Cleaner Air Better Life

Clean Air & Healthy Soil

Confederation of Indian Industry

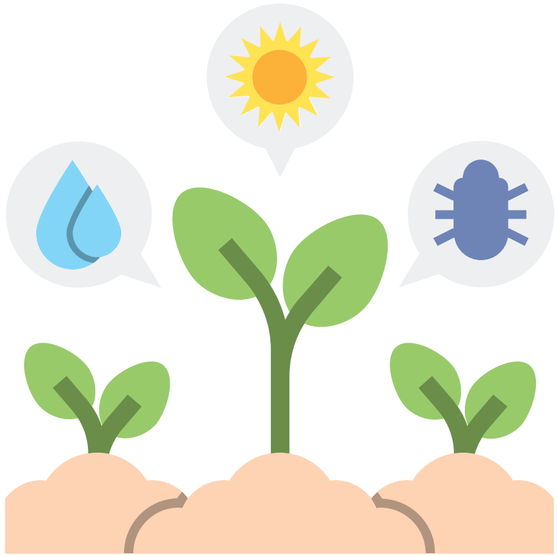



Farmer Toolkit 2.0

Sustainable Farming Practices for

Rice Straw Management In Punjab & Haryana Region

October 2025



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About CII Cleaner Air Better Life

The Cleaner Air - Better life was incepted in November 2016 with a vision to provide cleaner air and a better quality of life to every Indian citizen. The initiative aims to support a nationwide movement to cleaning air by (1) Lending common platform to governments, businesses, communities, and change makers to improve air quality, (2) Building momentum and capacities for evidence-based action on the ground and (3) Providing industry leadership for driving cross-sectoral action on air pollution. Cleaner Air - Better Life undertakes actionable research to support communities and decisionmakers in government and industries to assess and improve outdoor air quality. We do so by engaging local communities, policymakers, industry leaders and change-makers to design and execute solutions with participatory planning and disseminating good practices and environmentally-sound solutions for wide scale adoption.

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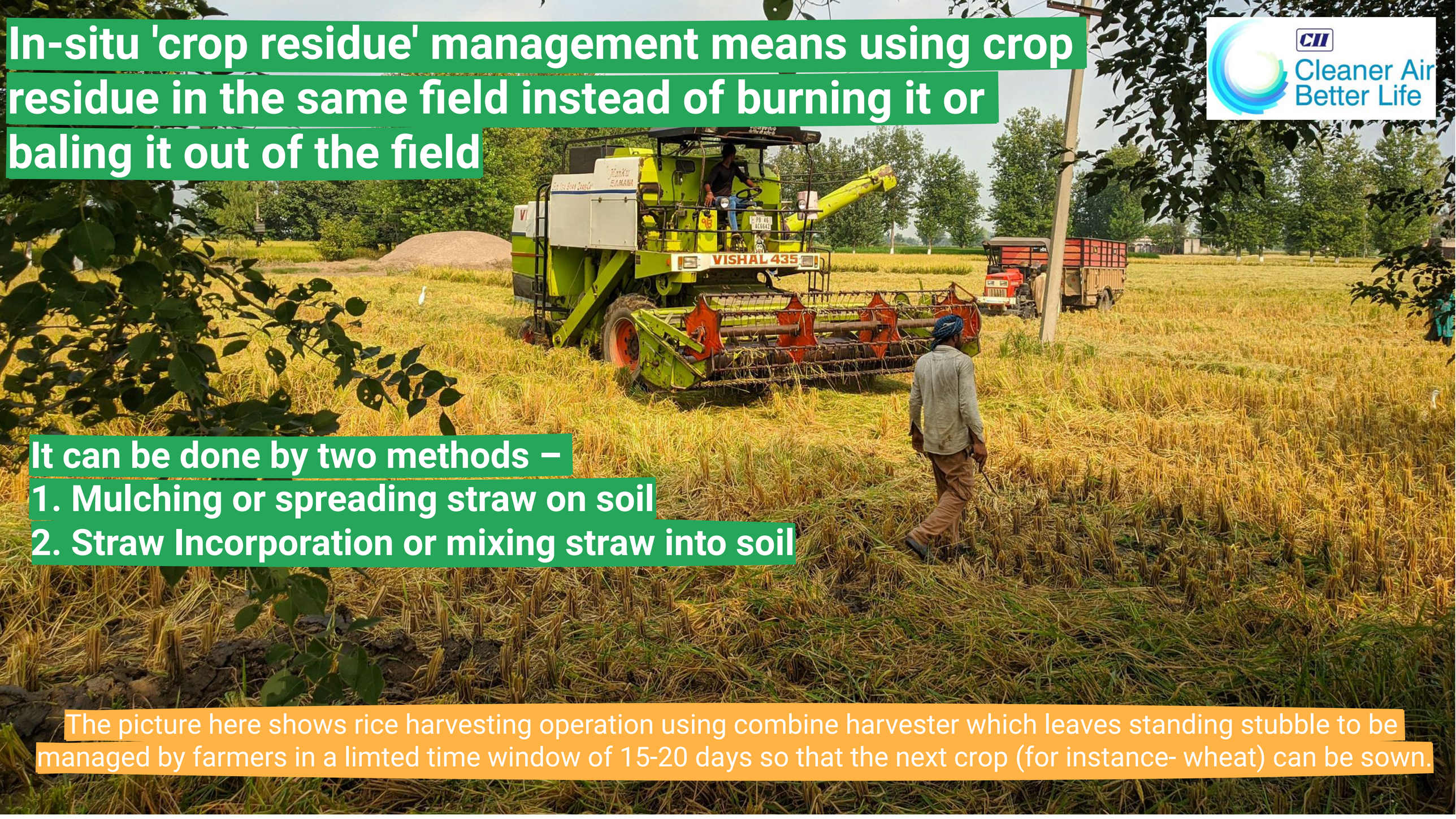
Introduction: In-situ Management of Rice Straw

In-situ 'crop residue' management means using crop residue in the same field instead of burning it or baling it out of the field



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It can be done by two methods –

1. Mulching or spreading straw on soil
2. Straw Incorporation or mixing straw into soil

The picture here shows rice harvesting operation using combine harvester which leaves standing stubble to be managed by farmers in a limted time window of 15-20 days so that the next crop (for instance- wheat) can be sown.


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Mulching
Spreading straw on soil
Rice straw mulched field immediately after sowing wheat

Mulching for Resilient Crops & Healthier Soil

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Mulching returns organic matter back to the top soil in manner which is cost effective & leads to most environmental gains for farmers

(1) Mulch layer regulates top soil temperature & moisture, supporting beneficial microbes and imporving soil health. The layer decomses over time, releasing key nutrients like NPK to the soil

(2) Mulching helps building organic carbon reserve in top soil, leading to improved soil structure, nutirent holding capacity and stronger root growth. All these factors lead to resilient crops and reduced soil erosion in case of extreme climatic or weather events.

