K.R. MANGALAM UNIVERSITY
THE COMPLETE WORLD OF EDUCATION

Sohna Road, Sohna
Gurugram

School of Agricultural Sciences

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"Management strategies of rice crop residues at nearby village of Sohna and rectify the effect on germination of next crop"

(Case Study Report)

Introduction

Crop burning is the practice of using fire to reduce or dispose of vegetative debris from an agricultural activity. The burning of stubble, contrasted with alternatives such as ploughing the stubble back into the ground has a number of consequences and effects on the environment. Stubble burning is the deliberate setting fire of the straw stubble that remains after paddy and other grains have been harvested. Rice residue burning is a recurring problem, during October–November, in the north western regions (Punjab and Haryana) of India. The main cause of crop residue burning is that there is a very short window of time between harvesting of paddy and cultivation of wheat, at the end of the *kharif* season. India is an agrarian economy and generates around 600 Mt of crop residues, from which 70% accounts for cereals, 13% of fibres, 6% of oilseeds, 3% of pulses, 2% of sugarcane and 6% of others (Jain et al., 2014). In November 2016, the Capital literally came to a standstill because of the smog created by the burning of crop residue in neighboring Haryana and Punjab. This practice has also become popular in other parts of the country. And today, the particulate matter emitted from crop burning across India in a year is more than 17 times the total annual particulate pollution in Delhi from all sources such as vehicles, garbage burning and industries. Burning of crop residue is a cause of concern because it leads to air pollution (Mittal et al., 2009).

Crop residues, considered as the waste materials, are the crop parts left in the field after it has been in gathered and separated. Recycling of these residues can be a beneficial asset in terms of improving the soil physical as well chemical conditions along with the complete ecological balance of the crop production system. In India, Punjab is the second largest producer of rice (Agriculture census; 2020-11). Rice cultivation leads to two major types of residues: Straw and Husk. Management of rice

husk is done through various technologies in many Asian countries However; management of the rice straw has been a major challenge as it is rarely used as a source of renewable energy or as animal feed due to high silica content. So, most farmers resort to stubble burning as a practise due to its cost-effectiveness as well as time saving solution for managing the residue. The process of burning not only leads to the huge loss of biomass but also causes various environmental problems (Parmod kumar.et.al 2015). One of the principal reasons for husk preference is its easy availability from the rice mills. In the case of paddy straw, its collection is a tedious task as well uneconomical as most of the collection machines are quite expensive and time consuming. With the prevalence of stubble burning in the NW states of India, it has contributed to around 20% organic carbon towards the overall budget of emissions from biomass burning.

In this report, an attempt has been made to discuss the implications of stubble burning in some villages of states of Haryana and methods to mitigate these practices.

Objectives

- To identify the problem faced by farmers in residue management
- To educate farmers about the harmful effects of residue burning
- To educate farmers about the various rice residue management practices

The study will help us in understanding the problem of stubble burning in ground level (village level), its implications on the local as well as regional environment. It will help us to understand the in-situ management with the use of various machines along with its economic viability for the farmers. The ex-situ management of stubble in terms of market of various products made from rice straw (biochar, briquettes etc.) is also studied along with its loop holes in the system. The

study will also provide us with insights on the existing policies in India regarding the failure of such products

Study area

The study was conducted in two phases. The area selected for the study is depicted in the images. In phase-1, lakhuwas village was selected for the study and In phase-2, total 2 clusters Tigaon and sohna of Haryana state were included as the study area. Nearby villages of these two clusters have been surveyed and selected for the study on rice residue activities.

Figure 1 : Map of the study area in Haryana (Phase-1)

Figure 2 : Map of the study area in Haryana (Phase-2)

Methodology

Phase -1

1. Workshops and lectures: Faculty of SOAS conducted interactive workshops and lectures to educate farmers about the impact of crop residue management on soil health, crop yield, and the environment. They discussed various management practices and their associated benefits.

