

# **RICE RESIDUE MANAGEMENT**

A photograph of a vast field of rice residue (straw) under a clear sky. The straw is golden-brown and scattered across the ground, with some green stalks still visible. The background shows a line of trees under a pale blue sky.

**PAMETI - UNEP project  
on  
Climate & Clean Air Coalition  
to Reduce Short Lived Climate Pollutants**



# RICE RESIDUE MANAGEMENT

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# PAMETI

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# Extension Efforts for *In-Situ* Crop Residue Management

Dr Rajbir Singh Brar, Dr Arvind Kumar & Dr Ashish Santosh Murai

Mechanized harvesting has given rise to the issue of managing the crop residue before sowing the next crop. Farmers opted for the most convenient and the easiest alternative, i.e., setting residue on fire. On the contrary, the seemingly convenient choice they made has infinite repercussions for human health, soil biodiversity and organic matter content, animal health, etc. The aftermath of crop residue burning witnessed many road accidents, breathing difficulties among humans and animals, smog, poor visibility, affected operations of modes of conveniences be it airplanes, trains or buses, and other numerous problems. These issues got scaled up to the level that it attracted the attention and invited action from the National Green Tribunal (NGT). The farmers needed to be aware about the subject under question and sensitized for taking suitable action. Moreover, they had to be convinced about the effectiveness of technologies of residue management without affecting the volume of their pockets. Also, after that, they had to be competent enough to operate these machines in the field to bring out the best.

ICAR-ATARI, Ludhiana, along with its Krishi Vigyan Kendras (KVKs), accepted this challenge and initiated education and environment building against residue burning in a systematic and well-designed campaign. This attempt has received wider attention from all the stakeholders at the grass-root level.

## **The Beginning**

During 2013-14, ICAR-ATARI, Ludhiana, and KVKs of Punjab and Haryana started demonstrating technological options for effective residue management like Happy Seeder, Zero-Till drill, Chopper-cum-shredder, reversible mould-board plough, mulcher, etc. Moreover, KVKs were preparing farmers through capacity building programmes and extension activities for in-situ residue management. They established Custom Hiring Centers (CHCs) and encouraged farmers' participation through community management



### **Method Demonstration on Chopper cum Shredder in Bathinda**

of these CHCs. These villages were being developed as model villages for showcasing the viability of the technologies to the farmers of other villages.

**Mass Campaign:** The movement got boost when the institute and its KVK started organizing “Mass Awareness Campaign against Crop Residue Burning” since 2015 during October-November, the paddy harvest season. The objectives of the campaign were to aware all the stakeholders about the ill-effects of crop residue burning and to demonstrate available technologies for residue management. The campaign revolved around three main themes. The first, “*Vatayaran Ko Bachao, Bhuse Ko Na Jalao*”, which meant do not burn crop residues and save the atmosphere; the second, “*Khet Ke Avsesh, Khet Main*”, which meant keep the crop residue in the field itself; and, the third, “Earn, not Burn”, which meant burning crop residue is total waste and farmers should earn not just from the grain but also from the residue of the crop.

**Convergence:** Under the campaign, many agencies were involved in accomplishing the stated objectives. The diverse expertise and resources with these partners were considered valuable assets, and the convergence of efforts was seen as the most powerful tool to reach the desired goal. ICAR institutes like CSSRI, Karnal; IIWBR, Karnal; IARI, New Delhi and international institutes like CIMMYT-BISA and other institute like PAMETI, PAU, Ludhiana

were specifically involved considering their expertise with the issue. Further, the platform of 'Mera Gaon, Mera Gaurav' was also utilized to reach to the farmers in the villages. State agricultural universities like PAU, Ludhiana, and CCSHAU, Hisar were the active partners along with the state departments of agriculture of Punjab and Haryana. Cooperative societies, farmers' clubs, farmers' organizations, etc. were also roped in to widen the base of operation. Moreover, noted environmentalist, religious saints, opinion leaders, etc. have also helped in mobilizing masses for the cause. Likewise, print and electronic media, specifically DD Kisan and All India Radio (AIR), were collaborated as the broadcast partners to emphasize the seriousness of the issue of residue burning and highlight the activities undertaken.

**Mass outreach:** KVKs published articles in local newspapers in local language about improved technologies and scientific recommendations for residue management. Moreover, KVKs developed and distributed farm literature in the form of folders, handouts, leaflets, pamphlets, etc. so that all the stakeholders can be made aware about the Central sector scheme on *in-situ* crop residue management and options available for effective residue management. Lakhs of such literature were distributed among the stakeholders. Similarly, timely mobile advisories were released through M-Kisan to enable them to make smart farm choices. Likewise, through the means of smartphones, the necessary information was regularly disseminated among masses. Whatsapp groups were created by each KVK to share experiences, success stories and demonstration results of residue management. Tech-savvy farmers were superbly connected with the KVKs, which paved the way for the virtual platform for sharing lessons and resolving issues, concerns, and queries. KVKs organized radio talks to deliver timely advice to the farmers and to discuss the ill effects of residue burning and options available to manage the residue. TV talks with experts and farmers, success stories and documentaries of farmers managing paddy straw, farmer-scientist interactions and panel discussions, etc. were organized and broadcasted.

