

National Academy of Agricultural Sciences

Innovative Viable Solution to Rice Residue Burning in Rice-Wheat Cropping System through Concurrent Use of Super Straw Management System-fitted Combines and Turbo Happy Seeder



New Delhi
October 2017

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October 2017

Printed : 24 October, 2017

Citation : NAAS 2017. *Innovative Viable Solution to Rice Residue Burning in Rice-Wheat Cropping System through Concurrent Use of Super Straw Management System-fitted Combines and Turbo Happy Seeder. Policy Brief No. 2*, National Academy of Agricultural Sciences, New Delhi. 16 p.

Preface

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In recent years, rice crop residue burning has become a serious national concern due to deteriorating air quality, particularly in the rice-wheat cropping system in North-West India. **This problem was also highlighted by the Hon'ble Prime Minister** in the meeting of the Secretaries of Science Departments chaired by him on July 18, 2017, and **he desired the urgent need "...to address this problem in next one year"**.

This policy brief, developed by the National Academy of Agricultural Sciences, to address the problem of air pollution due to crop residue burning, **provides an innovative viable solution to check burning of rice residues**, which is a major contributor to air pollution in the early winter months in North-West plains of India. The Academy hopes that the Central and State Governments of the affected States will approve promotion of the simple solution suggested in the brief as complementary approach to the ongoing efforts, to provide a sustainable solution to the problem of crop residue burning. **Main advantage of the approach proposed in the brief is that it will improve economic returns to the farmers and will improve soil health, while eliminating environmental pollution from the area covered by the proposed technology, without any extra cost to the exchequer.**

The NAAS can play an important role in implementing the suggested recommendations, by (a) organizing interactive meeting of the Agriculture Officers of the affected States, representatives of industry, service providers and other stake holders, (b) developing extension materials – posters, leaflets, short videos, TV programmes, etc., (c) arranging training programmes, (d) providing technical back up to the industry and farmers, and (e) monitoring and impact assessment.

On behalf of the Academy I compliment the **Committee and discussants** for their valuable efforts in developing the policy brief.

Dated : 24 October, 2017



Panjab Singh
President

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Innovative Viable Solution to Rice Residue Burning in Rice-Wheat Cropping System Through Concurrent Use of Super Straw Management System-fitted Combines and Turbo Happy Seeder

1. Introduction

The ricewheat cropping system (RWCS) is a major production system in the Indo-Gangetic Plains of India covering nearly 10.5 million hectares including 4.1 million hectares of the northwestern (NW) states comprising Punjab, Haryana, Uttarakhand and western Uttar Pradesh (Figure 1). RWCS in NW states produces about 34 million tonnes of rice residues of which Punjab alone contributes about 65%. The mechanized harvesting and threshing of rice using combine harvesters is a common practice in NW India. In the process, residues are left behind the combine harvesters in a narrow strip (windrow) in the field. Disposal or utilization of the leftover residue in the short window of ten to twenty days for timely planting of wheat crop is a difficult task⁹. Therefore, the farmers commonly opt for burning of rice residue in the combine-harvested fields due to lack of access to user-friendly, cost- and time-effective options¹⁴. Estimates indicate that up to 80% of rice residues are burnt by farmers in Punjab. In other NW states also, rice burning is practiced in a sizeable area. It is estimated that in NW states of India about 23 million tonnes of rice residues are burnt annually. Collection and storage of such a huge quantity of residue is neither practically feasible nor economical⁹. Therefore, the need for providing a cost-effective and farmer friendly option for the management of rice residue is both a major challenge as well as an opportunity for the sustainability of the intensive RWCS in NW India.