2. Field Demonstrations: Field demonstrations were organized to showcase different crop residue management techniques, such as incorporation and removal. Faculty explained the process, benefits, and potential challenges associated with each practice. 3. Information Dissemination: Informational materials, including brochures and pamphlets, were distributed to farmers. These materials provided detailed guidelines on sustainable crop residue management practices, highlighting their advantages and implementation strategies.

Phase-2

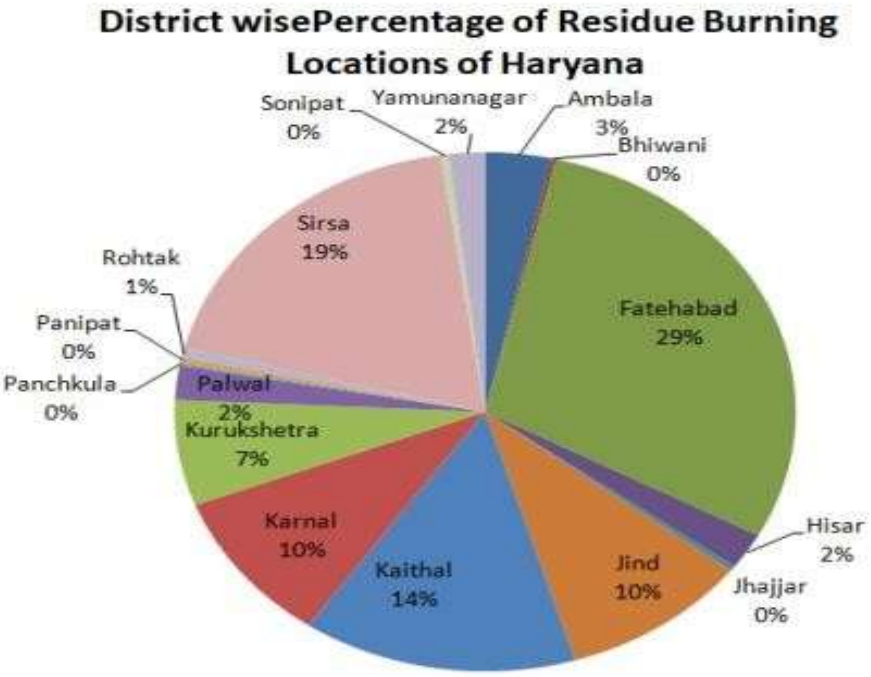
Estimation of harvesting date and selection of farmers

The activity was conducted in collaboration with the Agriculture Department. Sample size for the farmer survey was chosen based on random sampling of farmers or rural households involved in farming. A list of farmers from these villages was shared by the agriculture block office. Rice harvest dates are very useful information since they are the key factors in accessing rice residue burning period. The telephonic interaction was conducted with the farmers of these selected villages before visiting the farmer on field.

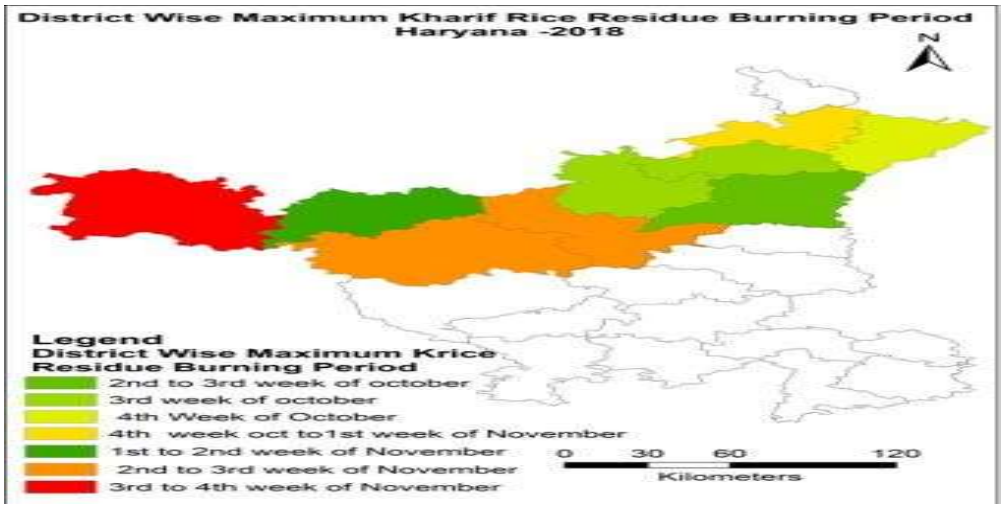
Collection and analysis of active fire events

Various researches were done on the history of fire events taken place in the Haryana state and in the selected area. Fire hotspot data from past years during the

months of Oct-Dec is collected to get an understanding of the trend of burning incidents in and around Haryana.