The KVK scientists delivered more than 22 TV talks and 27 radio talks. Experts from ATARI, Ludhiana, and KVKs participated in the programme “*Vaad Samvad (Dhan ka Dhuan)*” telecasted on November 5, 2016, on DD KISAN, in which a detailed discussion was held on the seriousness of the residue burning problem and how to effectively and efficiently manage the crop residues. Similarly, DD KISAN also aired “*Vichar Vimarsh- Parali ki Pareshani ko Takniki Madat se Khushhali me Kaise Badla ja Sakta Hai*” on 13<sup>th</sup> and 16<sup>th</sup> of October 2017. The salient findings of experimental sites were also captured in collaboration with DD KISAN in a programme titled “*Khet ke Avshesh Khet me.*” This programme was broadcasted in two series on DD KISAN on May 31, 2018 and June 1, 2018.

**Linking with young minds:** School children can prove to be significant assets when it comes to spreading messages about social welfare issues. Therefore, Krishi Vigyan Kendras (KVKs) delivered lectures in schools, organized poster making, and slogan writing competitions, conducted rallies in the villages with school children during harvesting season. Students and children participated in the rallies enthusiastically and raised slogans to spread awareness about the adverse effects of burning residues and educated people about alternative residue management strategies through the distribution of pamphlets. KVKs motivated students to influence their farmer parents, neighbors, and villagers to give up the practice of residue burning and adopt different residue management technologies. Moreover, Ms. Sonali Sheokand, a Class X student of RE Kanya Mahavidyalaya, Narwana, Jind was honored at ICAR-ATARI, Ludhiana for lodging complaint against her father for burning residues on his farm and being a role model for others as well.

**Extension tools:** The campaign involved organizing activities like *kisan melas*, *kisan sammellans*, *kisan goshies*, trainings, demonstrations, field visits, group meetings with *panchayat* members, etc. Through the campaign, more than 50000 farmers and other stakeholders were contacted during the season. KVKs organized ‘*Village Pheris*,’ ‘*Village Jagran*,’ ‘*Village Sandhya Pheri*,’ ‘*Scientists in evening Chaupals*’ in villages by involving *panchayats*, farmers and officials from agriculture department and



stayed in the villages. Live demonstrations of the technologies were displayed for convincing the farmers about the package of technologies. Interactions between farmers and scientists were organized for answering the queries of farmers. Farmers to Farmers Dialogues (F2FD) were also arranged for sharing experiences and lessons learned.

**Stakeholders' congregations:** A rigorous exercise involving all the stakeholders of agriculture was organized at the ICAR-ATARI, Ludhiana on 17<sup>th</sup> October 2017 titled "Stakeholders' Meet on Residue Management." Similarly, a one-day Stakeholder Dialogue on "Sharing Key Learnings on Sustainable and Scalable Solutions for Rice Residue Management" was organized on 15<sup>th</sup> March 2018. These exercises aimed at sharing experiences and learnings on the issues of crop residue management using different options that would help in developing the future action plan for large scale promulgation of the no-burning agriculture on a sustainable basis. Important reflections that emerged from these meetings were to be used for refining the future strategy.

**Frontline Demonstrations:** Convincing farmers to adopt the technologies, demonstrations on sowing wheat with happy seeders were conducted in KVKs. These demonstrations were laid out by 19 KVKs in prime locations in an area of about 57.6 ha during 2015 and in 64.5 ha in 2016. Farmers were expected to try these technologies in their own field, maybe on an experimental basis, to get firsthand experience of residue management. The results were discussed during SAC meetings of the KVKs and other platforms to spread the word; moreover, special field days and visits were organized to give farmers an exposure of the technologies. Further, similar demonstrations were also organized in farmers' fields in collaboration with the state agriculture department following the participatory approach. *In toto*, demonstrations were laid out in 1335 hectare area during 2015 which increased to 2373 hectares during 2016 involving 151 villages. In Punjab, most numbers of demonstrations were conducted in villages in Fatehgarh Sahib (17 villages) followed by Moga (16), Ropar (13), Gurdaspur (12) and Patiala (10).



### **Harvest Field Day on Happy Seeder Sown Wheat in Sangrur**

**Harvest Field Days:** Krishi Vigyan Kendras (KVKs) of Punjab planned for organizing Harvest Field Days at the demonstration sites of wheat sown with Happy Seeder to educate and convince farmers about the multi-benefits of combo technology of Super Straw Management System (Super-SMS) and Happy Seeder. More than 10,000 farmers were mobilized through these Harvest Field Day and such activities across the districts. The farmers' opinions about the technology were documented and were published through newspapers for broader attention. This unique exercise helped to build confidence among farmers to adopt the technology on a mass scale.