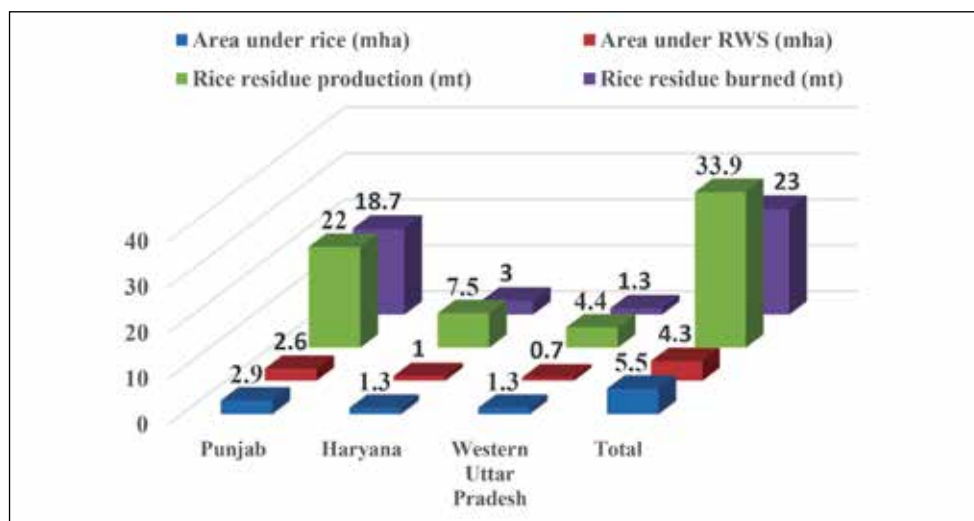


Figure 1. Estimated area and production of rice, total rice residue production and burnt in North-West India (Estimates are based on residue: grain ratio of 1.3. Area under rice includes 0.45 million ha under basmati rice in Punjab and 0.5 million ha in Haryana. Uttarakhand and western Uttar Pradesh comprises Meerut, Saharanpur and Bareilly Divisions and Nainital, Haridwar and Dehradun districts).

2. Adverse impact of rice residue burning

The problem of crop residue burning has been intensifying over time and spreading across the Indian Sub-continent. The NASA satellite images of early November 2016 (peak period of rice residue burning) depicts the burning hot spots across south Asia and shows that the intensity of rice residue burning in Punjab, Haryana, western Uttar Pradesh and Uttarakhand is very high (Figure 2), resulting in deterioration of air quality in vast geographical area. Crop residue is contributing to atmospheric pollution that has serious environment, soil, and human health as well as economic implications due to release of large amounts of air pollutants. Therefore, **a concerted collective action to solve the problem of crop residue burning is urgently required.**

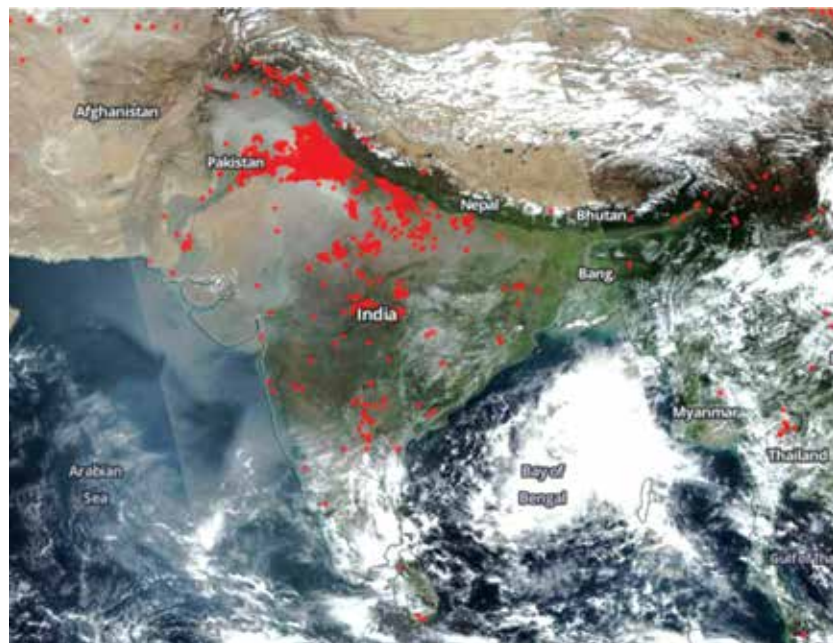


Figure 2. NASA satellite images (November 03, 2016) showing intensity of rice residue burning (shown in red dots) in North-West India.