District wise fire counts percentage in Haryana



Maximum rice residue burning period of Haryana.

On field solution and practical demonstration

A block level kisan mela were organized in Tigaon and Sohna block in collaboration with the agriculture department to provide a platform for the farmers of selected village to come together and to learn about management practices for the rice residue. During the kisan mela, the agriculture department and faculty of School of Agricultural Sciences, KRMU arranged various activities such as field demonstrations of the in-situ and ex-situ management of rice residue and discussed some other management practices with the farmers of the areas.

Dean, SOAS Sharing important pratices about rice residue management (Tigaon)

For conducting the survey, a questionnaire was prepared to facilitate dialogue with the farmers. The questionnaire includes the important aspects of farmers' such as socio-economic situation, their perception on stubble burning issues, cropping patterns, use of natural resource, rice residue management practices opted by them, their positive results etc. The study area covered villages of tigaon and sohna block which is dominated by rice-wheat cropping patterns.

Students and Faculty members of SOAS interacting with the farmers (Tigaon)

Students and Faculty members of SOAS interacting with the farmers (Sohna)

Discussion Highlights of the kisan mela conducted on 9/11/2023 in Tigaon block and on 29/11/2023 in sohna block were:

1) **Prevalent methods of crop residue disposal**

Farmers generally rely on various techniques for disposing off crop residues, which includes using straw as cattle bedding, animal fodder, thatching for rural home roofs, soil mulching, incorporation, fuel for domestic and industrial use.

Prevalent methods of crop residue disposal

2. Importance of Rice Residue Management:

- The discussion emphasized the significance of proper rice residue management in maintaining soil health, conserving water, and reducing environmental impact. - Farmers were made aware of the negative consequences of burning rice residue and encouraged to adopt alternative practices.

3. Alternative Management Techniques:

- Various techniques for managing rice residue were discussed, such as:
- Incorporation into the soil: Farmers were educated about the benefits of incorporating rice residue into the soil, which enhances organic matter content, improves soil structure, and promotes nutrient cycling.

- Mulching: The use of rice residue as mulch was highlighted, as it helps retain soil moisture, suppresses weed growth, and provides a protective layer for the soil.
- Animal feed and bedding: Farmers were informed about the potential of utilizing rice residue as animal feed or bedding material, which can provide additional income streams.

4. Challenges and Solutions:

- The discussion addressed the challenges faced by farmers in implementing alternative rice residue management techniques, such as labor requirements and access to appropriate machinery.
- Potential solutions were explored, including government support in terms of subsidies, provision of machinery, and training programs to facilitate the adoption of sustainable practices.

5. Knowledge Sharing and Collaboration:

- The discussion emphasized the importance of knowledge sharing and collaboration among farmers, agricultural experts, and relevant stakeholders.
- Farmers were encouraged to share their experiences, challenges, and success stories related to rice residue management, fostering a sense of community and collective learning.

Conclusion:

The discussion on rice residue management with farmers aimed to raise awareness, provide information on sustainable practices, and encourage the adoption of alternative techniques. By implementing these practices, farmers can contribute to environmental conservation, improve soil health, and enhance the overall sustainability of rice cultivation. Continued support, knowledge sharing, and collaboration among

farmers and relevant stakeholders are crucial for the successful implementation of effective rice residue management strategies.