Mulching: Retaining Rice Straw on Field Surface

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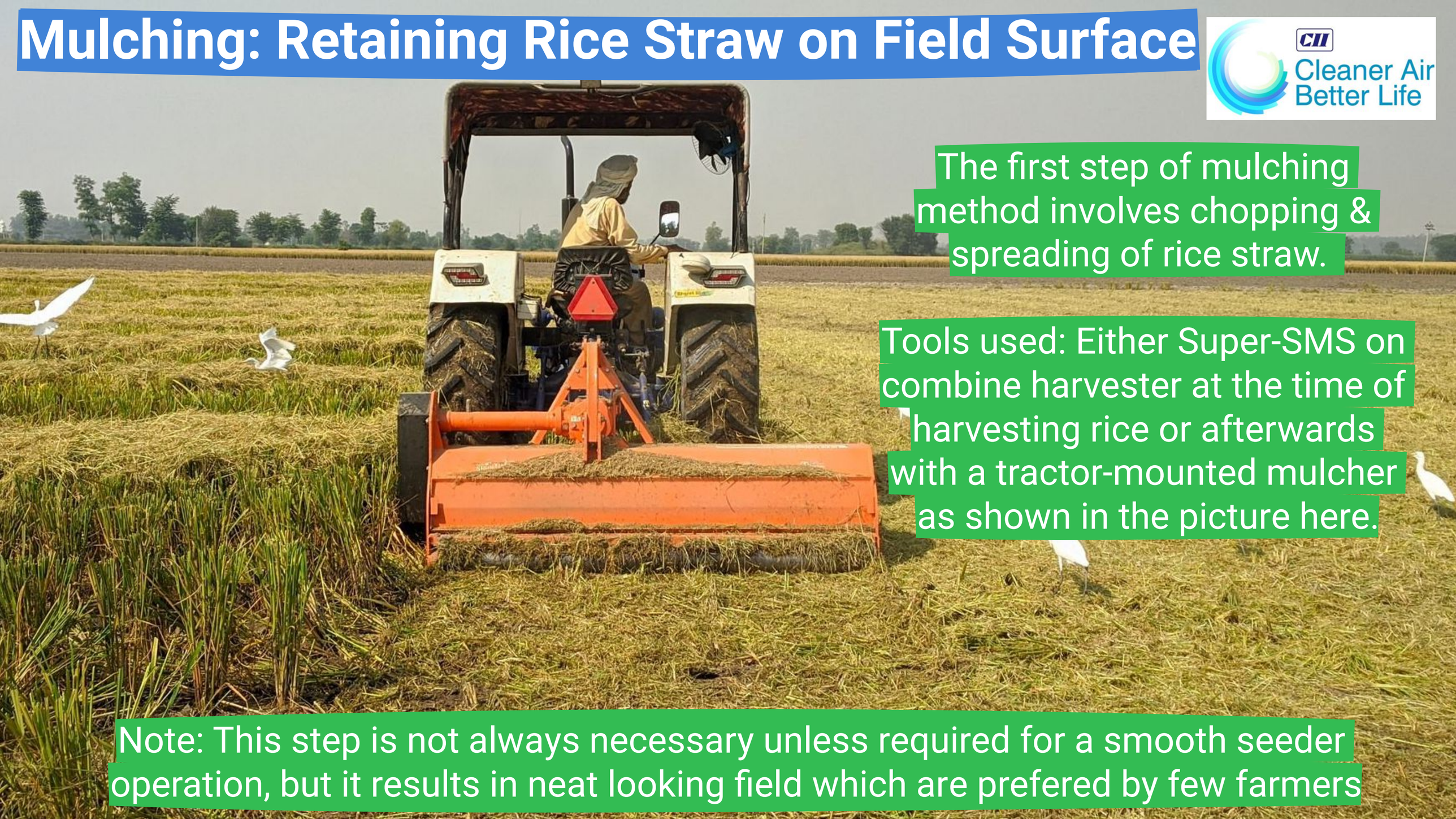

The first step of mulching method involves chopping & spreading of rice straw.

Tools used: Either Super-SMS on combine harvester at the time of harvesting rice or afterwards with a tractor-mounted mulcher as shown in the picture here.

Note: This step is not always necessary unless required for a smooth seeder operation, but it results in neat looking field which are prefered by few farmers

Mulching: Wheat Sowing with Less Tilling

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Machines like Happy Seeder or Smart Seeder (as shown in picture) mulch (chop slightly & press) the straw and sow wheat seeds together at once.

Farmers can simply use this step to sow wheat with standing rice stubble & cut down cost

Recommended Sowing depth for Happy seeder/Smart seeder is between 1.5 to 2.0 inch with 8 inch row spacing

Three Decades of In-situ Crop Residue Management

A Progressive Farmer Case Study

Mr. Balwant Singh, from village Khanaura in Nabha, Patiala (Punjab), has been incorporating rice straw into the soil for more than 30 years. He is a 95-year-old progressive farmer who pioneered in-situ management- initially using a disc harrow and cage wheel (long before rotavators were available), before switching to the rotavator eventually. It has consistently improved crop yields for him while significantly reducing the need for fertilizers and micro-nutrients.

Mixing straw in the fields: **30+ years**
Tools used: **Rotavator-cum-seed drill**
Yield improvement: **Wheat 20–25% higher, Rice 15–20% higher than conventional practice- burning followed by extensive tillage**
Fertilizer use: **One-third less inorganic fertilizer; no micro-nutrients required**

Risk and Solutions: Fire Hazard in Mulched Field

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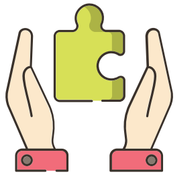
Risk

Fire hazard 🔥 poses a real risk to any mulched field if a neighbouring farmer sets his/her field on fire as burning still prevails in many parts of the region



Solution

Educate neighbouring farmers & entire village to build **capacity & confidence** to switch from burning agri waste to using it as a mulch layer or incorporate it into the soil using a tool combination suitable to his/her needs

Get crop yield insurance. If already subscribed, follow your package of practice as agreed with the service provider

Risk and Solutions: Uneven sowing and poor germination

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Risk

Misperception about new practice & falling back to the old or conventional practice

Uneven sowing & poor germination of next crop observed in the field in patches leading to lower farm productivity

Solution

Tool training & know-how are necessary for the proper calibration of the sowing tool. Approach experienced farmer or local Krishi Vigyan Kendra for training & know-how

Laser land levelling advisable in the gap of 2-3 years -or- as per actual field conditions. This operation is usually subsidised by State Governments in paddy-growing areas

Risk and Solutions: Yellowing of wheat plants

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Risk

Yellowing of wheat plants shortly after germination in the first year of adoption

It is temporary and not a major cause of concern but it may need remedial measure

The event means that your soil is regaining health after years of burning and needs more food or nutrients

Solution

Farmers are advised to **apply urea & micronutrient solutions** in affected growing areas

Not more than 30-40 kilogram urea per acre per application (standard requirement is 110 kilogram per acre in rabi crop)

If the problem persists, consult your local Krishi Vigyan Kendra, farmer co-operative society or crop insurance service company

Mulching with Manual Broadcasting

This cost saving mulching method involves direct/Manual broadcasting or scattering wheat seeds uniformly over the field in the standing stubble; as opposed to using a happy/smart seeder to sow wheat

The method may or may not involve use of mulcher or chopper to finely chop the standing stubble after broadcasting

Cultivation Cost Savings from Mulching Rice Straw

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A Progressive Farmer Case study

Mr. Harinder Singh from village Mutton, Ludhiana, Punjab has been practicing rice straw mulching for the past ten years. He follows the unique & cost-effective method of manually broadcasting wheat seeds in standing rice stubble and then using a mulcher to chop it, creating an even mulch layer. What began on a single acre has now expanded to his entire 28-acre farm while is also actively advising & supporting other farmers on necessary know-how to adopt this method.