ICAR-ATARI, Ludhiana ensured that every KVK has its



### **Sarpanch, Khosapando, Moga Awarded for Zero Residue Burning by District Administration on Republic Day**

Happy Seeder and KVKs were asked to target the clusters of two to three villages at a time. As a result, during the year 2017, 25 villages in Punjab were made free from residue burning, and more than 120 nearby villages reported negligible residue burning incidences.

### Activities Under the Central Sector Scheme on In-Situ Crop Residue Management

Ministry of Agriculture & Farmers' Welfare, Government of India initiated the Central Sector Scheme on "Promotion of agricultural mechanization for *In-situ* management of crop residue in the state of Punjab, Haryana, Uttar Pradesh and NCT of Delhi" amounting Rs. 1152 Crores for 2018-19 and 2019-20. The Department of Agriculture, Cooperation & Farmers' Welfare (DAC&FW) sanctioned a project to Indian Council of Agricultural Research (ICAR) under this scheme with an outlay of Rs. 21.29 Crores for 2018-19. This project was implemented by ICAR-ATARI, Ludhiana through 22 Krishi Vigyan Kendras (KVKs) of Punjab. KVKs executed the activities under the Information, Education, and Communication (IEC) component. ICAR-ATARI, Ludhiana was also the Nodal Agency for conducting activities of ICAR in Haryana as well as Uttar Pradesh.

**Environment building:** More than 2100 walls of buildings near village streets, village entrance, highways, bus-stops, rain sheds, schools, *panchayats*, pump houses, etc. were painted with slogans to appeal to the eyes of passerby. Similarly, more than 5000 posters, banners, and hoardings were deployed to urge to the value system and shake the conscience. The messages carried information regarding



Wall paintings at prominent places in the villages

ill-effects of burning, technological options, prices of machines, subsidies under the Central scheme, etc.

Local newspapers were flooded with the articles and columns focusing residue management, activities done by KVKs, and efforts of the Government for shunning residue burning. More than 420 advertisements of the scheme and KVK programs were published in the local newspapers. Nonetheless, about 23 specific tunes, songs, and jingles were recorded and played regularly on radio since paddy harvesting season till wheat sowing was over. More than 65-panel discussions and programs were broadcasted on local television channels, DD Kisan and other private channels. Alongside, publicity materials like leaflets, folders, and pamphlets were distributed among more than 3.5 Lakh stakeholders to provide preliminary information about ill-effects of residue burning and provisions under the Central scheme. Moreover, around 500 awareness programs were conducted at village, block and district levels. Likewise, 36 *kisan melas* in which around 2 lakh farmers participated were organized to drive people's attention to the issue and to exhibit technological solutions to solve the issue.



**The alliance with the young minds:** School and college students were specifically targeted as the potential stakeholders to help their farmer parents, neighbors and villagers to come out of their

comfort zone and adopt latest technologies for *in-situ* residue management. About 23,000 students of 142 schools and colleges were informed about the problem of residue burning and the Central scheme and were asked to read more in newspapers and magazines to get necessary details and understanding of residue management issue. Lectures were delivered to inform students, and different competitions were organized to bring out their reflections in the forms of posters, slogans, essays, etc. KVKs with the motivated young minds organized awareness rallies/*chetna pheries* in village to convey the message for *in-situ* residue management. Such rallies also involved distribution of literature on the topic of residue management among farmers and other stakeholders.

**Preachers and conservationists in the driver's seat:** Few KVKs handed over the steering wheel of residue management drive to religious leaders like Baba Sewa Singh, Baba Balbir Singh Seechewal and Baba Gurmeet Singh and results were astounding. They lead the campaign from the front and mobilized farmers and other stakeholders to spread the message. Verses of religious texts highlighting the necessity of co-existence between nature and humankind were time and again reiterated. It helped people in introspecting themselves and giving a serious thought on the way human beings are affecting nature and its phenomenon.

**Padma Shri Baba Balbir Singh Seechewal:** Also known as the "Eco Baba," environmentalist Baba Seechewal collaborated with KVK, Jalandhar and KVK, Kapurthala in its awareness drive. During an awareness rally in Kapurthala, he covered around 50 villages with devotees, volunteers, and KVK staff to popularize *in-situ* residue management practices. He invited youth to come forward and take the lead in adopting new technologies and searching entrepreneurial avenues of self-employment through Custom Hiring Centres. Similarly, he presided as the Chief Guest of *Kisan Mela* organized at KVK, Jalandhar, where he talked about the adverse effects of residue burning and appealed to the participating 3500 farmers to follow environment-friendly practices.

**Padma Shri Baba Sewa Singh:** Social worker and environmentalist Padma Shri Baba Sewa Singh was the Chief Guest of *Kisan Mela*



organized by KVK, Kapurthala for popularizing *in-situ* crop residue management. He interacted with the participating farmers and other stakeholders about the issue and guided to stay away from all the activities that pollute our environment. He inaugurated the exhibition on machines used for residue management and appealed farmers to follow scientifically proven technological solutions than opting for burning. He also urged everyone to treat soil as a living being and respect its ability to sustain humankind.