Kisan mela (Tigaon)

Inauguration of the Kisan Mela (Sohna)

Result and Discussion

Phase-1

Faculty of SOAS along with the students visited the fields of the farmers of lakhuwas village and discussed some some important points regarding the crop residue management in the field. The discussion emphasized the significance of proper crop residue management in maintaining soil health, conserving water, and reducing environmental impact. The farmers were made aware about the importance of proper crop management. The various points discussed with farmers were:

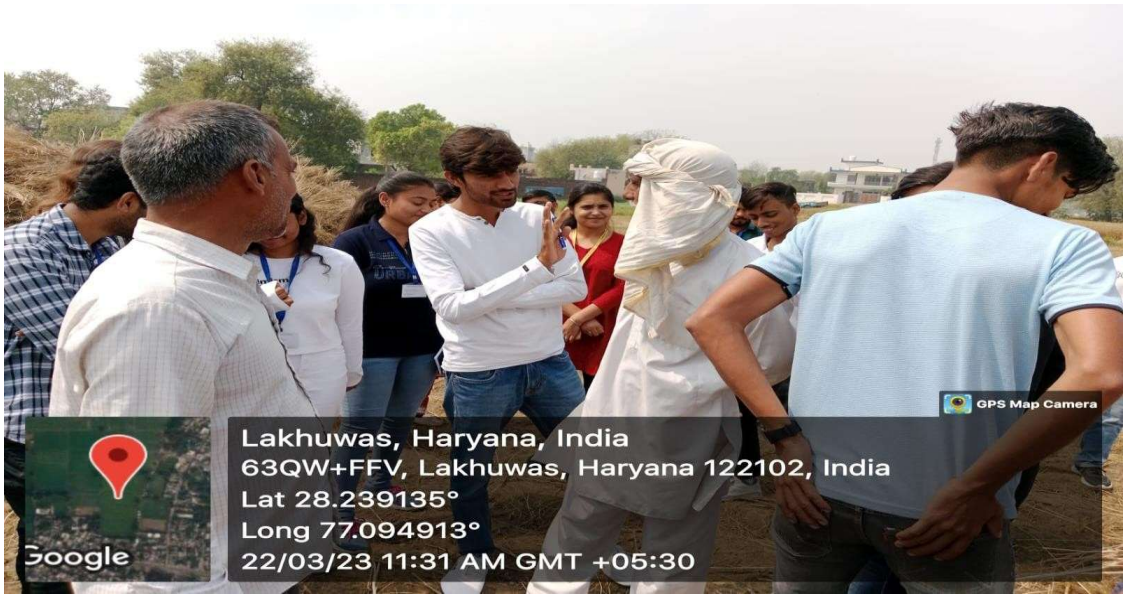
1. Importance of Soil Health: The workshop emphasized that proper crop residue management is essential for maintaining soil health. It helps improve soil fertility, structure, and nutrient availability, leading to better crop growth and yield.
2. Environmental Sustainability: Farmers were made aware of the environmental impact of improper residue management, such as air pollution and greenhouse gas

emissions. Sustainable practices, like incorporation, were highlighted as effective ways to mitigate these issues.

3. Economic Benefits: The workshop highlighted the economic benefits of sustainable residue management practices. By reducing the need for external inputs like fertilizers and improving soil health, farmers can potentially increase their crop yield and reduce production costs.

4. Knowledge Exchange: The workshop encouraged farmers to share their experiences and knowledge regarding crop residue management. It emphasized the importance of learning from each other and adopting best practices suitable for their specific farming systems.

The awareness activity on crop residue management aimed to equip farmers with knowledge and understanding of sustainable practices. By adopting proper residue management techniques, farmers can enhance soil health, increase crop productivity, and contribute to environmental sustainability. It is crucial for farmers to implement these practices in their farming operations to ensure long-term agricultural success and preserve the health of our ecosystems.



Phase-2

Effects of rice straw burning

Approximately 17.6% of rice straw is burnt within three to four weeks during October and November each year in NW India. It is estimated that the burning of crop residues releases about 627 kilotonnes (Kt) of PM10 and 4677 Kt of carbon monoxide to the atmosphere annually in India. Moreover, the burning of crop residues emits 26.1 Mt of carbon and 0.35 Mt of nitrogen each year. According to previous studies, large volumes of farm residue are burned in situ, posing a substantial detrimental impact on the local air quality. The rice straw burning causes environmental pollution through the discharge of many gases such as CO2 (70%), CH4 (0.66%), CO (7%), N2O (2.09%), and ash. Due to this, in the National Capital Region (NCR) the air quality index (AQI) often reaches severe levels due to harsh pollution.