Mulching practice: **10 years**
Method: **Manual seed broadcasting + mulcher**
Area under practice: **28 acres**
Weedicide savings: **₹ 2,000 per acre**
Cultivation Cost Saving: **35% lesser than conventional**
Water Savings: **Irrigation not required for one & half months after sowing**

Mulching: Wheat Germination Timeline

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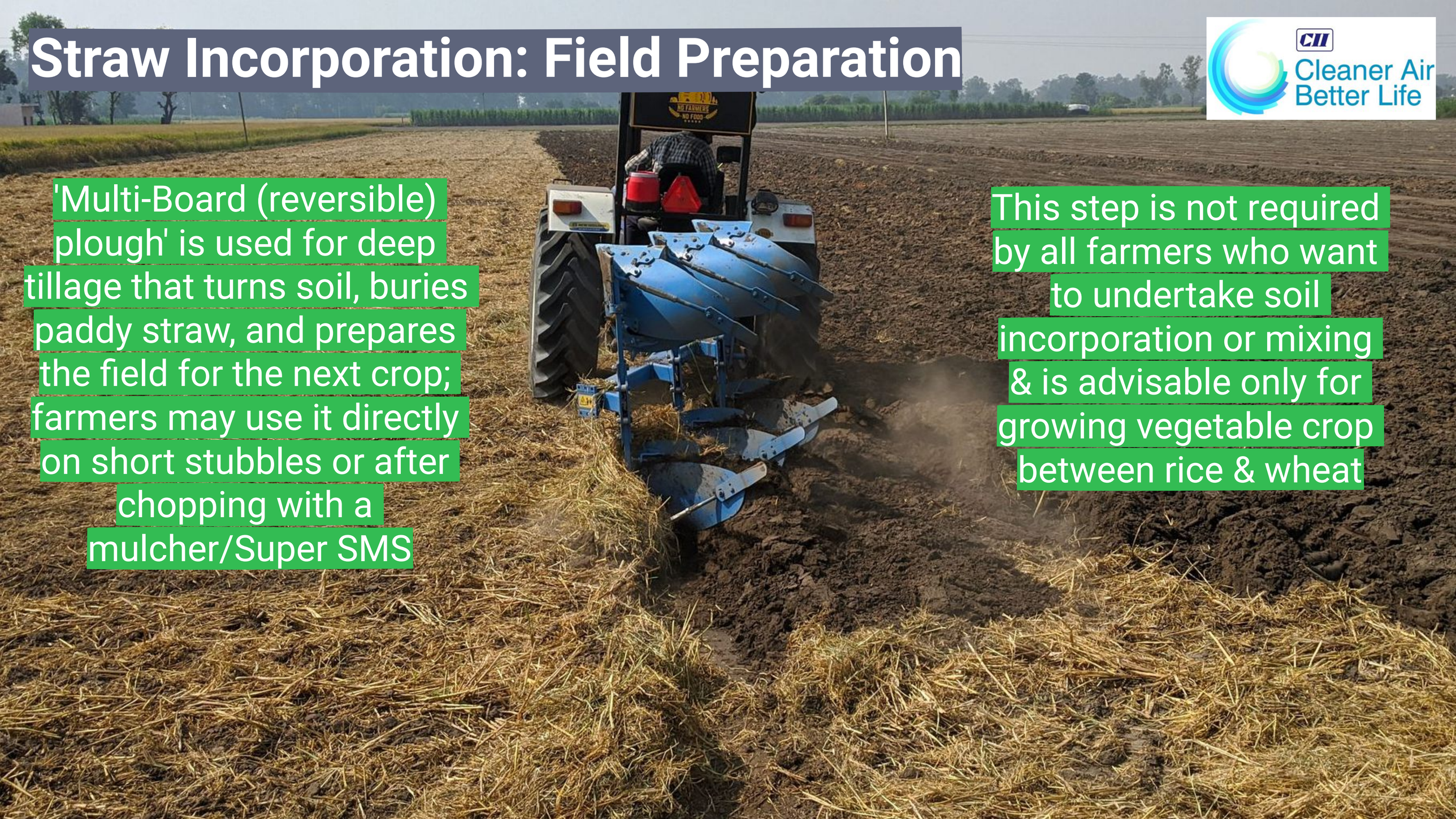
Straw Incorporation
Mixing straw into the soil
Field with incorporated rice straw, followed by wheat sowing.

Straw Incorporation: Field Preparation



'Multi-Board (reversible) plough' is used for deep tillage that turns soil, buries paddy straw, and prepares the field for the next crop; farmers may use it directly on short stubbles or after chopping with a mulcher/Super SMS

This step is not required by all farmers who want to undertake soil incorporation or mixing & is advisable only for growing vegetable crop between rice & wheat

Zero micronutrients requirement from Mixing Rice Straw

A Progressive Farmer Case Study

Mr. Ravinder Singh from village Mungo, Patiala, Punjab has avoided stubble burning for the past five years. By using a Mulcher followed by an MB Plough, he no longer needs to apply micronutrients, as the green manure strengthens crops and improves their resilience to diseases. This practice is cost-effective and reduces expenditure on fertilizers.

Stubble burning avoided: **5 years**
Method: **Mulcher + MB Plough**
Micronutrient use: **Not required**
Benefits: **Stronger, disease-resilient crops; cost savings**

Straw Incorporation: Field Preparation

After chopping and spreading straw with a Mulcher or Super SMS, farmers can use a Rotavator to mix straw and then sow wheat with a Zero Drill, or use a Roto Seed Drill (as shown) to mix straw and sow wheat in one go (may require multiple runs depending on soil type & quantum of straw).

Straw Incorporation: Mixing & Sowing in One Go

Super Seeder is an advanced tool that mixes paddy straw into the soil and sows wheat at the same time in one go, but it needs a high horse power (> 50 hp) tractor to operate.

Straw Incorporation: Wheat Germination Timeline

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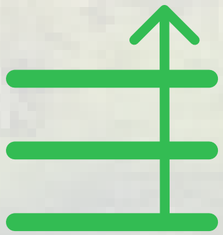
Good Practices: In-situ Management

The sowing depth and row spacing needs to be adjusted as per the field conditions. The optimal depth of planting seeds is 5-8 cm. Conventionally, sowing depth varies 4-6 cm and spacing of 6-8 inches between rows gives good yield.



Do not run tools in the same direction as the combine harvester or its heaped straw rows. Instead, move them across (perpendicular) to the harvester's path.

Check for uneven sowing and manually spread seeds in those spots.

Good Practices: Paddy Varieties & Alternate Crops

Long-duration varieties like Pusa-44 get easily affected by climate change and are more prone to pests and diseases

Short-duration crop varieties (PR 126, PR 121 etc. for rice and HD 3086, HD 2967 etc. for wheat) give farmers extra time for third crops, lesser amount of crop residues, easier in-situ operations with less fuel, and big groundwater savings.

Please check the recommended varieties from your State Agriculture University, and try to include traditional crops like millet, pulses, and corn wherever possible.