2.1 Environment

The major pollutants emitted by crop residue burning - CO_2 , CO , CH_4 , N_2O , NO_x , SO_2 , black carbon, non-methyl hydrocarbons (NMHC), volatile organic compounds (VOC) and particulate matter (PM_{2.5} and PM₁₀), contribute enormously to global warming^{5,10}. Extensive crop burning, resulted in Delhi air becoming the most polluted in the World in the first week of November 2016, compelling the Government to declare Delhi air pollution an emergency (www.theguardian.com/World/India). It is estimated that one tonne rice residue on burning releases 13 kg particulate matter, 60 kg CO , 1460 kg CO_2 , 3.5 kg NO_x , 0.2 kg SO_2 ³. The black carbon emitted during residue burning warms the lower atmosphere and it is the second most important contributor to global warming after CO_2 .

2.2 Soil health

Apart from the damage caused by air pollution, burning of rice residue also results in loss of soil organic

matter and plant nutrients and adversely affects soil health⁹. **About 90% of N and S and 15-20% of P and K contained in rice residue are lost during burning⁴**. Burning of 23 million tonnes of rice residues in NW India leads to a loss of about 9.2 million tonnes of C equivalent (CO₂-equivalent of about 34 million tonnes) per year and a loss of about 1.4×10⁵ t of N (equivalent to Rs 200 crores) annually. In addition, in-field burning of crop residues also destroys the beneficial micro-flora and fauna of soil causing adverse impact on soil health.

2.3 Human health

Increase in the concentration of PM 2.5 and PM10 during the large scale burning of rice residues is a major health hazard⁵. For example, the children are more sensitive to air pollution (smog), as rice residue burning poses some unrecoverable influence on their pulmonary functions⁸. The emission of high levels of PM2.5 and PM10 in the air causes chronic diseases like cardiopulmonary disorders irrecoverable lung capacity or asthma in human population of NW India. The survey and economic evaluation showed a clear increase in medical and health-related expenditure and workdays lost during the rice residue-burning period (September–November) each year in Punjab¹⁰. These health-related expenditures tend to be higher for children, older people and farm workers who are directly exposed to rice residue burning. The human health costs from rice residue burning in rural areas of Punjab are estimated at Rs. 7.61 crores annually¹⁰. The costs would be much higher if expenses on averting activities, productivity loss due to illness, monetary value of discomfort, etc., are also included.

3. *Practices in current use for rice residue management*

The practices in current use, for utilizing rice residue, include livestock fodder, livestock bedding, in-situ incorporation, composting, generating electricity, mushroom cultivation, roof thatching, biogas (anaerobic digestion), furnace fuel, biofuel, and paper and pulp board manufacturing^{4,8,9}. Presently these options together utilize <15% of the total rice residue produced in NW India. Of the various available options, electricity generation, production of bio-oil and on-farm utilization of rice residue are the major practices in current use.

3.1 Electricity generation

Generation of electricity is an attractive option but, at present, only seven-biomass energy plants have been installed in Punjab and six more are in the pipeline. However, these biomass energy plants together can consume only about 10% of the rice residues in the state. A 12 MW rice residue power plant requires 1.20 lakh tons of residues in a year which needs a large dumping ground. In addition, these biomass energy plants produce large amount of ash and there is a serious challenge for its disposal. For the time being, it is dumped in landfills or depressions created by brick kilns.

3.2 Bio-oil and gasification

Technologies to produce bio-oil (pyrolysis) and gasification are still under research and development to make them economically viable. Most of the furnaces in the Punjab use 25-30% of rice residue mixed with 70-75% of other biomass and the present utilization of rice straw is only 0.5 million tonnes annually. Limited utilization of this technology is primarily due to high silica content in rice straw, which causes clinker formation in the boilers. Moreover, collection (baling) and removing the rice residue from the fields

for use in biomass based energy plants is counterproductive for the soil health mission of Government of India. Because removal of crop residues deprives the soil of huge amounts of essential plant nutrients and soil organic matter, which will adversely affect soil health and sustainability of cropping systems.

3.3 On-farm management of rice residue

Surface retention, incorporation (*in-situ*) and composting (*ex-situ*) are the promising on-farm management options to address the issue of burning as well as maintaining soil health and long-term sustainability of RWCS. However, *in situ* incorporation and composting (*ex-situ*) are energy and cost intensive, and time limitation options. For example, residue incorporation requires 2-3 extra tillage operations in addition to the use of chopper to reduce the size of residue, and one additional irrigation as well as extra dose of urea to hasten its decomposition. That's why the rice residue incorporation and composting have not been adopted at large scale by the farmers. Furthermore, time needed for decomposition of rice residue is a major limitation, because of little turn-around time (10-20 days) available between rice harvest and optimal wheat sowing time. The delay in sowing due to time needed for residue decomposition adversely affects wheat productivity.