A. **Effects of rice straw burning on human health**

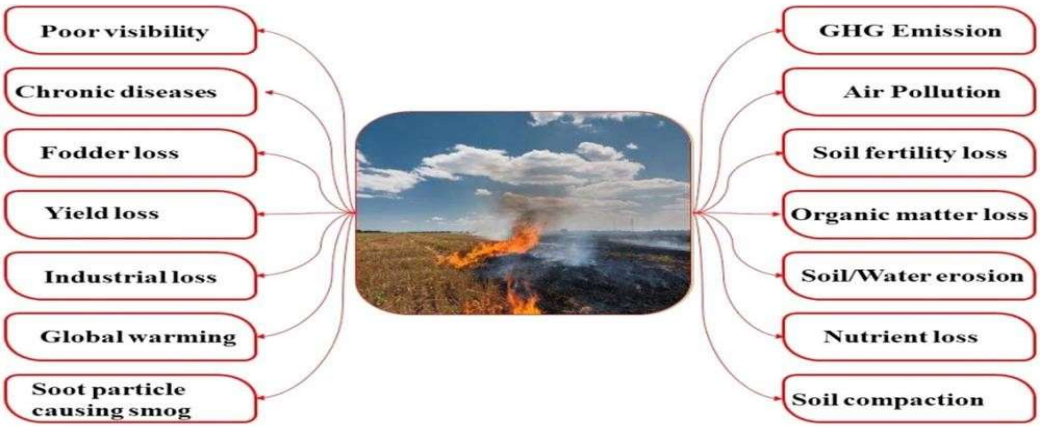
The burning of straw in open fields releases a range of air pollutants known to impact the human health negatively. The crucial pollutant from a human health

perspective is particulate matter (coarse particles 2.5–10 microns and fine particles < 2.5 microns in size), the impacts of which are mainly local and depend on concentration, population density, extent of exposure, and weather. The amount of particulate matter emitted from burning the crop residues in and around Delhi is 17 times higher than that from all other sources such as vehicle emissions and garbageburning industries. Females, infants, and individuals with serious diseases are particularly affected by the harmful implications of stubble-burning pollution.

Additional adverse health consequences of straw burning are eye irritation, corneal opacity, and skin illnesses that occur off-site. Among various sources of outdoor air pollution, crop residue burning is estimated to be responsible for approximately 66200 deaths in 2015 in India. Burning residue also enhances ozone pollution in the troposphere.

B. Effects of rice straw burning on agricultural productivity

Air pollution through rice residue burning may pose direct or indirect effects on agricultural productivity. Direct effects entail injury to foliage and grains, or assimilation of toxic heavy metals in biomass. In addition, exposure to excess nitrogen oxides(NO) can damage the tissue of plants and cause discoloration, while SO2 emissions results in acid rain, which have severe detrimental effects on soil and causes lower productivity.



Adverse effects of straw burning in open field

Hence, stubble burning negatively impacts agricultural productivity; and appropriate measures are required to overcome its effects, which would improve the agricultural productivity necessary to meet the increasing food demand.

Rice straw management techniques

Effective rice straw management techniques are crucial for sustainable agriculture and environmental conservation. By incorporating rice straw into the soil, composting, utilizing it as animal feed, or converting it into bio-energy, we can minimize the negative impacts of rice straw and promote a more sustainable farming ecosystem. It is essential to raise awareness, provide training, and offer support to farmers to encourage the widespread adoption of these techniques. A Block level event, Kisan mela were conducted at two places in collaboration with the Agriculture department to make farmers aware about the various rice stubble management techniques.

