# HARNESSING MICROBIAL CONSORTIA: A SUSTAINABLE APPROACH FOR CROP RESIDUE DECOMPOSITION

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In the pursuit of sustainable agriculture, crop residue management has become an important global concern as agricultural waste generation of per year is around 998 million tons (Agamuthu et al., 2009). Eighty percent of organic wastes can be converted into organic manure at a rate of 5.27 kg/day/1000 kg weight through sustainable and eco-friendly disposal methods. Crop residue management through burning affects the environmental health through air pollution (Lan et al., 2022), loss of soil organic matter and essential nutrients from soil (Bhattacharjya et al., 2021) and also the human health. Issues associated with improper disposal of agriculture waste led to the development of microbial consortia based decomposition technologies (Sahu et al., 2019) to recycle crop residue for enriching soil with nutrients and thereby promoting healthy plant growth and developing clean environment.

## UNDERSTANDING MICROBIAL CONSORTIA

Microbial consortia consist of communities of different microorganisms which work synergistically to perform specific functions. In the context of crop residue decomposition, these consortia consist of bacteria, fungi, and other microorganisms that collaborate to break down complex organic matter. Each member of the consortium has a unique set of enzymes and metabolic pathways, enabling them to degrade specific components of crop residues efficiently.

## DIVERSITY IN ACTION

One of the key advantages of using microbial consortia lies in their diversity. As different crop residues vary in the compositions of cellulose, lignin, hemicellulose, and other organic compounds, use of microbial consortium ensures that there are specialized micro-organisms capable of breaking down each and every component. Bacterial players viz., cellulolytic bacteria, initiate the process by breaking down cellulose, while fungi, particularly ligninolytic fungi, play a crucial role in decomposing the lignin-rich residues. Actinomycetes contribute to the decomposition of complex organic molecules, and synergistic interactions between these microbial groups facilitate fast decomposition and also enhance overall decomposition efficiency.

## ENHANCED NUTRIENT CYCLING

Microbial consortia not only facilitate the breakdown of crop residues but also contribute to the nutrient cycling in the soil. During the decomposition process, microorganisms release enzymes that break down organic matter into simpler forms, making nutrients more accessible to plants. This enhances the nutrient content of the soil, promoting better crop growth and reducing the need for external fertilizers.

## ENVIRONMENTAL BENEFITS

Use of microbial consortia for the decomposition of crop residue offers benefits. Unlike burning, which releases harmful pollutants into the atmosphere, microbial decomposition is a clean and sustainable process. It helps in retaining soil structure, preventing erosion, and mitigating the negative impact of residue burning on air quality. Additionally, the organic matter left in the soil improves its water-holding capacity, leading to better water retention and reduced irrigation requirements.

## APPLICATION IN PRACTICE

Farmers can adopt microbial consortia for crop residue decomposition through various methods. Incorporating these consortia into the soil along with crop residues, or using them as bioinoculants, are common practices. Additionally, microbial consortia can be applied as composting agents, accelerating the decomposition process and producing nutrient-rich compost.

## WASTE DECOMPOSER


Waste decomposer technology has gained popularity as an eco-friendly alternative to conventional waste disposal methods. In India, where organic farming practices are gaining momentum, technologies like 'waste decomposer' are being promoted by different agencies to support the environmental friendly and nutrient-rich soil management. Also, farmers adopting waste decomposer technology would be benefited not only with improved soil fertility but also with reduction in the cost of cultivation due to relatively low dependence on synthetic fertilizers. Besides, it is a more sustainable approach for waste management in agriculture. The 'waste decomposer' technology is developed by the National Centre of Organic Farming (NCOF) now known as National Centre for Organic and Natural farming (NCONF), Ghaziabad. A bottle of waste decomposer is for decomposing bio-waste of more than 1 lakh metric tonnes in 30 days (Source: https://pib.gov.in/newsite/PrintRelease.aspx?relid=175861).. The directions for use are as follows:

### For Mass Multiplication

1. Mix 2 kg of jaggery in 200 liter of water in a container and stir well.
2. Open the bottle and pour the contents of bottle into the solution (avoid direct contact of contents with hands).
3. Stir the contents of the container and cover it with a paper/cardboard etc and stir it daily once, solution will be ready in 7 days.