**Baba Gurmeet Singh:** Sant Baba Gurmeet Singh has been the proponent of KVK in villages namely Khosa Pando, Khosa Kotla, Khosa Randhir, Khosa Jalal, and Ghagra to bring down burning to almost zero. During the farmer-scientist interfaces, he recommended the latest paddy residue management technologies to the farmers. He also stressed on youth to start Custom Hiring Centers. He asked farmers to swear by the *Gurbani* to never burn crop residues. Baba also partnered with the KVK to sensitize school students about residue burning and its effective management. He stresses on collective efforts and actions for enabling youth to manage paddy straw scientifically.

**The proponent of mission 'zero burning':** A 53-year-old devotee Sikh, Sardar Gurbachan Singh, a resident of Burj Deva Singh Wala village of Tarn Taran has close coordination with Krishi Vigyan Kendra, Tarn Taran (Punjab) and ICAR-ATARI, Ludhiana. S. Gurbachan Singh first time narrated the incidence of fixing the marriage of his son on the condition that bride's father will not burn crops residue on his farms during the Stakeholders' Meet at

ICAR-ATARI, Ludhiana on 15th March 2018 which was shared with media, and consequently it reached to PMO. Hon'ble Prime Minister of India, Sh. Narendra Modi recognized the contribution of S. Gurbachan Singh efforts in paddy straw management in "Mann Ki Baat" (Episode 49, 28 October 2018) programme.

Hon'ble Prime Minister also recognized Kalar Majri village (near Nabha Tehsil of Patiala) for its dedicated work of residue management which was declared as Zero Stubble Burning Village in the convergence mode where KVK, Patiala and Agriculture department worked together for making this village Burning Free during 2017. He admired all farmers of this village for this unique work and urged others to follow the path shown by Kalar Majri.

**Capacity Building:** ICAR-ATARI, Ludhiana in collaboration with Department of Farm Machinery and Power Engineering, PAU, Ludhiana organized capacity building programme on "In-situ paddy residue management through machinery" for the experts of KVKs during early August. These training programs aimed at providing technical know-how of machines, their usage, etc. along with the details of the Central Scheme and expectations out of KVKs. Live demonstrations on machine operations, hands-on training sessions, and visits to machine fabricators, custom hiring centres, etc. were also organized.

KVK scientists organized more than 160 hands-on trainings for about 4500 farmers, tractor owners and machine operators on managing crop residue with the machines, their calibrations, maintenance, etc. The participants were specifically apprised about the combo technology of Super Straw Management System (Super-SMS) and Happy Seeder and its multi-benefits. Participants were provided literature on practical usage of machines in the field, certain specific tips, do's and don'ts, etc. Special Question-Answer (Q&A) sessions were conducted to remove doubts and bring clarity in terms of using machines.

**Demonstrating the potential of technologies:** Result demonstrations on Happy Seeder sown wheat, Zero-Till drill sown wheat, etc. were conducted in the farmers' fields to display actual field condition. The farmers were free to see the crop condition at any



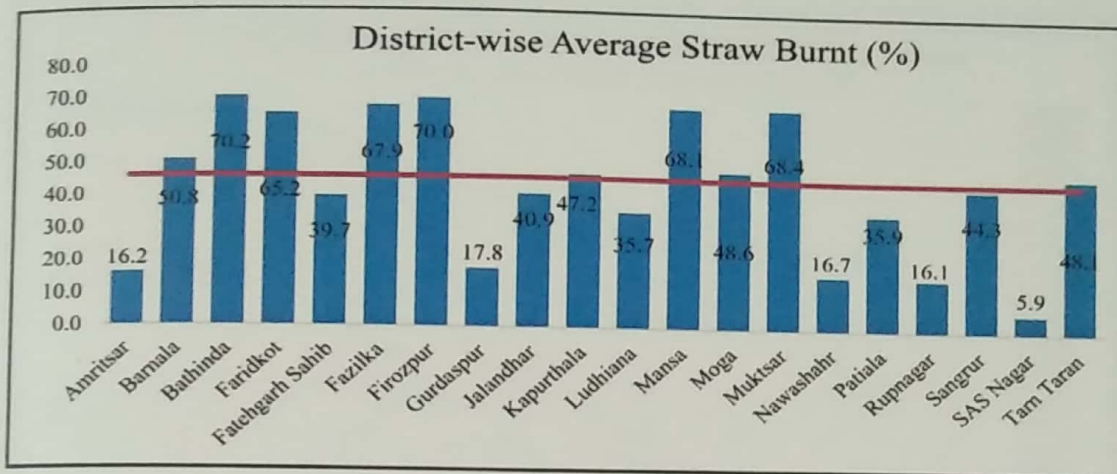
point of time and were expected to try out the same in their farms. Moreover, few active and curious farmers were selected during exposure visits and discussions to conduct demonstrations on their fields. Thus, demonstrations in the farmers' fields on different in-situ residue management technologies were organized in more than 9500 ha while obtaining the participation of around 12,000 farmers. Similarly, around 110 exposure visits were organized, in which the farmers from other villages were taken to show demonstrated the potential of technologies in the field.