Soil Health Benefits of Recycling Straw at Field

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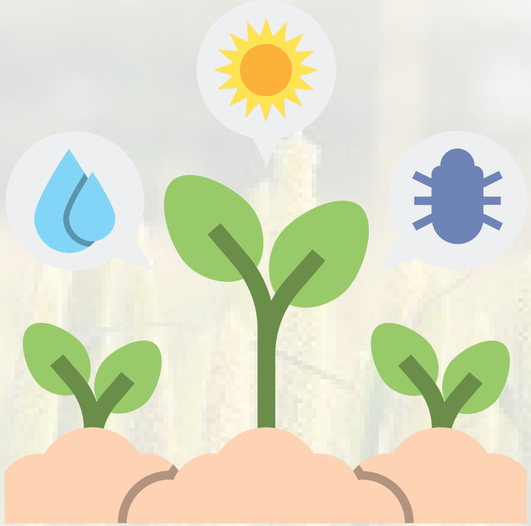
Mulching

Prevents soil erosion

Suppresses Weed Growth

Retains moisture which reduces water evaporation and maintains soil temperature



Mixing

Recycles Essential Nutrients

Improves Soil Structure

Boosts soil organism Population, like earthworms

Enhances microbial activity

Increases Soil Organic Carbon

Builds long-term soil health & crop resilience

Mulched Field versus Mixed Field

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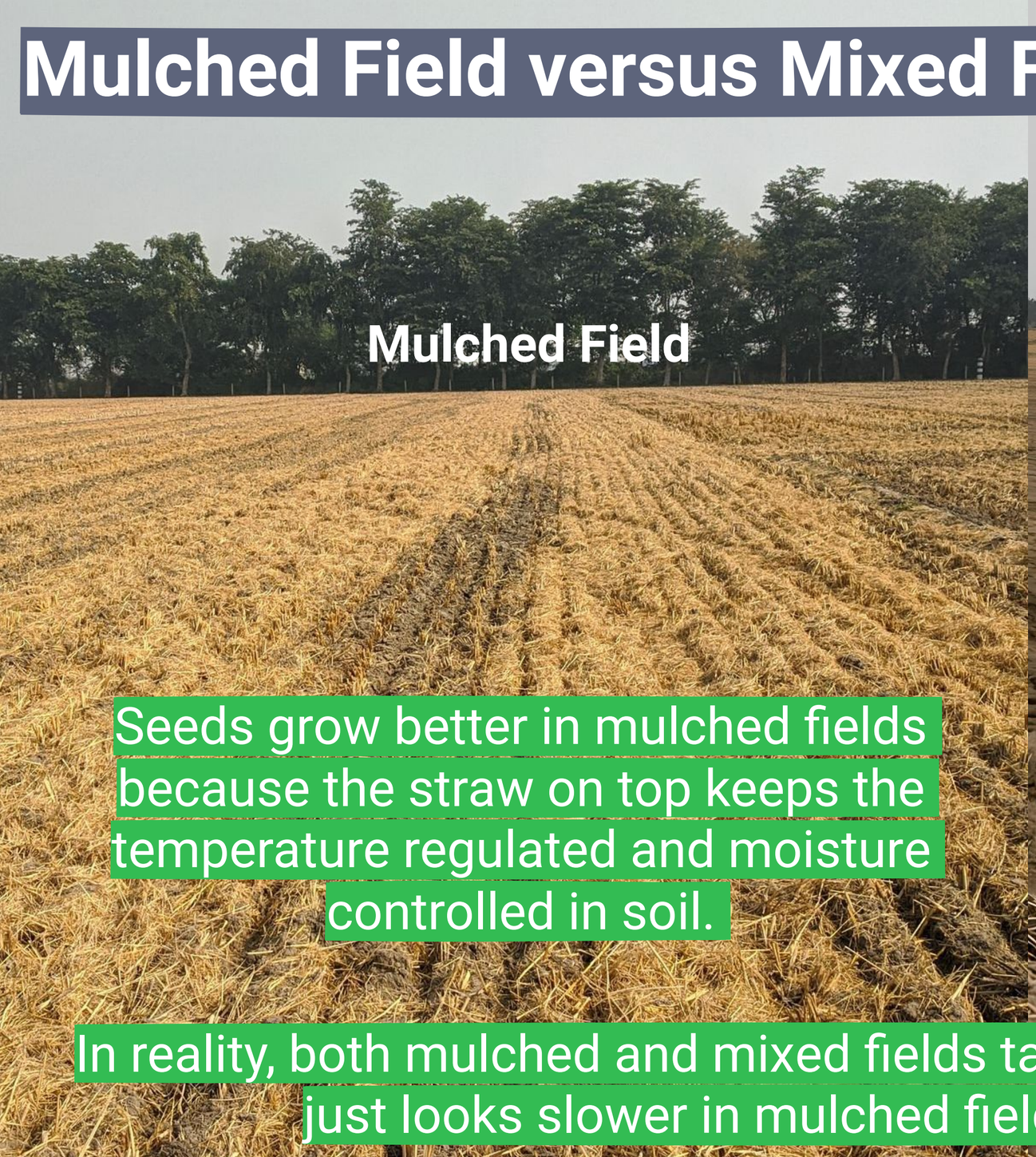


Seeds grow better in mulched fields because the straw on top keeps the temperature regulated and moisture controlled in soil.

In mixed field, rice straw is buried in top soil so the field looks clean, preferred by farmers as they believe that clean fields mean fewer pests & faster germination

In reality, both mulched and mixed fields take almost the same time to germinate — it just looks slower in mulched fields because straw covers the soil.

Myths versus Facts

Myth: Mulch causes pest attacks & lower yields

Fact: Mulching increases crop yield & helps farmer break yield plateau

Our evidence clearly shows that these events and the extent of damage remains limited-

- Approx. 2% of mulched fields affected during such event in the year 2020, and overall yields remained slightly higher than in burned fields.

Farmers, however, need to be careful about any pest or rodent infestation in general.

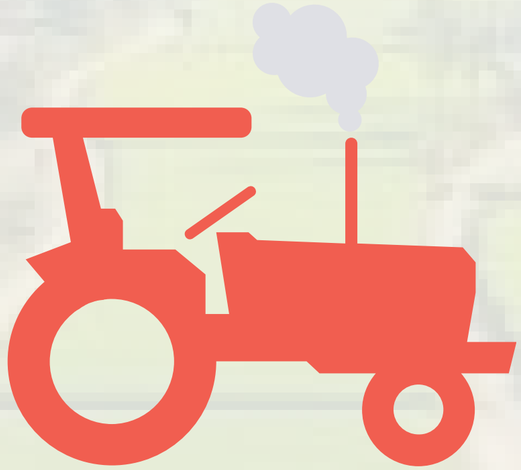
Myths versus Facts

Myth: In-situ crop residue management is more expensive than burning straw

Fact: In-situ management methods like mulching and soil incorporation are cost-effective.

Benefits: Fuel Savings

In-situ management can reduce diesel consumption & save fuel cost for farmer depending on the tool combination or method adopted & soil type

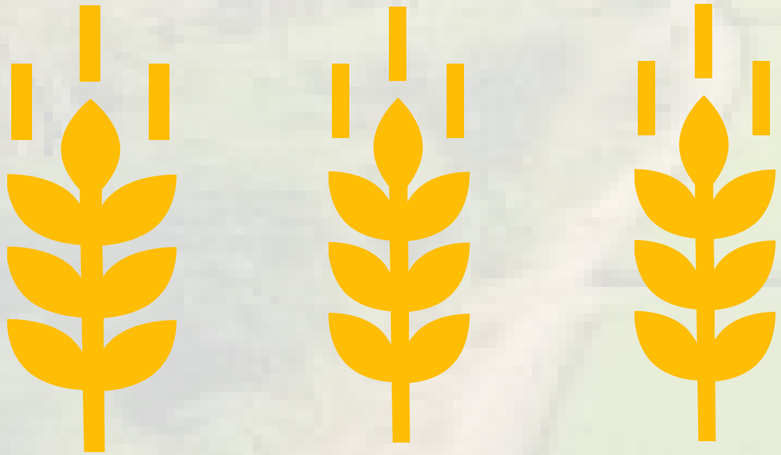


Approx. **27%** fuel savings with mulching rice straw using standalone drill-cum-seeder operation

Benefits: Reduced Cost of Cultivation

Mulching

Standalone happy seeder operation can save up to 20%
Manual broadcasting technique can save up to 35%



Straw Incorporation or mixing

Rotavator-cum-seed drill can save up to 23%
Superseeder saves 5%

These costs may vary depending soil, climatic factors, tool combinations etc. Still the average savings across all farmers in CII-intervened areas are found to be- on average **8%** lower for mulching, followed by **2%** lower cost for straw incorporation as compared to crop residue burning.