### For Off-situ Composting

1. Spread 1 tonne of waste material.
2. Wet it with decomposer solution.
3. Spread one more layer of waste material above the existing layer.
4. Wet it with decomposer solution over the layer.
5. Maintain 60% moisture during entire period of composting with waste decomposer solution.
6. Turn over the compost at 7 days interval, if required again wet the waste with decomposer solution.
7. The compost is ready to use after 30 days.

**As Foliar Spray:** Spray the decomposer solution (up to 50%) on all crops every 7$^{th}$ day, vegetable crops (40%) every 3$^{rd}$ day, fruits crops (60%) every 7$^{th}$ day.

**As Drip irrigation:** Use 200 litre of solution per acre

**For In-Situ Composting of Crop Residue:** Spray 200 litre of solution per acre on the post-harvest stalks of crop plants.

**As Seed Treatment:** Simply spray/ sprinkle the waste decomposer solution uniformly over seeds. Then leave the treated seeds under shade for 30 minutes. After 30 minutes the treated seeds are ready for sowing.

## ICAR-IARI- PUSA DECOMPOSER CAPSULE

Pusa decomposer, also known as Pusa decomposing agent or Pusa waste decomposer is a microbial formulation developed by the ICAR-Indian Agricultural Research Institute (IARI) New Delhi. The technology was introduced as an innovative and cost-effective solution to accelerate the decomposition of crop residues and other organic matter in agriculture. The Pusa decomposer is in the form of a capsule made by extracting mushroom stalks, helping rice straw to decompose much faster. Fungi help to produce the enzymes needed for the decomposition process (source: https://www.youtube.com/watch?v=cDY_DFYmuUQ)

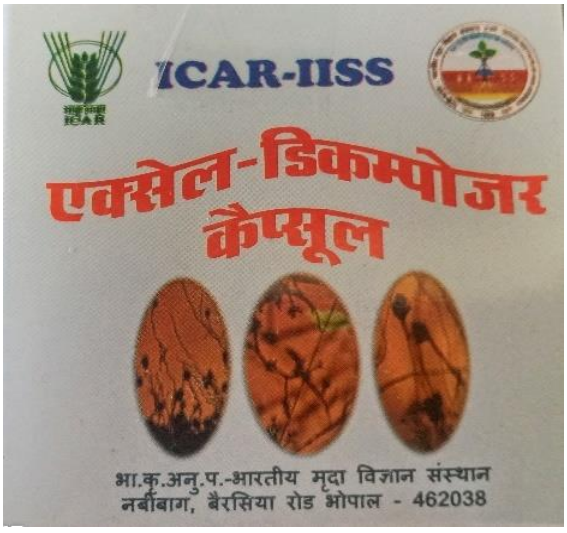

## How to use Pusa Decomposer

Prepare liquid formulations using decomposition capsules, ferment them for 8-10 days, and then spray the mixture onto the field of grain stubble to ensure rapid biodegradation of stubble. Farmers can prepare up to 25-litre liquid mixture containing 4 capsules, jaggery, and chickpea flour. The mixture can cover 1 hectare of land.

**NOTE:** It takes about 20 days to complete the degradation process. Under normal circumstances, it takes at least 45 days to decompose finely irrigated rice straw when mixed with soil. Pusa decomposer capsules contain fungal culture which is used for all types of crops waste, kitchen waste, garden waste & cow waste. The contents of the packet are sufficient for preparing compost from 5 ton farm waste. It hastens the rate of decomposition of various agriculture waste. Pusa decomposer helps to prepare compost in pits, heaps, and as well as in the field for degradation of agriculture residue. It can be used to make 25 litre of solution effective for one hectare of land.

## ICAR-IISS EKCEL DECOMPOSER CAPSULE

EKCEL Decomposer is a microbial consortium of four fungi (each capsule contains one fungal species) having ability to decompose the crop residue rapidly in-situ or off-situ (Thakur et al., 2021).




## How to use EKCEL-Decomposer Capsule

For in-situ decomposition of crop residue in one hectare field, five capsules of each culture (total 20 capsules) is required. The capsules are activated by adding 500g of jaggery/gud in 50L water and boiled for 5 minutes and then 500g wheat bran is added to this solution (bran-sugar solution). After cooling, five capsules of each organism are dissolved in this bran-sugar solution. The solution is covered and left for 6 days for activation of culture. The activated fungal solution can be sprayed on crop residue in field. Since the crop residue has

wide C:N ratio, 30 kg/ha urea is spread over the residue in the field and entire materials are incorporated in the field using a rotavator. The field is irrigated immediately and left for decomposition for 30 days. If possible, fresh cattle dung @4 tonnes/ha can be applied in the field to accelerate the decomposition process. Sowing of next crop can be done after 30 days of application of culture. The seed is to be treated with carbendazim @2g/kg seed.