4. Innovative Viable Solution to Rice Residue Burning

4.1 Rationale of concurrent use of super straw management system (SMS)-fitted combines and Turbo Happy Seeder in rice-wheat cropping systems

In NW India, combines are used for harvesting rice in 70-90% of the area under RWCS, leaving huge quantities of residues and stubbles on the field. Efficient and economic management of 8-10 t/ha rice residues and seeding of wheat crop on time is a daunting task for the farmers, due to the availability of a short window of about 15 days to complete these operations. Loose residue in combine harvested rice fields interfere with the tillage and seeding machinery. Until recently, non-availability of suitable machinery was a major constraint to direct drilling of wheat in combine harvested fields. This constraint has been resolved by the innovative **latest version of the Turbo Happy Seeder, which is recognized as a significant technological innovation for *in-situ* residue management**¹². Through extensive trials, participatory validation and demonstrations, the Turbo Happy Seeder has proven to be extremely useful¹². It was a step forward for developing viable solution to rice crop residue burning.

For efficient sowing of wheat using Turbo Happy Seeder, the loose rice residue need to be uniformly spread across the field, but the traditional combine harvesters put the loose residues in narrow swath. Manual spreading of residues is a cumbersome, uneconomical, inefficient and laborious process, compounded by the acute shortage of labour. Therefore, a straw management system (SMS) named as Super-SMS has been developed and commercialized by Punjab Agricultural University, Ludhiana, to equip the combine harvesters with mechanized straw spreaders, which help in uniformly spreading the rice residue as a part of the process of harvesting rice. Harvesting of rice by super SMS fitted combine harvesters allows concurrent sowing of wheat, which saves time, energy and one irrigation by utilizing the residual moisture of rice fields. **Most importantly, it dispenses the need for crop residue burning.** This valuable eco-friendly innovation is an attractive option for adoption by the farmers.

The innovative concurrent use of super SMS-fitted combines and Turbo Happy Seeder (Figure 3) was successfully evaluated for wheat sowing on 120 ha at the Borlaug Institute for South Asia (BISA) at Ladhowal (<https://www.youtube.com/watch?v=HjMbHuBGYd4&feature=youtu.be>) and in over 100 ha in the climate smart villages under CIMMYT-CCAFS program on climate smart agriculture (CSA). This combination facilitated easy operation of the Turbo Happy Seeder with about 20-25% increase in its capacity and less wear and tear of cutting flails.

The following two are basic requirements for large-scale **adoption of concurrent use of super SMS-fitted combines and Turbo Happy Seeder in rice-wheat cropping systems**

- (i) availability of combine harvesters fitted with straw management systems (SMS), and
- (ii) farmer access to quality Turbo Happy Seeder coupled with skills to operate it.

To facilitate the first requirement, **the Government of Punjab has made Super SMS attachment mandatory for the registration of all new combine harvesters. Similar policy decisions are also required for all the other States affected by crop residue burning issues.**

The cost of each super SMS attachment is approximately Rs. 1.2 lakh, and the cost of Turbo Happy Seeder is about Rs. 1.3 lakh. These costs can easily be recovered by the custom hiring service providers, through marginal increase in the charges for custom hiring. Considering the economic advantage to the farmers and other environmental and social benefits of the technology package requiring concurrent use of SMS-fitted combines and Turbo Happy Seeder compared over the conventional tillage based management practices, this innovative technology is expected to be adopted by the farmers very fast. Though the adoption of this technology has remained slow in past but with the introduction of complete package specially the super SMS attachment with combine harvesters coupled with awareness campaign by range of stakeholders, the technology is gaining popularity. Accordingly, within past couple of months in Punjab alone, over 1000 combine owners have already mounted Super SMS and a demand of nearly 2000 happy seeders has been put to manufactures. This shows scalability potential of the technology.