**Field Days and Harvest Days:** Therefore, Harvest Field Days were organized to bring farmers to locations of demonstrations to witness results in terms of wheat yields. It enabled Farmer-to-Farmer (F2F) dialogue and exchange of experiences and reflections. Thus, more than 120 Field Days and Harvest Days were organized across three states in which more than 7,000 farmers participated. Farmers were motivated to celebrate *Baisakhi* as “*No Crop residue Burning Day*” and were informed about alternative residue management technologies. KVKs collaborated with officials of ATMA and State Department of Agriculture & Farmers' Welfare for wider impact of the program.

### **Impact of Activities**

In order to know the effect of various activities carried out under this project in term of area expansion, improvement in air quality and monetary benefits, data on different aspects were collected from different agencies like ICAR-CREAMs, PSRSC, PSPCB, Department of Agriculture, etc., and analyzed which are described below:

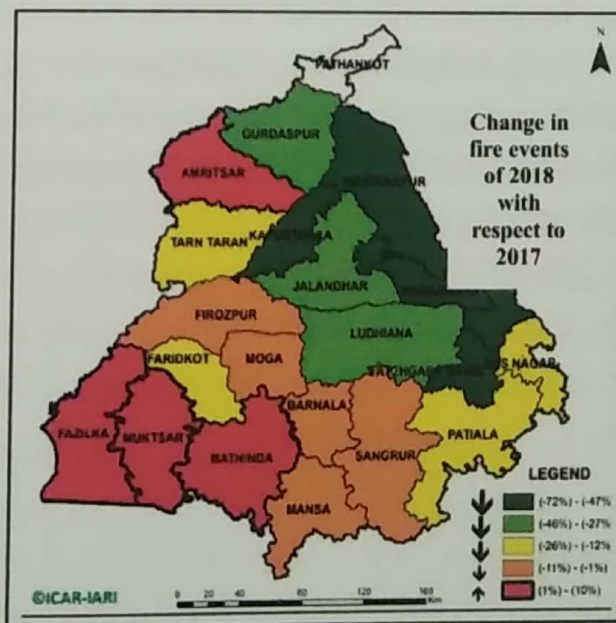


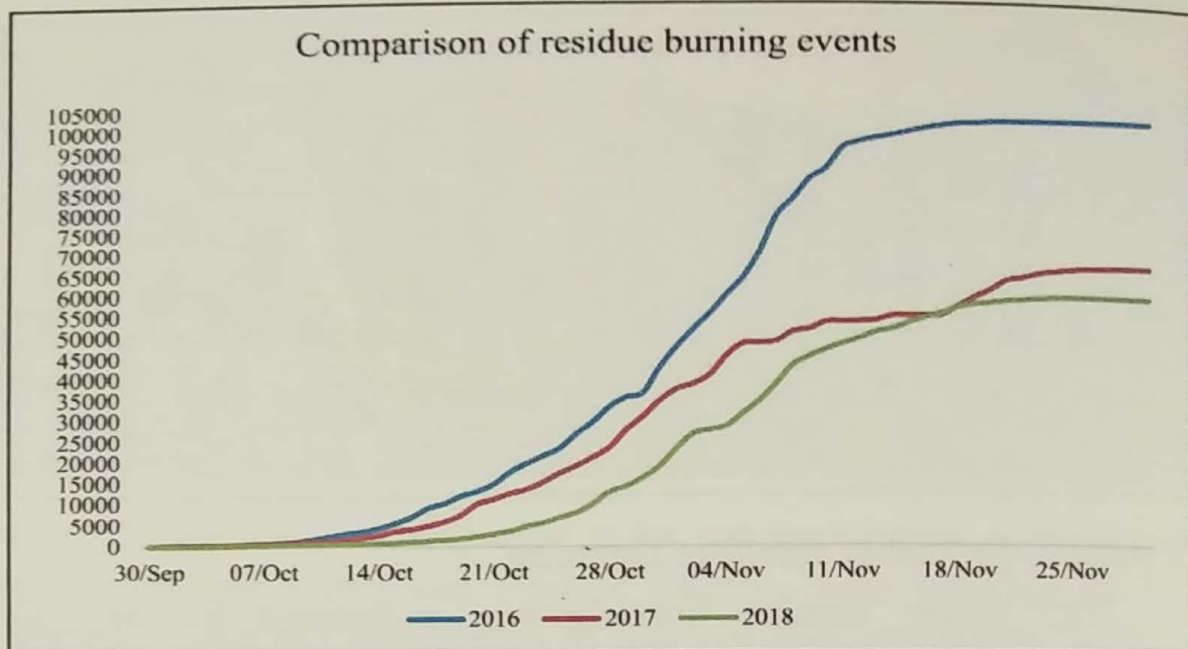


### i) Impact on Paddy Residue Burning

The paddy residue burning was monitored by multiple satellites with thermal sensors during the paddy harvest and wheat sowing season period from 30 September to 30 November. High-resolution satellite images at 20 m were acquired for pre-burning and post-burning period to map paddy acreage and paddy area burnt in 20 districts of Punjab during 2018. The area statistics were used to estimate paddy straw burnt by the Indian Council of Agricultural Research's (ICAR) Consortium for Research on Agro-ecosystem Monitoring and Modeling from Space (CREAMS) Laboratory at Division of Agricultural Physics, Indian Agricultural Research Institute (IARI), New Delhi.