Benefits: Savings in Weedicides

Mulching saves farmers **20-29%** on weedicides' cost in 2-3 years, and **45-100%** in 5-10 years

Small weed infestations can cut yields by **10–20%**, while heavy or unmanaged weeds can cause **30–50%** loss, and in severe cases up to **80%.**

Reduced Weedicide demand from Mulching Rice Straw

A Progressive Farmer Case study

Mr. Butta Singh from village Mehdoodan, Ludhiana, Punjab has been using a Happy Seeder for mulching for the last 7 years. By avoiding tillage, his fields retain a mulch layer that suppresses weeds almost completely, bringing his weedicide demand down to nearly zero.

Mulching with Happy Seeder: **7 years**
Weedicide demand: **Near zero**
Pesticide use: **1 standard spray/season (unchanged)**
Fertilizer savings: **Urea reduced by 45%; DAP reduced by 25%**

Benefits: Reduction in Fertilizers

In-situ management practices lead to approx. **6%** lower fertiliser (urea & DAP) use in 3 years

Mulching rice straw leads to 24% chemical fertilizer savings in 5 years

In-situ management practices can completely eliminate micronutrient requirements within 5-10 years of adoption

Long-term Farm Inputs Savings from Mulching

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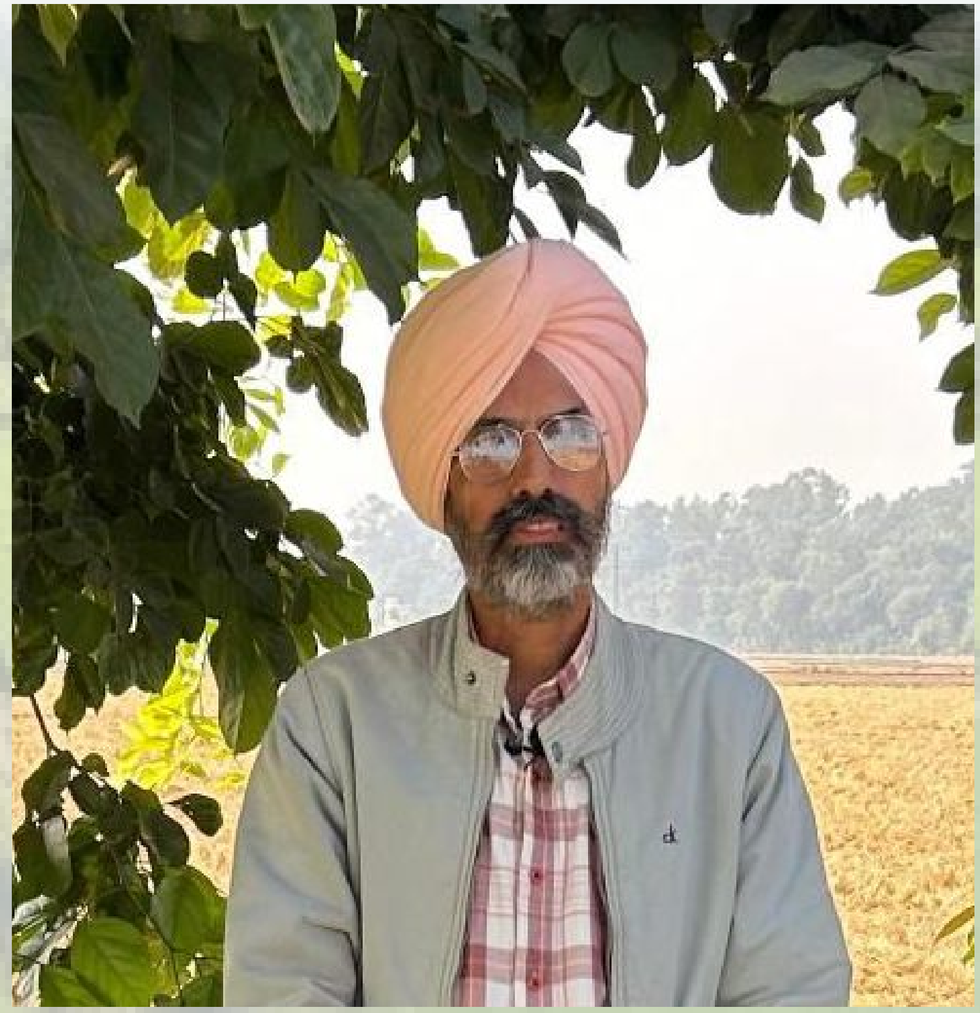
A Progressive Farmer Case Study

Mr. Chhinderpal Singh from village Rampur theri, Sirsa, Haryana has been practicing mulching and no-tillage on his 30-acre farm for the past eight years. By avoiding disturbances to the topsoil, he has rejuvenated his soil, eliminated the need for micronutrients, and drastically reduced fertilizer use.



Mulching + no-tillage: **8 years**
Fertilizer use: **Reduced from 150 kg/acre to 30–35 kg/acre**
Micronutrients (Zn, K, S): **No longer required**
Weedicide cost: **Reduced to zero (from ₹ 500/acre)**
Fuel/diesel cost: **1/3rd of conventional burning method**
Tools used: **Mulcher + Happy Seeder for 1401 Basmati rice**

