IISS EKCEL DECOMPOSER FOR SUSTAINABLE SOIL HEALTH MANAGEMENT AND CIRCULAR BIO-ECONOMY

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India's agricultural landscape produces over 680 million tons of crop residues annually, with rice, wheat, and sugarcane contributing the bulk. While a significant portion is repurposed for fodder, fuel, and compost, nearly 178 million tons are still burnt in open fields yearly (Sen et al., 2024). This practice severely impacts soil health, air quality, and climate resilience. This not only strips the soil organic carbon and essential nutrients but also releases greenhouse gases and harmful particulate matter, posing risks to environment and public health. To counter this, microbial consortia offer a sustainable and eco-friendly alternative. These synergistic blends of fungi, bacteria, and actinomycetes act synergistically to break down complex plant polymers like cellulose, hemicellulose, and lignin. Fungi like Trichoderma and Aspergillus initiate the breakdown of fibrous material, while bacteria like Bacillus and Pseudomonas convert decomposed organic matter into plant-available nutrients. Actinomycetes further assist in degrading resistant compounds, ensuring complete decomposition. By converting residues into humus-rich organic matter, microbial consortia prevent pollution along with enhancing soil fertility, microbial diversity, and nutrient cycling. This biological approach supports sustainable agriculture, reduces reliance on chemical inputs, and transforms waste into a valuable resource, aligning perfectly with climate-smart farming goals.

STATUS OF AVAILABILITY OF MICROBIAL DECOMPOSER IN INDIA

Microbial consortia play a vital role in residue management by accelerating the decomposition of crop residues and enriching soil health. Institutions like ICAR-National Bureau of Agriculturally Important Microorganisms (ICAR-NBAIM), Indian Agricultural Research Institute (IARI), and Indian Institute of Soil Science (IISS) have developed innovative formulations such as liquid bio-compost, solid capsules, and gel-to-liquid decomposers that can be easily applied by farmers in the field (Table 1). These technologies not only reduce the environmental impact of residue burning but also recycle nutrients back into the soil, supporting sustainable agriculture practices across India.

Table 1. Availability and status of microbial consortia used for residue management

Microbial Consortia	Type of Formulation	Source
Bio-Fast	Liquid	ICAR-National Bureau of Agriculturally Important Microorganisms, Mau
Bio-compost	Liquid	ICAR-National Bureau of Agriculturally Important Microorganisms, Mau
Tejas	Solid	M/s Indore Biotech, Indore
PUSA decomposer capsule	Gel to Liquid (As per manufacturer instructions)	ICAR-Indian Agricultural Research Institute, New Delhi
NCOF decomposer capsule	Gel to Liquid (As per manufacturer instructions)	National Centre for Organic Farming, Ghaziabad, India
CRIDA microbial consortia	Pseudomonas putida P7 + Paenibacillus favisporus B30 (Consortia 1), Pseudomonas putida P45 + Bacillus amyloliquefaciens B17 (Consortia 2)	CRIDA, Hyderabad

(Source: Modified and updated from Mageshwaran et al., 2024)

IISS-EKCEL DECOMPOSER

The Indian Institute of Soil Science (ICAR–IISS), Bhopal has developed the EKCEL Decomposer, a powder consisting of microbial propagules packed in capsules containing four fungal species in the year 2020-21 and released in the year 2022. These fungi release enzymes (cellulases, hemicellulases, laccases, lignin peroxidases) that rapidly degrade crop residues. Instead of burning, farmers can use this eco-friendly, low-cost solution to convert residues into humus-rich organic matter. Benefits of IISS EKCEL decomposer include improvement in soil organic carbon, nutrient cycling, and soil microbial activity which results in soil health and crop productivity in the long run (Bhattacharjya et al., 2021; ICAR-IISS, 2019).

Field Application: For in-situ decomposition of crop residues, the microbial capsules are first activated in a 1% jaggery solution mixed with wheat bran (Figure 1). The mixture is boiled, cooled, and then inoculated with the capsules. It is subsequently kept under cover and allowed to ferment for six days to ensure proper microbial activation. The activated solution is sprayed uniformly over crop residues in the field, along with the urea application @ 30 kg ha^{-1}. The residues are then thoroughly mixed into soil using a rotavator and irrigated to facilitate microbial activity. Crop residues start decomposing in about 30 days, and field conditions become suitable for sowing the next crop without any adverse effect on germination. Also, it is important to treat seeds with carbendazim @ 2 g/kg seed before sowing to protect young seedlings from soil-borne diseases.

Application in Compost Pit: When used in compost pits, activated decomposer culture is incorporated into organic materials arranged in layers (Fig. 2). Activated solution applied on each layer of cattle dung used in between the layers of crop residue supplemented with urea @ 1 kg per 100 kg of biomass to promote balanced nutrient availability and effective decomposition. During composting, moisture is maintained at 50–60%, and the pit is turned twice at 7-day intervals to ensure uniform decomposition. Within 90-120 days, the process yields a dark brown, odourless, and nutrient-rich compost suitable for field application