In Punjab during 2018, remote sensing estimated burning in 1.51 mn ha paddy area (51%) out of total 2.96 mn ha area planted for 20 major paddy growing districts. The estimates suggest burning of 11.81 Mt paddy straw (46.4%) out of total 25.48 Mt, on dry weight basis. Firozpur, Sangrur and Muktsar districts reported highest paddy area burnt and highest burning events in 2018. During 2018, about 11.01% and 41.69% reduction

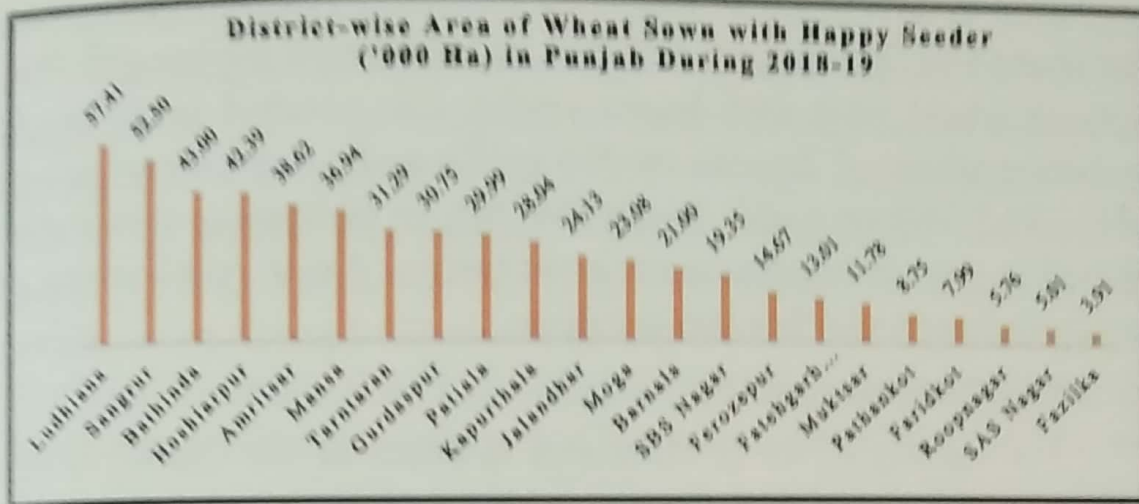




in the number of burning events were observed in 2018 as compared to that in 2017 and 2016, respectively. The districts of Hoshiarpur, Kapurthala, Nawanshahar (SBS Nagar) and Ropar witnessed 47% to 72% lesser burning events in 2018 as compared to 2017. Similarly, Gurdaspur, Jalandhar and Ludhiana districts reported 27% to 46% reduction in burning; whereas it was 12% to 26% for Mohali (SAS Nagar), Patiala, Faridkot, and Tarn Taran districts. At the same time, an increase of 1% to 10% in number burning events was observed in Amritsar, Fazilka, Muktsar and Bathinda districts. The majority of burning events were recorded between 27<sup>th</sup> October and 09<sup>th</sup> November. The comparison between fire intensity classes between the events of 2018 and 2017 for Punjab suggest a change of about 1.2% of fire event's intensity from very high to low. This change in terms of fire intensity signifies shift towards partial burning of residue implying lower emission of particulate matter.