Water Conservation in Mulched Field

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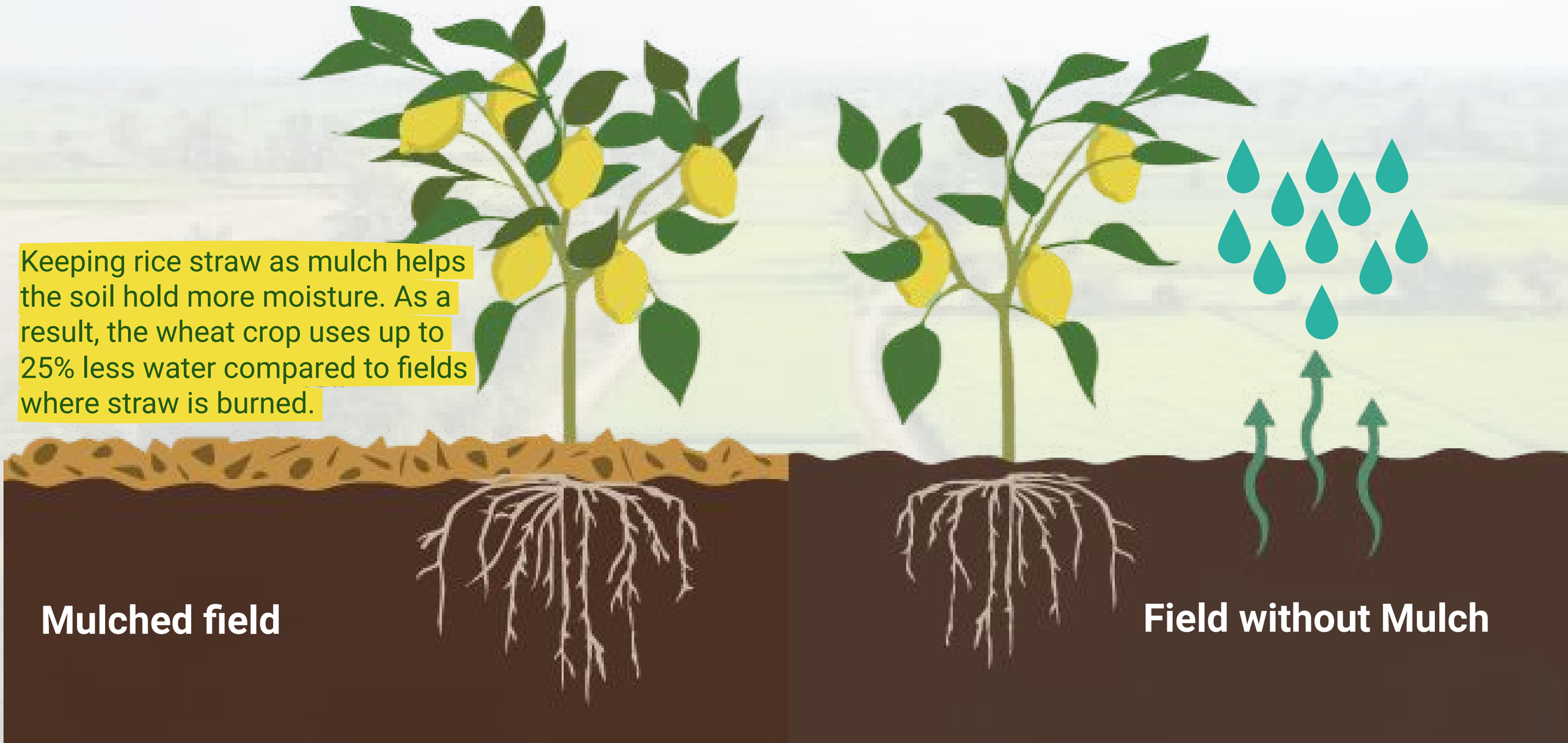
Keeping rice straw as mulch helps the soil hold more moisture. As a result, the wheat crop uses up to 25% less water compared to fields where straw is burned.



Benefits: Water Conservation

Groundwater is scarce resource in the region & mulching rice straw helps retaining soil moisture & in-situ management in general improves soil's capacity to retain water

In-situ managed fields need **1-1.5** lesser irrigation cycles or **13%** less irrigation water (for both rice straw mulched and mixed fields on average)

Benefits: Better Crop Yield & Quality

In-situ management can increase wheat yield by **6–10%** in **2–3** years, but not in the first year, as soil health takes time to improve.

Straw in Soil = Improved Soil Health = Better grain quality

Wheat Grain Comparison

Grain quality of field under Rice straw burning practice

Grain quality of field under Rice straw mulching practice

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Fungus or Blackening Impact of Heavy Rain on Paddy Yield

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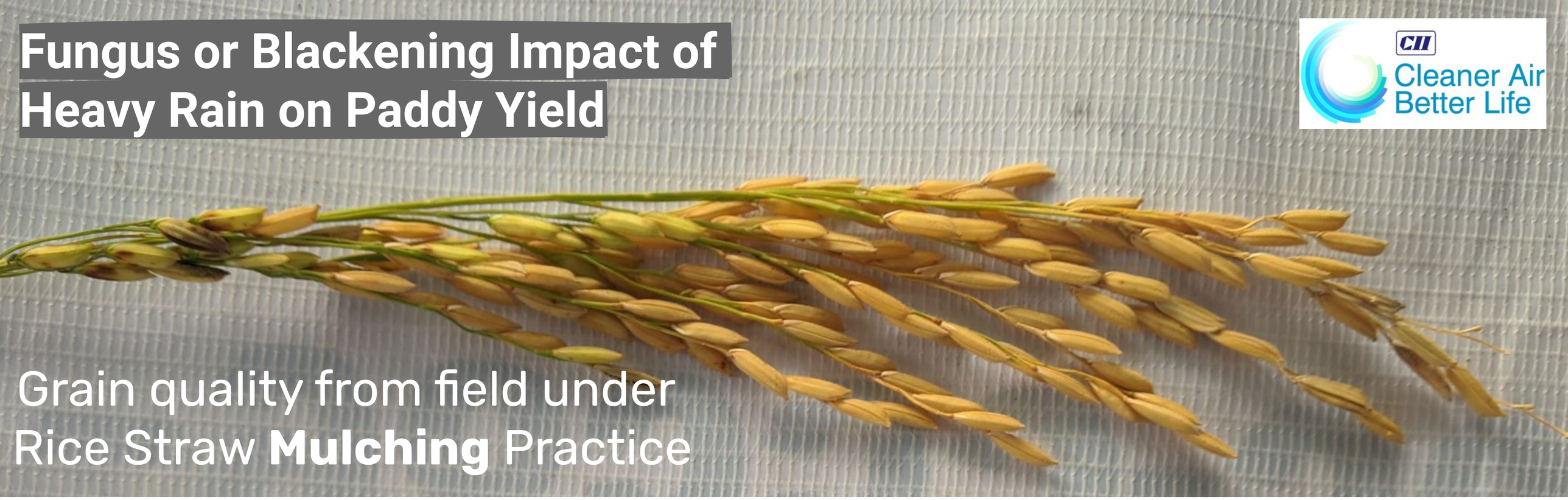
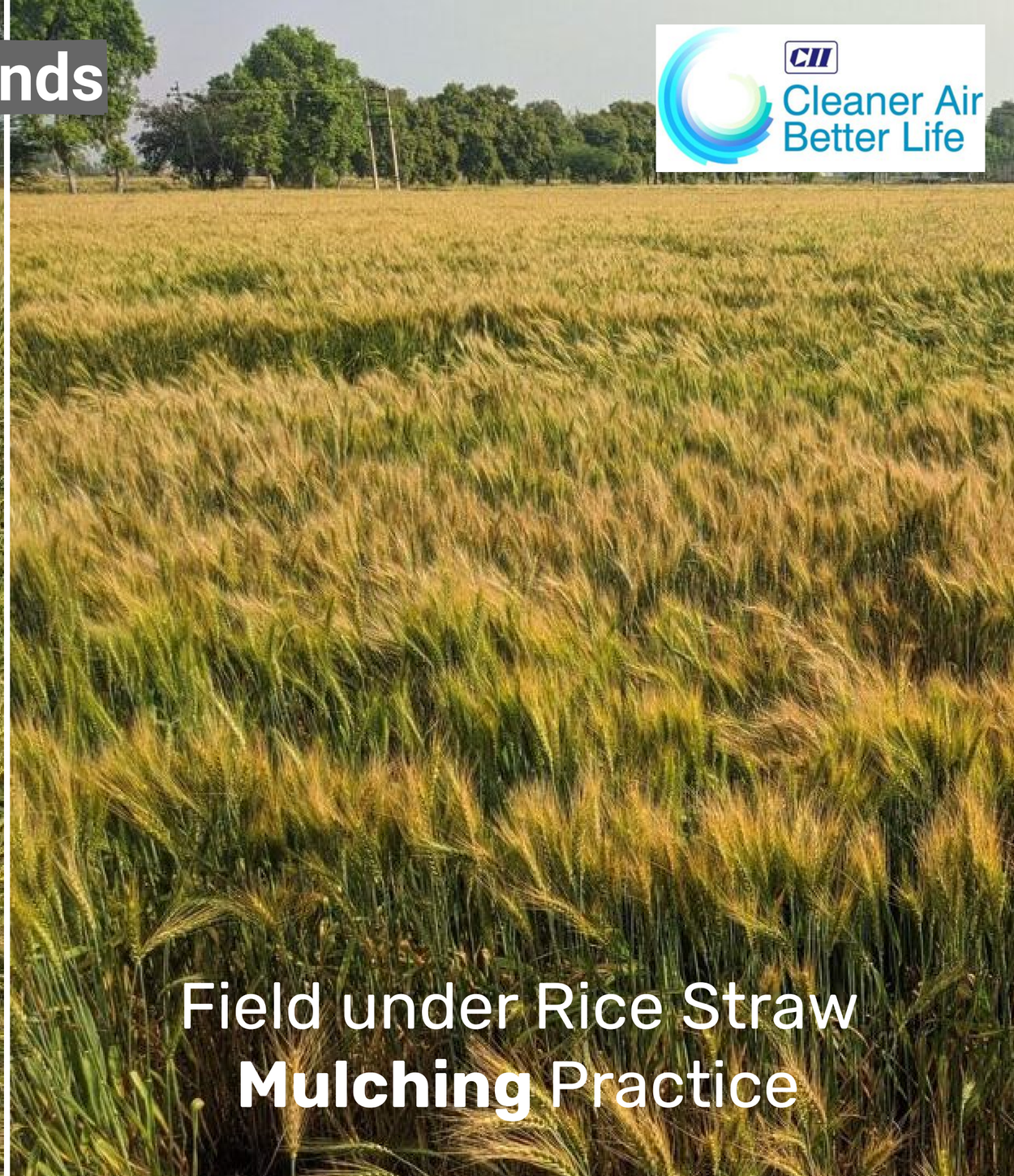