Figure 3. Concurrent use of SMS-fitted combine for harvesting rice and sowing of wheat by two Turbo Happy Seeder for efficient operation.

4.2 Advantages of concurrent use of SMS-fitted combines and turbo happy seeder

Concurrent use of SMS-fitted combines and turbo happy seeder for wheat sowing has distinct production, economic, environmental and societal advantages (Figure 4). Some of the major advantages are:

- **Increase in average yield** of wheat by 2-4% compared to conventional till wheat¹².
- **Economical cost of production**, through savings in the cost of labour, fuel, chemicals, etc.¹²
 - ❖ Saves about 20 liters of fuel per hectare due to sowing of wheat in a single operation. A total saving – $20 \times 4.3 \text{ Mha} = 86$ million liters of diesel fuel per season.
- **Increase in nutrient use efficiency**^{6,13}, by continuous recycling of residues using Turbo Happy Seeder for over 3-4 years results in producing same yield with 30-40 kg ha⁻¹ less nitrogen use and hence significantly higher (10-15%) nutrient use efficiency.
- **Produces more crop per drop of water**, by saving up to 1.0 million liters of water per hectare due to elimination of pre-sowing irrigation⁷. Moreover, residue mulch reduces evaporation loss equivalent to about 45 mm (0.45 million liter) during the wheat season.
- **Reduces risk of biotic and abiotic stresses**, by reducing weed growth, crop lodging, karnal bunt infestation and termite attack. Wheat yields were nearly 16% more than farmers who followed conventional practices, when heavy rains fell late in the wheat season at grain filling stage in 2014-15².
- **Improves soil health**, by improving soil **organic matter** over time, which enhances soil health, productivity potential and soil biodiversity⁶.
- **Improves environment** by :
 - ❖ Reduction in greenhouse gas emissions. It significantly reduces fossil fuel requirement, thus further reducing CO₂ emissions⁷.



Figure 4. Multiple benefits of the rice residue management through concurrent use of SMS-fitted combines and turbo happy seeder ^{2,4,7,12,13}.

- ❖ Reduces terminal heat effects, as straw mulch lowers canopy temperature in wheat and helps in adapting to terminal heat⁷.
- ❖ Reduction in air pollution by PM_{2.5} and PM₁₀ particles, black carbon and obnoxious gasses, by preventing burning of crop residues.
- **Improves health of on-farm and off-farm workers³.**
- **Saves depletion of N, P, K and S in soil.** It is estimated that one tonne of rice residue contains about 400 kg of C, 5-7 kg N, 1-1.7 kg P, 15-25 kg K and 1.1-1.4 kg S in addition to the significant amounts of micronutrients. Total amount of N, P, K and S (NPKS) in 23 million tonnes of rice residue (currently burnt in NW India annually) is about 7 lakh tons N, P, K, S valued at >Rs. 1000 crores. Whole of organic carbon and about 2.8 lakh tons of NPKS (equivalent to about Rs. 250 crores) is lost during burning. Thus, rice residue recycling offers an important source for meeting the nutrient requirements of crops and improving soil health.
- **Inclusion of this effort in carbon credit program** would help in farmers actually receiving incentives and additional income, which will further encourage adoption of Happy Seeder technology.
- **The estimated gross additional income from the adoption of Turbo Happy Seeder technology package**

Even if the 50% of the wheat seeding in RWCS of NW India is targeted; the benefits from 2.0 million ha alone would be about Rs. 1430 crores per year against the total one time investment of Rs. 470 crores. The input costs include, Rs. 325 crores for the purchase of 25000 Turbo Happy Seeders and Rs. 145 crores for 12000 super SMS. The benefits include increased wheat yield @ 200 kg/ha (Rs. 600 crores), reduced production costs of Rs. 2500/ha (Rs. 500 crores), eliminating loss of N and S during burning (Rs. 20 crores), saving in pumping cost due to saving in pre-sowing irrigation (Rs. 200 crores), reduction in environmental costs @ Rs. 250/t of CO₂ eq (Rs. 100 crores) and another benefits equivalent to Rs. 10 crores (soil health improvement, accidents, loss of biodiversity, etc.).