## ii) Impact on Spread of Happy Seeder/Zero Tillage Technology

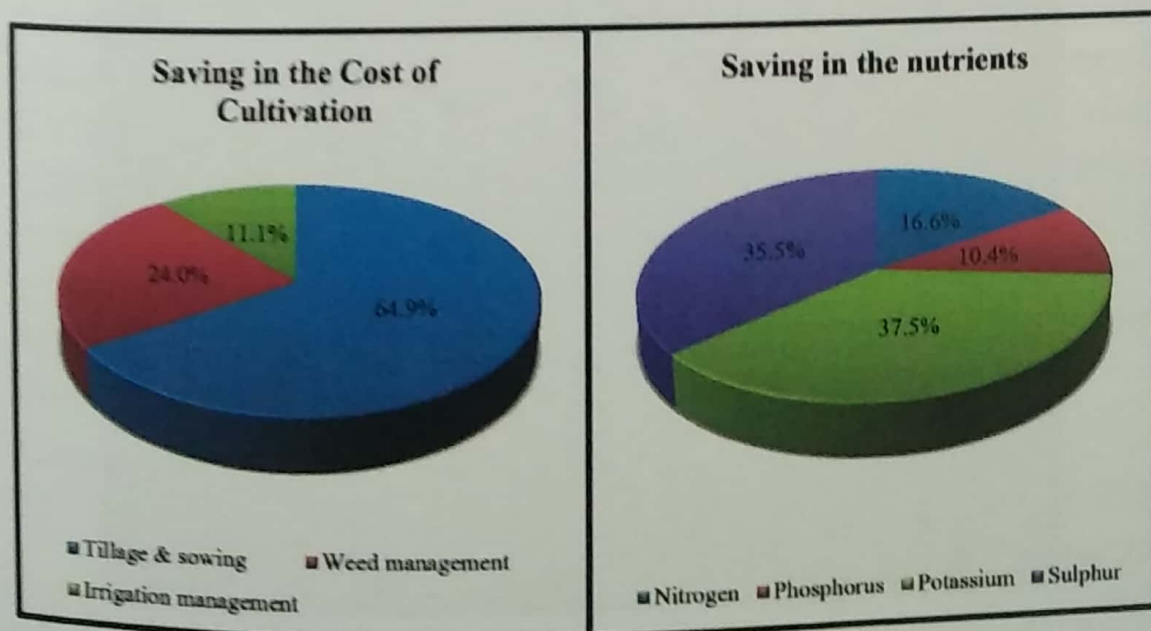
Punjab Remote Sensing Centre (2019) estimated that the wheat area under Happy Seeder in Punjab was at 5.49 lakh ha, while remote sensing technology couldn't assess area under residue incorporation. The district-wise Happy Seeder sown wheat area in Punjab was the highest in Ludhiana (57,410 ha) followed by Sangrur 52,500 hectare, while the minimum area was in Fazilka (3,910 ha). Print media reported the estimated figure of 6 lakh ha of wheat sown area



under paddy residue management (zero paddy straw burning) using various approaches during 2018 (The Indian Express, 21 December 2018).

**Impact in monetary terms:** Our earlier studies based on 4100 demonstrations laid on 1640 ha clearly indicate saving of cost of cultivation to the tune of Rs. 4500 ha<sup>-1</sup>. This saving is mainly due to reduction in the cost of tillage (64.8%), cost of weed management (24%) and cost of irrigation management (11.1%). If we extrapolate on an area of 0.8 million ha, the saving into cost of cultivation is 247.05 Crore year<sup>-1</sup> in the states of Punjab during 2018.

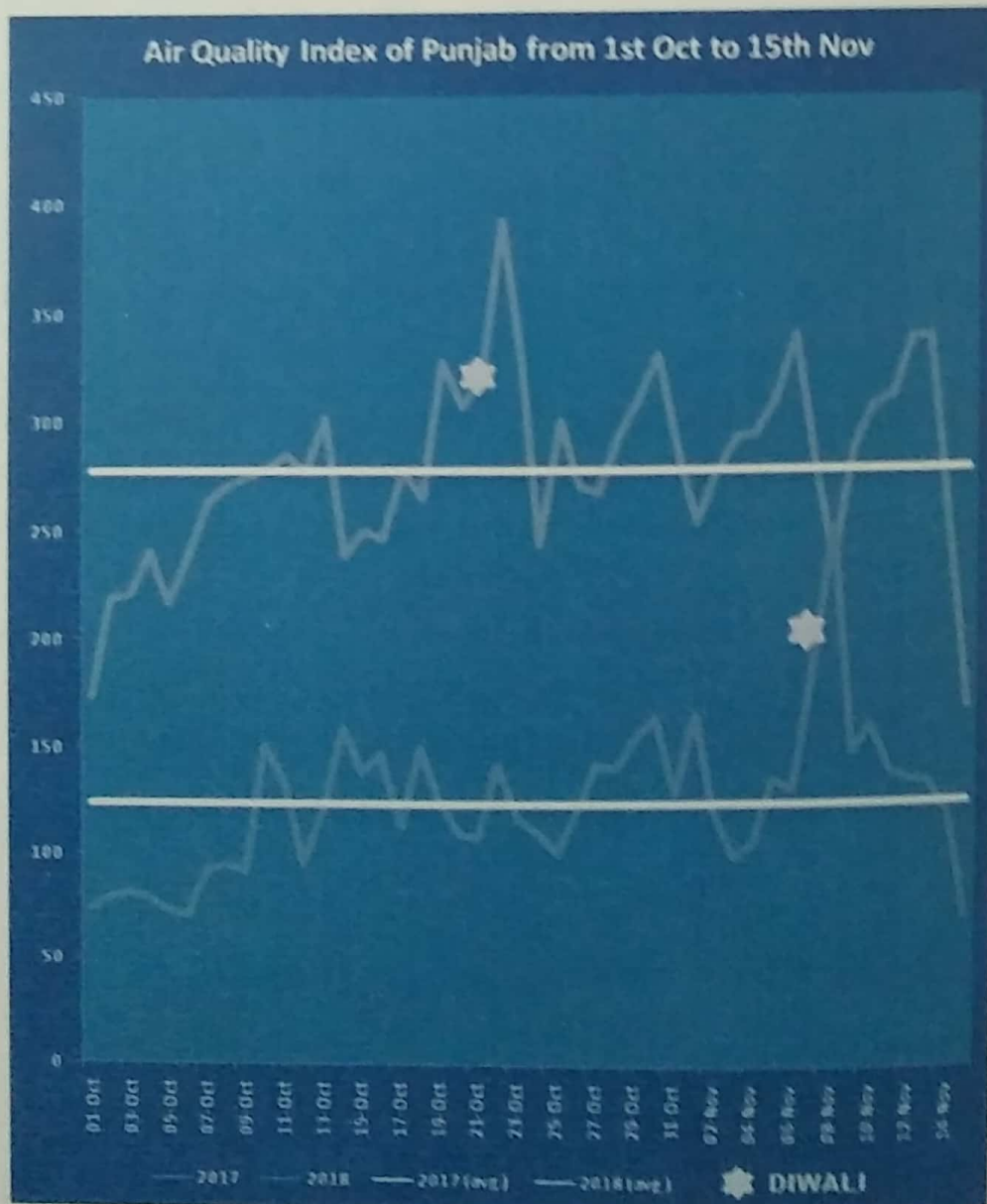
Similarly, the equivalent value of loss of nutrients due to burning of paddy straw is estimated to be Rs. 3300 per ha; thus, the total value of nutrient loss due to burning of paddy straw is Rs.181.17 Crore/year. The saving in terms of cost nutrients can be