Grain quality from field under Rice Straw **Mulching** Practice

Grain quality from field under Rice Straw **Burning** Practice

Visible Impact of Heavy Rains & Winds

Field under Rice Straw
Burning Practice



Field under Rice Straw
Mulching Practice

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Harmful Emissions from Parali Burning

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Burning of straw in open field releases large amounts of harmful (1) **particles & (2) gases out in the air, impacting not only your village, but also the air in neighbouring villages.**

Burning in Winters especially leads to severe air quality across North India plains, as these polluting particles and gases get trapped closer to the ground

(1) Highly toxic gases/compounds like VOCs & PAHs **that cause cancers, skin disorders and reduced lung functions**

(2) Fine particles that usually do not settle and can travel thousands of kilo-metres. They enter the lungs, bloodstream and hereby almost every part of human body causing heart attack, brain stroke, lung cancer etc.

VOC: Volatile Organic Compounds; **PAH=** Polycyclic Aromatic Hydrocarbons
Fine particles = Particles with size less 2.5 microns

Impact of Parali Burning on Agriculture

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Black carbon (BC) is soot particles released when parali is burnt and is major part of fine particle pollution explained earlier.

BC causes rapid metling of glaciers and accelerates global warming, which means- untimely & extreme weather events such as- hailstorms, droughts and floods due to melting Himalayan glaciers in the North.

Impact of Parali Burning on Soil Health

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Retained crop residues strengthen the habitat for earthworms, beetles, bacteria, fungi and other beneficial soil organisms, promoting healthier soil and natural pest control. **Open burning of Parali, however, kills beneficial soil organisms and reduces agricultural biodiversity that is necessary for healthy & thriving soil.**

Repeated parali burning over the years leads to over dependence on chemicals for farming and may lead to permanent soil dessertification where soil becomes dirt and looses its ability to grow food.

Crop Rotation with Legumes as a Solution to Parali Burning

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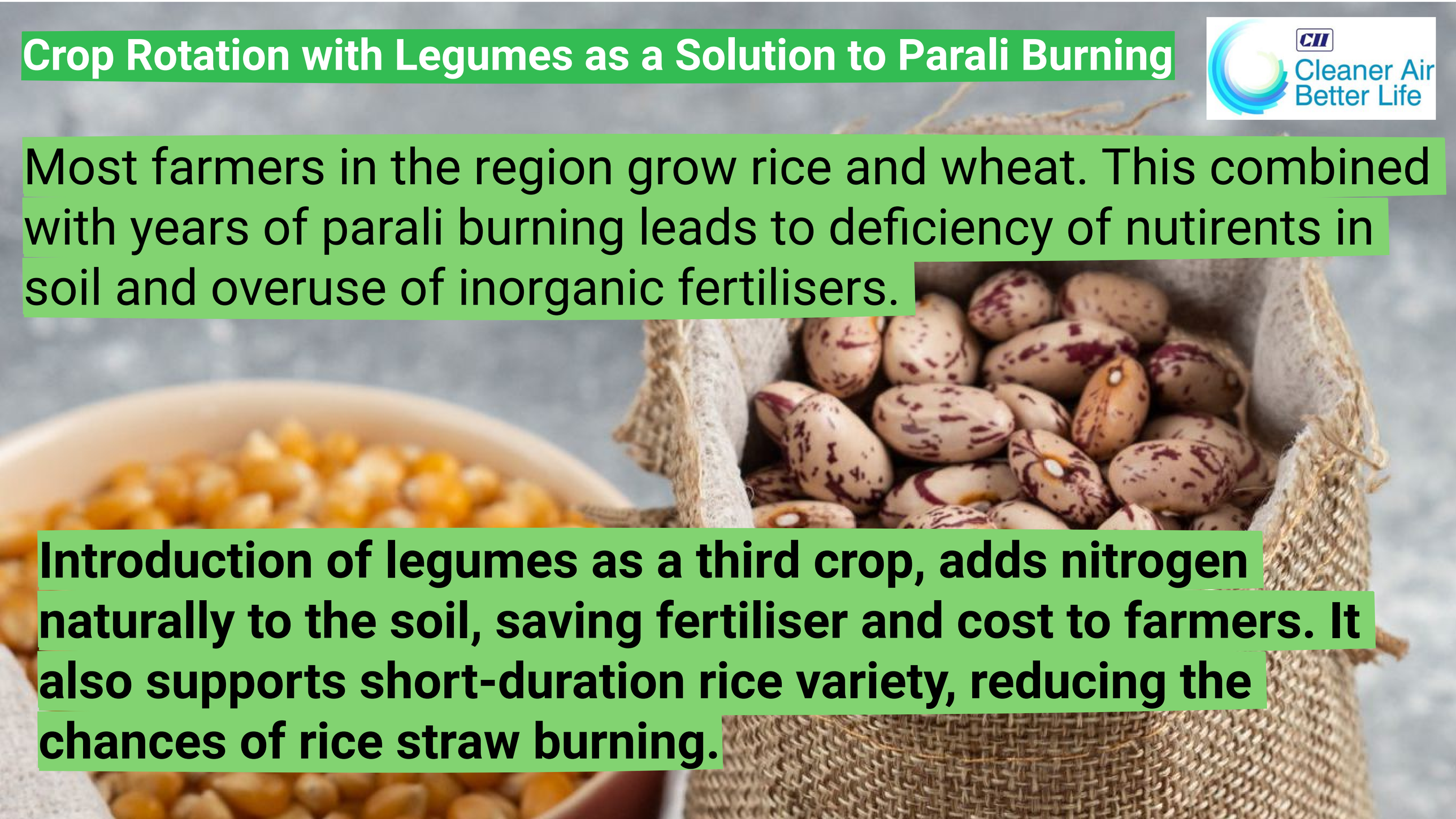
Most farmers in the region grow rice and wheat. This combined with years of parali burning leads to deficiency of nutirents in soil and overuse of inorganic fertilisers.



