EXTENSION INTERVENTIONS TO PREVENT CROP RESIDUE BURNING FOR GREEN AGRICULTURE AND CLEAN AIR

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Burning of crop residues leads to atmospheric pollution, nutritional losses and deterioration of soil health. Setting fire to a ton of paddy residue is found to pour 3 kg PM, 60 kg CO, 1460 kg CO_2, 199 kg ash and 2 kg SO_2 into the atmosphere (Singh, 2018). Annually, about 23 million tons of paddy straw is burned in Punjab resulting into about 70 per cent rise in CO_2 and 7 per cent rise in CO levels. It triggers respiratory and heart related problems among the humans in general and people with breathing difficulties in particular. Moreover, losing one ton of paddy straw is nothing but loss of nearly 5.5kg N, 2.3 kg P_2O_5, 25 kg K_2O, 1.2 kg S, 50-70% of micro-nutrients and 400 kg of carbon (Bhuvaneshwari et al, 2019). Alongside, soil properties like temperature, pH, moisture, available phosphorus and organic matter are negatively affected due to straw burning. Whereas, incorporation of this straw can augment fertility of soil; thereby reducing the need of chemical fertilizers worth ₹1500-2000 per hectare (Singh et al, 2018).

Even after making necessary machineries available, majority of the farmers were seen resorting to the convenient option of residue burning. It clearly indicated that the problem was more than just technology adoption; thus, a need to trigger a social change involving all the stakeholders was being felt.

EXTENSION INTERVENTIONS

ICAR-Agricultural Technology Application Research Institute (ATARI), Ludhiana and Krishi Vigyan Kendras (KVKs) of Punjab, took residue burning as a challenge and a concept of 'Innovation Hub' was introduced with sole objective of making it as the torch bearer in the technology diffusion process. Dissemination of crop residue management technologies was planned in such a way that the Innovation Hub villages across the districts of Punjab were linked by the KVKs. Role of KVKs was to get feedback from the farmers and provide technological solutions to their queries. Moreover, the new adopted villages were expected to act as technology hubs for the neighboring villages.

Sensitization: To spread intended message walls of structures at prominent locations in the villages were painted with motivational pictures, eye catchy slogans, messages and quotes using bright colors and larger font sizes. Similarly, posters and banners were designed with specific messages to urge to the value system of all the stakeholders and shake the conscience of farmers and farm families. Hoardings with volunteer farmer's photos and pledge to not burn residues were also installed to motivate farmers to give up the practice of residue burning.

Awareness Camp/ Farmers Fair: To mobilize farmers, farm women, rural youth and other stakeholders for an immediate action to reduce crop residue burning, KVKs organized awareness camps at the village, block and district levels. These camps highlighted the support from the State Government in procuring necessary machines individually and in groups. Similarly, farmers fairs (*kisan mela)* were organized to mobilize all the stakeholders and encourage farmers to celebrate the festival of *Baisakhi* as *"No Crop residue Burning Day"* and inform about alternative residue management technologies.

Mass Outreach: Mass awareness programs to popularize 'in-situ crop residue management options' were mainly through ATARI, Ludhiana and KVKs led television programs like '*vaad samvad (dhanka dhuan)', 'vichar vimarsh-parali ki pareshani ko takniki madat se khushhali mein kaise badlaja sakta hai'* and *'khetke avshesh khet mein'* telecasted through DD KISAN during 2016-18. Also, jingles and short tunes/songs composed in local languages were repeatedly played through different radio channels. To spread preliminary information about the issue among people, leaflets and pamphlets were distributed.

Engaging School/college Students: Connecting students was sought as a strategy, as they are more sensitive towards social evils and are prepared to vouch against them. They were expected to influence their parents, relatives and other community members to carryout environmental duties. Students were sensitized about the seriousness of residue burning and alternative management practices through informational and motivational lectures. Essay and slogan writing competitions were organized to invite their idea for furthering the campaign. Awareness rallies (*chetna pheries)* were organized to ensure their participation and support to the cause of sensitizing the community. Moreover, Ms. Sonali Sheokand, a Class X student of RE Kanya Mahavidyalaya, Narwana, Jind was honoured by the institute for lodging complaint against her own father for burning crop residues.