attributed to saving for nitrogenous fertilizers (16.6%), phosphatic fertilizers (10.4%), potash (37.4%) and elemental sulphur (35.4%). Sowing wheat crop with happy seeder also resulted in saving of irrigation water of 7cm/ha or 700 m<sup>3</sup>/ha and a total water saving of is 384.3 Million Cubic Meter (MCM). In addition to this, it also helped in overall improvement in air quality due to non-burning of paddy residue and other eco-services.

### iii) Impact on Air Quality

The quality of air is measured in terms of Air Quality Index (AQI), which considers the quantity of eight parameters in the air namely PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO, O<sub>3</sub>, NH<sub>3</sub>, and Pb. Punjab Pollution Control Board (PPCB) monitors AQI through eight Continuous Ambient Air Quality Monitoring Stations (CAAQMS)



across Punjab.

The Air Quality Indices for Punjab during 1<sup>st</sup> October to 15<sup>th</sup> Nov suggest that there was a significant improvement in the air quality during 2018 as compared to that in 2017. Punjab Government-issued data of air quality on National Pollution Control Day depicts that the Air Quality Index was 273 (Poor- breathing discomfort to most people on prolonged exposure) during November, 2017 which has significantly reduced to 132 (Moderate – Breathing discomfort to the people with lungs, asthma and heart diseases) during November, 2018. The range of AQIs during 2017 was from 168 to 393 (Moderate to Very Poor), which has come down 69 to 251 (Satisfactory to Poor) in 2018.

Moreover, the sharp rise in AQI during 21<sup>st</sup> October 2017 immediately followed by sharp decline can be attributed to the festival of *Diwali*, which was on 19<sup>th</sup> October. Since the festival was in October in 2017, a sharp decline in AQI was also noticed after 12<sup>th</sup> November. Similarly, the sharp rise in AQI on 8<sup>th</sup> November immediately followed by a sharp decline was due to *Diwali* on 7<sup>th</sup> November in 2018. Therefore, the decline in AQI after 12<sup>th</sup> November in 2018 was not as sharp as that in 2017.

#### **iv) Impact on Residue Burning Free Villages**

Each KVK has focused 3-5 adopted villages where intensive efforts were carried out for converting these villages into residue burning free villages. KVK Team worked with farmers and *Panchayats* in participatory mode. Consequently, in Punjab, 101 villages were declared as almost Stubble Burning Free by respective KVKs in 2018 covering more than 34,000 hectares. Villages, where eighty to eighty-five percent residue was managed without burning, were considered as nearly zero burning villages. Further, 1341 villages across Punjab (out of about 8000 villages where paddy is being grown, which constitute about 17%) were declared as Zero Stubble Burning Villages during 2018.

#### **Learning from CRM Project Implementation:**

- 1) All-out efforts should be made to ensure attachment of SMS with the combined harvesters. Enforcement of this in letter and

spirit will discourage burning, notably the partial burning.

- 2) All-out efforts should be made to utilize machines available with the Cooperative societies to use these machines to the fullest capacity. Maintaining logbooks and other strict monitoring measures should be kept in place to ensure proper utilization of the machines.
- 3) More machines and awareness activities are needed in the interior areas of the districts, particularly in the border belt of Punjab.
- 4) Previous experiences indicate an increase in fire events during holidays (Saturdays, Sundays, festivals, etc.); therefore, state department officials must work with farmers for residue management on the holidays at least during peak season i.e. 25<sup>th</sup> October to 15<sup>th</sup> November.
- 5) States should formulate list of all Nodal Officers well in advance and their duties must be well defined. Convergence is the most powerful tool; hence, all stakeholders should work as a team to mobilize farmers in a campaign mode.
- 6) Volunteers/scouts/para-extension workers should be involved and each village should have at least one of these to convey timely messages.