Various sessions were taken by agriculture officials to give valuable insights and guidance about the crop residue management. The feedback data on current rice residue management practices opted by farmers was also filled by students by selecting the farmers randomly. the Following points were discussed in the event conducted at two different places:

A. Ex-situ management

Ex-situ management of crop residue involves the off-field solutions for removing or utilizing rice straw, such as by packing them into bales, and using them as a raw material for energy generation; packaging material for fruit, vegetables, and glassware; for mushroom cultivation, and as bedding for cattle. This approach aims to remove crop residue and prepare the field for another crop. Ex-situ management increases the efficient utilization and value addition of rural biomass wastes, including derivation of biomass-based energy, and use for feed stock supply. Such operations at the farm level can also generate rural employment opportunities and provide additional income to the farming community. These ex-situ crop residue management techniques are can be frequently employed through government assistance in initial years:

1. Biomass power generation:

Crop residues can be used as a source of fuel for biomass power generation. This method involves burning crop residues to produce electricity or heat.

2. Animal feed:

Crop residues can be used as a source of animal feed, particularly for livestock such as cattle, sheep, and goats. Crop residues can be baled and stored for use as animal feed during the dry season when forage is scarce.

3. Composting:

Crop residues can be composted to produce a nutrient-rich soil amendment. This method involves collecting the crop residues and mixing them with other organic materials such as manure, leaves, and grass clippings. The compost can then be used to improve soil fertility and structure.

4. Biochar production:

Biochar is a type of charcoal that is produced by heating crop residues in the absence of oxygen. Biochar can be used as a soil amendment to improve soil fertility, water retention, and crop productivity.

5. Industrial uses:

Crop residues can be used in various industrial processes, such as the production of paper, textiles, and building materials.

In-situ Crop residue management

In-situ crop residue management is the practice of leaving crop residue in its natural state on the field. While lowering the danger of pests and diseases, in-situ management techniques can assist maintain the health and fertility of the soil.

Several of the techniques used to manage in-situ crop residues are listed below were discussed:

- **Mulching** is the practice of leaving crop residue on the soil surface to protect the soil from erosion and retain moisture. Mulching also helps to suppress weeds and provides nutrients to the soil.
- **No-till farming** involves planting crops without disturbing the soil. Crop residue is left on the soil surface, and seeds are planted through it. This method helps to conserve soil moisture and reduce soil erosion.

- **Strip-till farming** is similar to no-till farming but involves tilling only a narrow strip of soil where the seeds will be planted. Crop residue is left on the soil surface in between the tilled strips. This method helps to conserve soil moisture and reduce soil erosion while also providing a suitable environment for seed germination.
- **Cover crops** are planted in between cash crops to provide ground cover and add nutrients to the soil. Cover crops can also be left on the soil surface as a form of mulch.
- **Crop rotation** involves alternating the type of crops grown on a field each season. This method can help to reduce soil erosion and nutrient depletion while also improving soil health.

Details of survey taken from two clusters

Majority of respondents were between 36 to 50 years of age (56 approx.). In the study, of the total respondents, 30 per cent approx. were educated to senior secondary, 31 approx per cent were educated to secondary level, 13 per cent approx. were educated to graduation level and above. The remaining 17 per cent approx. of respondents were only educated at the primary level and rest percent were illiterates. In study area nearly half of the respondents were owned small to medium land holding. Half of the farmer respondents had mass media exposure. Approximately half of the farmers interviewed had a medium degree of innovativeness and ecological consciousness.

Students collecting data from farmers

Constraints: Constraints as perceived by farmers in adoption of crop residue management alternatives were studied in the study.

Technical constraints: Less time availability between harvesting of paddy and sowing of wheat was observed one of the major constraints. Due to these narrow gap farmers are unable to adopt any management practices. Hence, they perceived burning as a less time consuming and cost-effective practices.

Since the available techniques are not suitable to the agro-economic conditions of the farmers to address their management problems. The heavy machineries like

happy seeder (AC5), which requires high power tractors, which is not available in every household mainly for small and marginal farmers.

Constraints in use of paddy straw: The study reveals that farmers were not collecting crop residues due to less market demand at local level.