4.3 Current adoption scenario

The on-field management of rice residue using the technology for concurrent use of SMS-fitted combines and turbo happy seeder has a great prospect for reducing rice residue/stubble burning in NW India, but, despite the ban imposed by some State Governments, large quantities of rice residue are still being burnt. Notwithstanding the demonstrated multiple benefits of concurrent use of combines and turbo happy seeder, adoption of this technology is slow, covering merely ~5000 ha across NW India. To encourage its adoption, some States have made provision of subsidy for purchase of Turbo Happy Seeder. In December 2015, NGT in its order has directed the States affected by crop residue burning to subsidize straw management machines and incentivize farmers to collect the residue for alternative uses. NGT has also directed the States to implement the 'National Policy for Management of Crop Residue' drawn by Ministry of Agriculture and Farmers Welfare in 2014 and take steps to educate farmers, gram panchayats and corporations about the health hazards due to air pollution caused by crop residue burning. Also, the recent directions from the PMO have clearly instructed all the concerned departments and ministries for take suitable action for complete elimination of crop residue burning.

4.4 Business models for fast adoption of the technology

A large proportion of farmers of NW India hold small or marginal lands. For example, about two-third (one million) farmers in Punjab own less than 4 ha of land and approximately 70% of the land is held by medium and large farmers. The following strategic options can be adopted for upscaling of the innovative concurrent use of SMS-fitted combines and turbo happy seeder

- **Individual ownership of tractor and Turbo Happy Seeder for self-use.** This option is primarily for the medium or large farmers.
- **Medium farmers purchasing Turbo Happy Seeder for sowing their own fields and undertaking local custom hiring.** These farmers have the opportunity to supplement their farm income by the purchase of the Turbo Happy Seeder for use on their own and neighboring fields. The potential advantage in this model is that the localized nature of the business will allow higher operational efficiencies through strong local linkages with clients within 20 km from their home base.
- **Custom hiring of Turbo Happy Seeder through Primary Agriculture Cooperative Societies (PCAS).** The PCAS have the advantage of strong linkages with farmer members combined with ongoing support from the Government institutions. The PACS also have the advantage of availability of tractors, which are used for other operations. PCASs are well placed to provide custom hiring service at competitive rates (either with or without tractor and driver).
- **Custom hiring of Turbo Happy Seeder provided by private entrepreneurs.** Delivery of machinery services, particularly large and expensive machinery such as combine harvesters, laser leveler, etc., through private contractors, entrepreneurs is common in NW India. This model shows considerable potential to deliver the combination of extension and machinery. The advantages of this model are the economies of scale, which may be able to cover large areas without the need to upgrade tractor or operational skills. In India, there are 26000 combine harvesters, 50% of these operate in NW India and are mostly owned by private contractors. If about 50% (about 6500) of the combines available in NW India are fitted with super SMS, and the owners are encouraged to acquire two Turbo Happy Seeders for dedicated use with each combine, it may lead to a successful business model for large-scale adoption with a potential acreage coverage of 1.0 million ha within one year. Private contracting model for Turbo Happy Seeder along with tractor will also generate employment to youth and attract them in agriculture.

5. Policy needs

Attractiveness of the technology of concurrent use of combines and Turbo Happy Seeder that is profitable over farmer's current management practices, generates less air pollution and uses less fossil fuel and water inputs. Farmers of NW India and elsewhere are prepared to innovate and adopt any technology based on demonstrated sound economics. In this context, there exists ample possibility and opportunity for the farmers to use economically viable alternative option to residue burning through concurrent use of combines and Turbo Happy Seeder technology, which is "environmental as well as farmer friendly" option. This technology would usher a new policy paradigm by moving from subsidy to efficiency and environmental services for sustainability of agriculture, and farmers and public welfare.

Promoting the Turbo Happy Seeder technology package through payment for environmental services could be considered as a pilot for a mechanism to encourage increased adoption of technology that helps in eliminating residue burning on the one side and making more efficient use of financial resources on the other side. In addition, on a pilot scale carbon credit of Rs. 250/t¹¹ may be considered as sufficient to encourage the adoption of Turbo Happy Seeder technology package. Farmers may actually receive additional income by adopting the new technology. Also, in a broader policy perspective, promoting Turbo Happy Seeder technology will complement the Government schemes on soil health, water saving, climate risk reduction, food security, doubling farmer income, etc. and the 'One Health' program.

