of farmers for crop residue management and evolve farmer's interest in crop residue burning technologies. The following methods can be used for creation of awareness among the farmers.

- Demonstrations of the machinery at farmers' fields
- Using IT for flash messages

through SMS

- Roping in institutions like panchayats, religious places and schools in villages
- Identifying and training of ambassador farmers/opinion leaders
- Farmer training camps
- Preparation and distribution of farm literature like handouts/ brochures
- Farmer awareness camps
- Farmers-scientists meetings
- Field days/Farmers day
- Broadcast and telecast of Radio/ TV talks
- Wall paintings in the villages
- On and off campus farmers' trainings
- Use of mobile vans in the villages
- Print media, group discussion, field visits
- Mobile apps like PAU Kisan app

Farmer Led Extension

It has been observed that farmers will listen to progressive farmers or fellow farmers more than formal change agents like extension workers. Therefore, success stories of the farmers who have adopted happy seeder and stopped burning in their fields can be promoted through different media so that they can act as role model for other farmers in the area. Felicitating the farmers helps a great deal in motivating the farmers about the rice residue management. The results obtained from the method and result demonstrations coupled with honoring the farmers goes a long way in giving a boost to sustainable straw management. Farmer to farmer extension can be promoted through following activities.

- Felicitating the farmers practicing no-burning
- Exposure visit to demonstration plots of progressive farmers
- Inviting these farmers in training programmes
- Publishing their success stories in newspapers
- Organizing field days at their farms

Capacity Building

Farm machinery being used for straw management are more technical as compared to other traditional

machinery for managing the crop residue. Regular handholding and proper training of contractors and technical staff is essential for proper operation and maintenance of these machines. Training to farmers for using of such machineries can be provided at SAUs, KVKs or in ICAR institutes. Remember, burning is also a behavioral problem, which can be addressed by regular social interaction and training of the farmers. The objective should be to shift the mindset of the farmers by providing them timely and required training.

Government has some limitation and cannot use carrot and stick policy against the farmers, but has to use more carrots only. However, some economic disincentives can also be

rolled out to prevent repeated violations. Every planned change needs efforts and investment. Government is adopting all possible measures to provide machines and create awareness. These efforts can be supplemented and complemented by corporates by sharing part of their Corporate Social Responsibility (CSR) for providing machines and training to the farmers.

The described strategies are not all inclusive and not mutually exclusive, combinations of these can also be used for immediate solution of the problem. Since the alternative to straw burning involves additional cost and farmers may not be in position to transfer this cost to consumers, to compensate the farmers during initial years, public

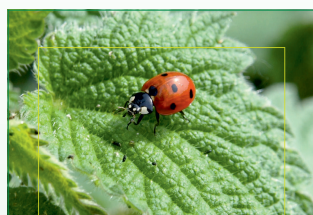
funding and support for the development and implementation of alternatives solutions is required.

Technologies should be such that it should reduce the environmental footprint, increase the revenue from rice farming to farmers. Though these measures intended at short to medium term, in long term diversification of crops should be focused. Coming out of rice-wheat cropping system would reduce the straw burning problem and also help in saving water footprint and restoring ecological balance.

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HANDBOOK OF INTEGRATED PEST MANAGEMENT

To reverse the loss of environmental resources and also to reduce biodiversity loss, the Government of India has Integrated Pest Management (IPM) as part of the National Agricultural Policy. Integrated Pest Management



HANDBOOK OF
INTEGRATED
PEST MANAGEMENT



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New Delhi

emphasizes the growth of a health crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. IPM is not new – mechanical, cultural and biological tactics were used by farmers for hundreds of years before chemical pesticides became available. Besides, there are IPM techniques that have been developed more recently and are effective in suppressing pests without adversely affecting the environment.

The task of spreading the message of IPM across is tough due to poor awareness about the subject among people in line-departments as also among the farmers. The information on integrated pest management as a whole is scattered. This *Handbook* comprehensively deals with all the aspects of integrated pest management in field crops, horticultural crops under traditional, protected systems. Information on basic strategies and tactics of different methods of management including mass production of biocontrol agents, IPM policy and pesticide registration is provided in comprehensive form.

The *Handbook of Integrated Pest Management* comprises 82 chapters which are well written in lucid language with crispy sentences by the renowned scientists. The role of IPM is elucidated with different pests like *Trichogramma*, *Bacillus thuringiensis*, *Nomuraea rileyi* etc. and agricultural crops like rice, wheat, maize, sorghum, pearl millet, pulses, soybean, rapeseed mustard, groundnut, minor-oilseed crops, sugarcane, cotton, jute and mesta, potato, vegetable crops, fruits, grapes, citrus, banana, pomegranate, coconut etc. This *Handbook* will provide information of available useful technologies to educate on how to reduce or judiciously use chemical pesticides, safeguard ourselves from chronic poisoning, save the National environment while also reducing input costs and raise farmers' income. This compilation will be useful to teachers, students, trainers, line-department personnel and policy makers.

TECHNICAL SPECIFICATIONS

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