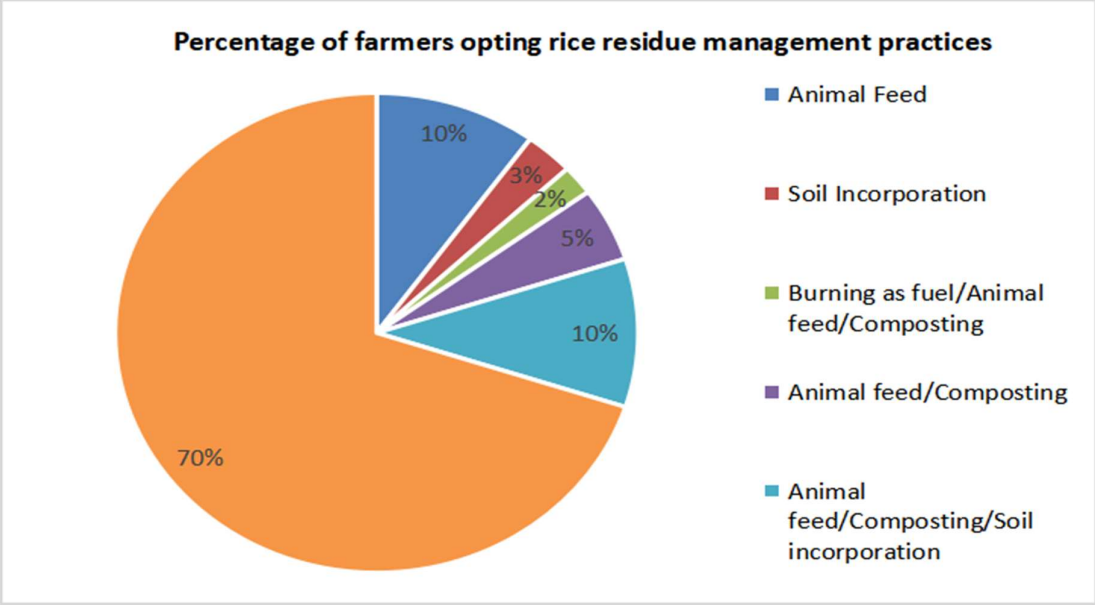
Communicational constraints: Less training facilities was available for farmers for management of crop residues in the field.

Farmer's opinion on rice straw burning

Farmers adopt crop residue burning because of two main reasons: low calorific value of straw and shortage of labour. In addition to being an inexpensive strategy, residue burning serves as a suitable pest management procedure and facilitates the reduction of insects resulting from inoculum reinjection into the straw biomass. Thus, burning provides an efficient alternative to control weeds, insects, diseases, and pests, both by direct elimination or by modifying their habitat. Some farmers have expressed that poor storage facilities and lack of market utilities of rice residue motivates them to burn the stubble in the field. Others state that in situ burning of straw saves the tractor fuel cost incurred when stubble remnants are processed mechanically. Burning offers a time-saving approach to clear the field and accelerates seed bed preparation for sowing of the successive crop. On the other hand, collection of straw or incorporation within soil is perceived to be a highly time consuming and expensive alternative. Moreover, farmers face significant challenges in obtaining cheap labour during peak harvesting seasons for these practices. During this period, there is minimal opportunity for efficient harvesting and the hourly charges of local labour are very high due to the high demand. These reasons compel the farmers to burn the residue and avoid high expenditure for labour or rentals for mechanized straw management options.

Outcome of the study:

The findings of the survey and field visits indicate a positive trend in farmers' practices regarding rice residue management. The majority of farmers have shown a commendable shift towards adopting alternative practices instead of burning the residue. The following key findings were observed:



1. Adoption of In Situ Management Practices:

A significant number of farmers have embraced in situ management practices, such as incorporating rice straw into the soil or using it as mulch. This approach not only helps retain soil moisture but also improves soil fertility and reduces the need for synthetic fertilizers.