Rapid adoption of Happy Seeder technology needs a major government push to publicize and popularize the technology. State governments of Punjab and Haryana have made some interventions such as financial support in the form of subsidy for purchase of Happy Seeder and legislation for completely banning residue burning. The scaling of this innovative technology is deemed vital for safeguarding objectives of National Mission on Sustainable Agriculture (NMSA). It is estimated that to cover 50% (5 million ha) of the total acreage under RWCS in India, about 60000 Turbo Happy Seeders and 30000 super SMS fitted combines will be required; at present, there are only about 3000 Turbo Happy Seeders and 1000 super SMS fitted combines available. We need to act soon to save the environment from further deterioration.

Fortunately the existing manufacturers have the capacity to increase their output to supply the required quantities of the two implements. This, however requires putting in place enabling policy environment and mechanism for quality control assurance.

6. Recommendations to encourage adoption of technology of concurrent use of combines and turbo happy seeder to reduce environmental pollution due to rice crop residue burning

Science based evidence, validated across diversity of farmer circumstances, shows that concurrent use of super SMS fitted combine harvesters and Turbo Happy Seeder is a practical and viable alternative to farmer's practice of burning and has multiple benefits including farmers' profits and environment services. To encourage quick adoption of this technology package by the farmers concerted efforts are required by all the stakeholders. To achieve this objective, the following approaches are suggested:

- A. Attachment of super SMS (straw management systems) needs to be made mandatory for registration of all new combine harvesters in all the states affected by crop residue burning; this approach has already been initiated by the State of Punjab. Also, there is a need to encourage all the combine harvester operators to attach super SMS on the old combine harvesters through an appropriate mechanism and policy environment.
- B. **Promotion of manufacturing of good quality happy seeders** to cover all the combine harvested rice acreage where residues are being burnt. It is estimated that a total of about 60000 Turbo Happy Seeders will be required. Fortunately, the manufacturing industry has the capacity to produce the required number of Turbo Happy Seeders and super SMS within a year's time.

- C. **Development of suitable mechanism to ensure availability of good quality happy seeders and SMS fitted combines to the farmers through promotion of Agriculture Service Centers:** Since most farmers are small and marginal, purchase and owning Turbo Happy Seeder and super SMS by individual farmers is neither feasible nor desirable. Hence there is a need to promote ‘Turbo Happy Seeder Technology Package’ led self-sustaining business models through cooperatives (agriculture service centres), private service providers, farmer groups, young entrepreneurs etc. Suitable policy environments need to be devised to facilitate the agriculture service centers.
- D. **Training and Capacity Development:** Training and capacity development is one of the core areas for out-scaling of ‘Happy Seeder Technology Package’. Therefore, there is a need for strengthening of capacity development of whole range of value chain actors involved in the process of Turbo Happy Seeder Technology Package (manufactures, operators, farmers, extension agents, civil society, policy planners, etc.). The SAUs and ICAR institutes can play an important role in training capacity building.
- E. **Awareness Programmes:** Large scale awareness campaigns at different stages of cropping season through range of activities including farmers’ fair, field days, exhibitions, traveling seminars, choupals, use of digital technologies (ICTs), social media, electronic and print media etc need to be launched and monitored for their efficacy in terms of implementation and adoption.
- F. **Convergence of relevant Government schemes and pooling resources:** There are several Government schemes related to soil health, water saving, adapting to climate risks, reducing environmental footprints, doubling farmers’ income, food security, etc., wherein promotion of Turbo Happy Seeder technology package can contribute substantially. A mechanism therefore should be devised for incentivizing adoption of efficient management of crop residues and elimination of crop burning. Turbo Happy Seeder technology package therefore can also get a special place in such policy and incentive programmes.
- G. **Inclusion of technology of concurrent use of SMS-fitted combines and Turbo Happy Seeder for Certified Emission Reduction (CER) certification:** A reduction in emissions entitles the entity to a credit in the form of a Certified Emission Reduction (CER) certificate. The CER is tradable and its holder can transfer it to an entity which needs Carbon Credits. This provision will not only accelerate adoption of this technology, but will also play an important role in increasing farmer’s income, to complement the Government’s policies in this direction.

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