### Application in Compost Pit

For application in pit (size 10'x4'x3' LxBxH, accommodating 800 to 1000 kg biomass) four capsules, one of each fungal culture is sufficient. In 10 L hot water, 100g jaggery is dissolved and 100g wheat bran is added to this solution. Four capsules are put in this bran-sugar solution after cooling the solution. The solution is covered and left for 6 days for growth of fungal cultures and then sprinkled on the composting materials in the pit. The sequence of the addition of materials in each layer should be followed as

Dung
↓
Activated fungal culture
↓
Crop residue
↓
Urea

Another layer is made in pit in the same sequence. The Urea @1kg/quintal of biomass is to be added. At the top layer after adding the culture, it is covered with thin layer of crop biomass and water is added thoroughly (60-70% of biomass) to facilitate the decomposition. The turning is to be given twice at 15 days, it can be dried before field application.

**NOTE:** It is to be ensured that the compost is free from any off – smell and its colour changed to dark brown.

### Precautions

- Keep the capsules away from direct sunlight and store in cool place.
- Do not inhale or consume or expose the capsule material to human contact or open wound.
- Wear gloves and mask while handling the capsules.

These decomposers are an example of how microbial technology can be harnessed to address agricultural and environmental challenges. Its adoption by farmers contributes to sustainable agriculture practices, waste management, and the overall well-being of agro-ecosystems. As with any technology, its effectiveness may vary depending on factors such as application methods, environmental conditions, and the specific context of its use. Several microbial decomposer products are available in the market, each with its own formulation and specific applications. These products are often developed to accelerate the decomposition of organic matter, including crop residues, and to promote soil health. Here are some more examples of microbial decomposer products that were known around:

**EM (Effective Microorganisms):** EM is a microbial inoculant that consists of beneficial microorganisms, including lactic acid bacteria, yeast, and phototrophic bacteria. It is used to enhance composting, reduce odors, and improve soil fertility.

**Vamsha Nature Care-Soil Enhancer:** Vamsha Nature Care offers a soil enhancer that contains a blend of beneficial microorganisms. It aims to improve soil structure, increase nutrient availability, and enhance plant growth.

**BioEnzymes by Jaivik Crop Care:** BioEnzymes is a product formulated to enhance the decomposition of organic residues and improve soil health. It contains a mix of enzymes and beneficial microorganisms.

**Jeevamrut by Center for Sustainable Agriculture (CSA):** Jeevamrut is an organic input developed by CSA, and it contains a combination of cow dung, cow urine, jaggery, gram flour, and soil. It is used to promote microbial activity in the soil.

**Sambhav Nature Farm - Microbial Consortium:** Sambhav Nature Farm offers a microbial consortium designed for composting and waste decomposition. It contains a diverse group of microorganisms to break down various organic components.

## CONCLUSION

Harnessing microbial consortia for crop residue decomposition is a sustainable and eco-friendly approach that aligns with the principles of modern agriculture. By promoting microbial diversity and enhancing nutrient cycling, these consortia contribute to soil health, reduce environmental impact, and provide a viable alternative to conventional residue management practices. As agriculture continues to evolve towards more sustainable practices, the use of microbial consortia is likely to play a pivotal role in shaping the future of crop residue management. For more information on microbial decomposers and related technologies, farmer can reach out to agricultural research institutions, government agricultural departments, and relevant organizations like:

1. ICAR- Indian Agricultural Research Institute (IARI), New Delhi, India
2. ICAR-Indian Institute of Soil Science (IISS), Bhopal, M.P., India
3. National Institute of Agricultural Marketing (NIAM), Jaipur, Rajasthan, India
4. National Centre for Organic and Natural farming (NCONF), Ghaziabad
5. State Agricultural Universities (SAUs)
6. Department of Agriculture and Cooperation (DAC)
7. Agricultural Research Stations and Krishi Vigyan Kendras (KVKs)

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