Soil Incorporation of the rice stubble

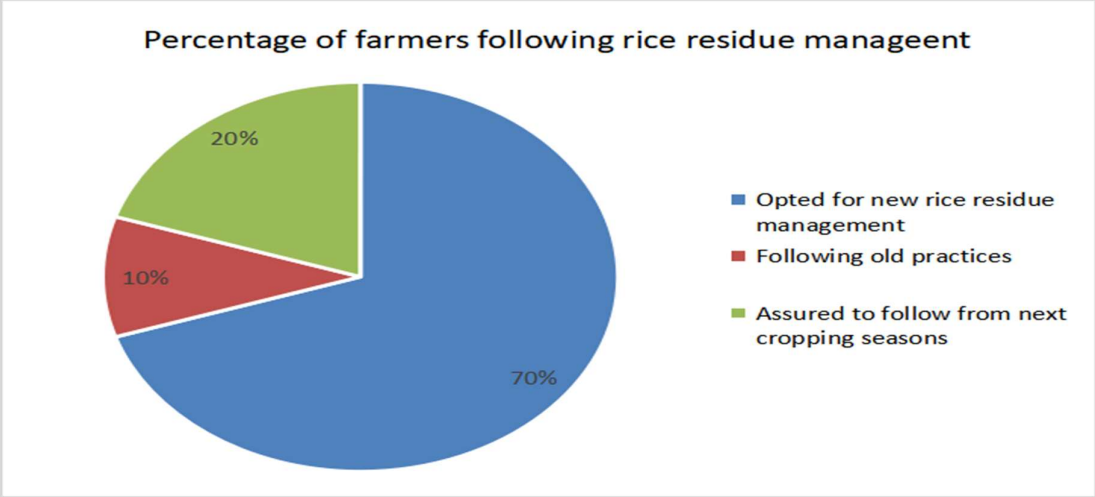
Demonstration of soil incorporation practice in farmer's field

2. Implementation of Ex Situ Management Practices:

Farmers have also demonstrated a growing inclination towards ex situ management practices. These include the collection and utilization of rice straw for various purposes, such as animal feed, composting, or bioenergy production. Such practices contribute to the circular economy and reduce environmental pollution.

3. Awareness and Education:

The survey results indicate that farmers' awareness of the negative impacts of rice residue burning has increased significantly. This awareness has been facilitated by various awareness campaigns, training programs, and extension services provided by agricultural authorities. Farmers are now more informed about the benefits of alternative practices and the potential risks associated with burning.



Conclusion

A sustainable option for opting a suitable alternative of residue management instead of burning in the open field is the need of hour. These alternatives are note economically viable and practically feasible as perceived by farmers. The major problems are less time availability between the harvesting of rice and showing of wheat crop, followed by cost of cultivation increases, if machinery is used, and lack of cost-effective & viable technologies. Hence, the result can be used to intervene technically to mitigate constraints in residue management. Thorough understanding of these constraints is necessary for practical solutions. Suggestion given by farmers should be consider, mainly policy related suggestion such as implementing biomass based power plant and promotion of crop diversification. Other than this, rice varieties producing minimum biomass &mature in short period can widen the time gap between harvesting of rice and sowing of wheat. Machinery which can be driven with low horse power tractors must be encouraged.

Oath taking ceremony to encourage farmers to not burn the residues in the field

From the study various gaps were observed in terms of subsidy from the government and the receiving end of the farmers. There is absence of concrete infrastructure at community level with end-to-end support. Crop diversification can act as a long-term solution which should be encouraged by the government. Due to absence of a formal marketplace for crop residues, various ex-situ products are absent from for commercial use. Few observations made from the study are:

Provision for incentivizing farmers for not burning paddy residues in the open fields and creating hard infrastructure at community level along with end to end support is a more inclusive approach and results into higher adoption across all farmers. Utilization of crop residue to generate energy for improvement of air and soil quality and mitigating climate change effects and global warming in long run by establishing bio- energy plants and encouraging them to utilize the surplus straw residue for generation of energy in a most environment friendly, sustainable and costeffective way. And collection and transportation of agricultural residues, gasification as a fuel for the

boilers, converting into briquettes and designing of suitable harvester should be promoted.

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