Environmentalists and Religious Leader's Appeal: Environmentalists, religious saints and leaders like Baba Sewa Singh, Baba Balbir Singh Seechewal and Baba Gurmeet Singh were roped in, as they have a command over people and can convince farmers at least to have a try on available residue

management options. Shiromani Gurdwara Prabandhak Committee (SGPC), the apex body for Gurdwara Management in Punjab, was also linked with campaign, considering its credibility among the *Sikh* community. BibiJagir Kaur, Former President, SGPC urged the farmers to shun residue burning from the platform of KVK Kapurthala.

Ensuring Convergence of Efforts: ICAR-ATARI, Ludhiana took the lead in making the stakeholders collaborate and synergize the efforts to accomplish the objectives. Therefore, stakeholders' meet, dialogue etc. were organized to bring partners like ICAR institutes, State Agricultural University, State Government Departments, International Institutions, NGOs, machine manufacturers, NABARD, Punjab Pollution Control Board, KVKs, Farmers' Organizations, and religious leaders to the table and provide them a common platform to devise a well thought out and mutually agreed plan of action.

Capacity Building Programs: Training programs were organized to train farmers and machine operators about crop residue management in general and operating machines in particular. Farmers were provided with the literature on effective usage of machines in the field with specific dos and don'ts. These trained farmers and operators were expected to act as Master Trainers to their fellow farmers. ICAR-ATARI, Ludhiana technically empowered KVK scientists with knowledge and skills through lectures, hands-on-training, visits to custom hiring centres etc. This helped KVK trainers to develop enough technical know-how and self-confidence so as to impart the same among farmers, machine operators and farmer master-trainers.

Frontline Demonstrations: Scientists-led method demonstrations were conducted on operating machines and sowing wheat while managing paddy straw effectively. Similarly, active and curious farmers were spotted during exposure visits and result demonstrations were laid in their fields to exhibit management of paddy residue in their own field conditions. The farmers were expected to experience the crop growth stages and share their experiences with other farmers. The demonstrations on Happy Seeder sown wheat have reported saving of nearly ₹4500/- per hectare in terms of cost of cultivation and ₹3300/- per hectare in terms of saving on nutrients (Singh et al., 2018).

Machinery Banks: Machinery Banks established in Punjab KVKs equipped with necessary paddy residue management machines for demonstrations, exhibitions, farmer trainings, and providing services to the needy farmers. During 2018-19 KVKs of the state procured machines to have a capacity to cultivate 11417 ha with Happy Seeder, 1266 ha with Cutter-cum-Spreader, 2738 ha with Mulcher, 1905 ha with MB Plough, 16085 ha with Zero Till Drill and 3720 ha with Rotavator.

Harvest Field Day Celebrations: Farmers were needed to be persuaded about the yield potential of the Happy Seeder sown wheat, which is sown in standing paddy stubbles without any tillage operation. Farmers were needed to develop confidence with respect to the technology to at least try it once in their field. Thus, KVKs celebrated Harvest Field Days at the demonstration sites of wheat sown with Happy Seeder to educate and convince farmers about the multiple benefits of the technology.

Model Villages of Residue Management: KVKs targeted development of few model villages to showcase 'crop residue management with zero residue burning' in the initial stage. The initiative began with six villages in 2016 covering an area of 2494 ha under paddy cultivation expanded to 25 village with nearly 10000ha in 2017, 101 villages covering 34742 ha in 2018 (Singh et al., 2019) and to 141 villages covering 47465 ha under paddy in 2019, which reportedly have nearly no residue burning.

Likewise, Sardar Gurbachan Singh (Tarn Taran district) who fixed marriage of his son on the condition that bride's father will not allow residue burning of on his land became a popular role model to such an extent that Hon'ble Prime Minister of India recognised his contribution in the paddy straw management through the 49th Episode of *"Mann Ki Baat"* programme aired on October 28, 2018.

CONCLUSION

The inclusive planning and united efforts of ICAR-ATARI, Ludhiana and its partners reaped fruits in terms of reduced extent and intensity of residue burning and increased scientific management of crop residues. The area under direct seeded wheat in Punjab increased from just 50000 ha in 2017 to 6 lakh ha in 2018 and 8.6 lakh ha in 2019. This change not only prevented burning but also saved cost of cultivation to the tune of INR 3870 Million, loss of nutrients worth INR 2838Million and 602 Million Cubic Meter (MCM) irrigation water; apart from the eco-services and improvement in air quality.

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