Introduction of legumes as a third crop, adds nitrogen naturally to the soil, saving fertiliser and cost to farmers. It also supports short-duration rice variety, reducing the chances of rice straw burning.

Sustainable Agriculture with Crop Rotation & Mulching

A Progressive Farmer Case study

Mr. Joginder Singh from village Bhroliyanwali, Sirsa, Haryana has been managing rice straw through mulching in his fields for the past twelve years. This practice, combined with growing legumes between rice and wheat, has helped him cut down his urea usage by half while maintaining consistent wheat yields. He uses a mulcher for field preparation and a happy-seeder for sowing, along with a waste decomposer to speed up the breakdown of mulch.

Mulching practice: **12 years with crop rotation- legume between rice and wheat**
Wheat yield: **22–23 quintal/acre (stable)**
Urea use: **Reduced by 50%**
Machines: **Mulcher + Happy Seeder**
Waste decomposer: **Used for faster mulch breakdown**

Generating Additional Income from Rice Straw

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- Pit-composting
- Community Bio-gas
- Biochar
- Animal Feed or Silage
- Rural Straw Bank
- Mushroom Cultivation

Pit-Composting (Green Manure)

What farmer can do:

- Make compost pits (30x10 ft) for rice straw. Each pit can produce 30–45 tonnes compost per year, adding ₹30,000 extra income with minimal cost

Community Bio-Gas

Community bio-gas plant can convert agricultural waste into biogas for cooking or electricity, with organic manure as a by-product for use in farming.

One such bio-gas plant for rice straw, as developed by PAU and shown in the picture here, **produces sufficient gas for a period of three months once the digester is loaded and activated with rice straw and cow dung.**

Biochar as a Soil Conditioner

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Bio-char is a charcoal like material made by processing organic biomass (like parali) in a purpose-built bio-reactor (called pyrolysis reactor) in an environment-firendly manner.

When mixed into soil, bio-char improves soil health, fertility, reduces need for fertilizers, retains moisture, and enhances microbial activity.

Animal Feed or Silage

Using Straw for Dairy Feed: treated rice straw has similar nutrition to wheat straw (38–42% digestible nutrients).

Dairy farmers or rural enterprises can use it to make Total Mixed Ration (TMR) pellets by mixing straw with locally available resouirces like maize, cake oil etc.

Community-level TMR mixers (2,000–8,000 litres) are available in market.

Farmers can avail (upto 50%) subsidies for it under the National Livestock Mission.

Rural Straw Bank

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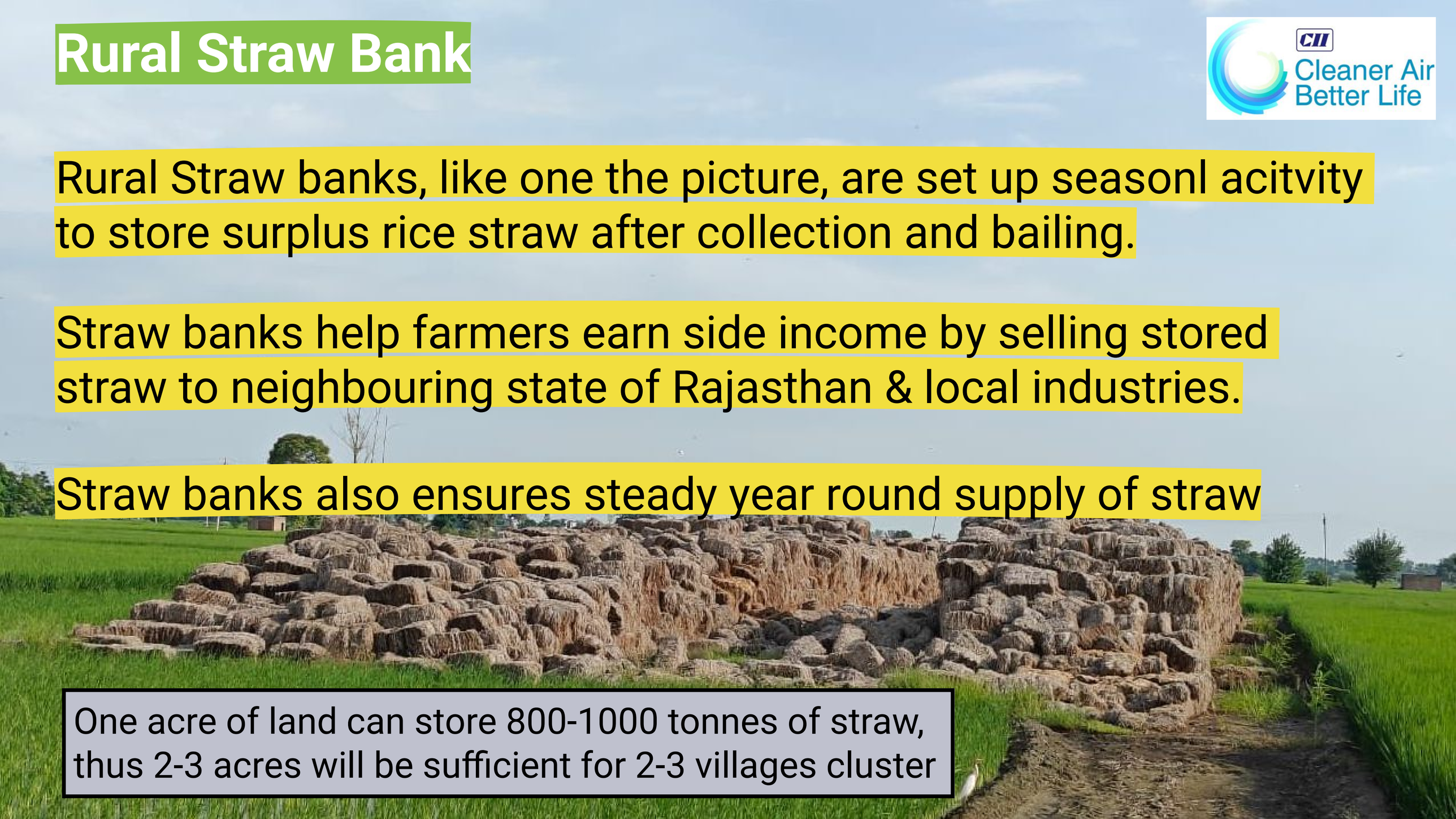
Rural Straw banks, like one the picture, are set up seasonl acitvity to store surplus rice straw after collection and bailing.

Straw banks help farmers earn side income by selling stored straw to neighbouring state of Rajasthan & local industries.

Straw banks also ensures steady year round supply of straw



One acre of land can store 800-1000 tonnes of straw, thus 2-3 acres will be sufficient for 2-3 villages cluster

Mushroom Cultivation from Rice Straw

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Farmers can use rice straw bales to grow button mushrooms.

About 3–4 acres of straw are enough for 10 mushroom sheds.

Each single shed gives 20–22 quintals of mushrooms, earning farmer around ₹40,000–₹50,000 profit.

After harvest, the leftover compost can be used as organic manure in farming

Notes

Notes

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This toolkit is the result of CII Cleaner Air Better Life's extensive work with farmers in Punjab & Haryana on crop residue management since the year 2018.
For more information on CII 'Cleaner Air Better Life' initiative, visit-
https://sustainabledevelopment.in/alliances/cleaner-air-better-life/

If you would like to deploy this toolkit in your area or have a query for us,

If you would like to suggest improvements or collaborate with us,

write to-
cabl@cii.in