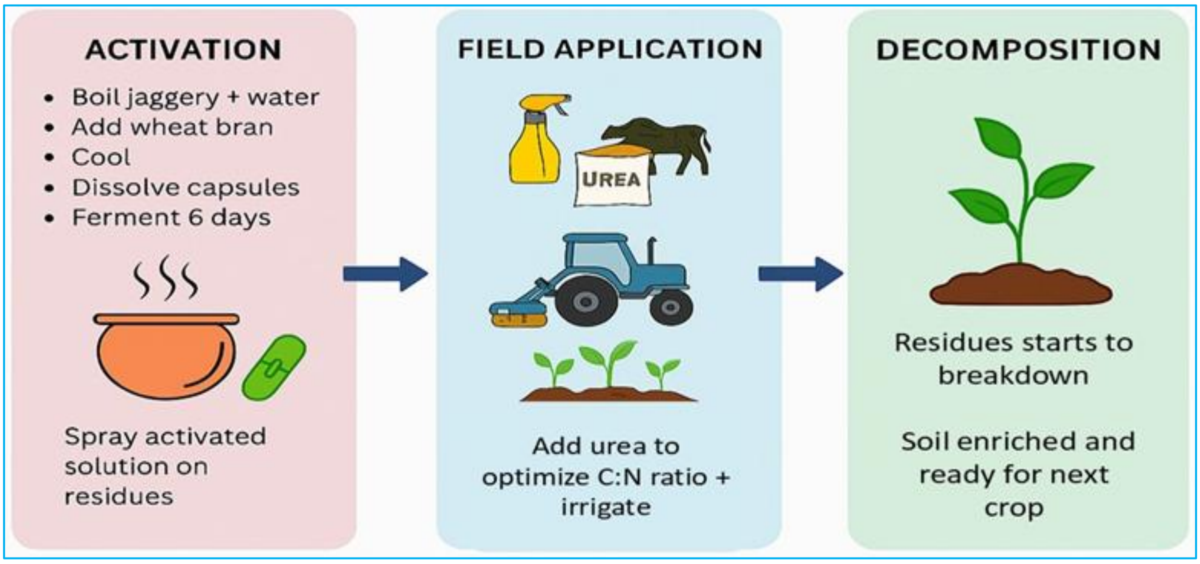

Figure 1 Methodology for application of IISS-EKCEL decomposer in-situ

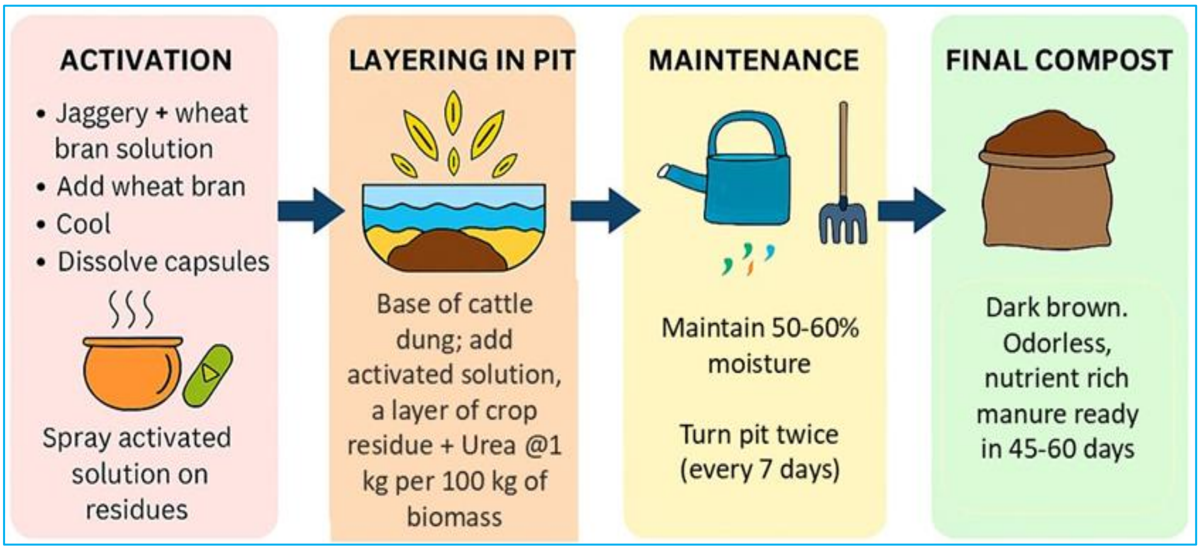

Figure 2 Methodology for application of IISS EKCEL decomposer in compost pit preparation

STUDIES ON THE EFFICIENCY OF IISS EKCEL DECOMPOSER

An experiment was conducted at the ICAR-IISS farm to assess the impact of EKCEL decomposer capsule application on soil health and crop productivity within a rice–wheat cropping system (Fig. 3). After two complete crop cycles, the residue removal (RR) treatment consistently recorded the lowest yields (4.5 and 4.6 t ha^{-1} for rice and wheat, respectively) compared to other treatments, namely consortia with residue incorporation (RI+C), consortia with urea application and residue incorporation (RI+C+U), and residue burning (RB) (Fig. 4a). Application of microbial consortia, with or without urea, enhanced system productivity by approximately 13–17%. Soil organic carbon, determined using the acid dichromate oxidation method, was highest under RI+C (0.81%), followed by RI+C+U (0.82%), while RB recorded the lowest value (0.77%) (Fig. 4b). Measurements of CO_2 flux taken for 15 days immediately after consortia application revealed a similar trend, indicating elevated microbial activity in plots treated with consortia.

It is observed that incorporation of microbial consortia, with or without urea, enhanced system productivity by approximately 13–17%. Soil organic carbon, determined using the acid dichromate oxidation method, was highest under RI+C (0.90%), followed by RI+C+U (0.87%), while RR recorded the lowest value (0.72%) (Figure 4b). CO_2 flux measured daily for 15 days immediately after consortia application, revealed a similar trend, indicating elevated microbial activity in consortia treated plots.

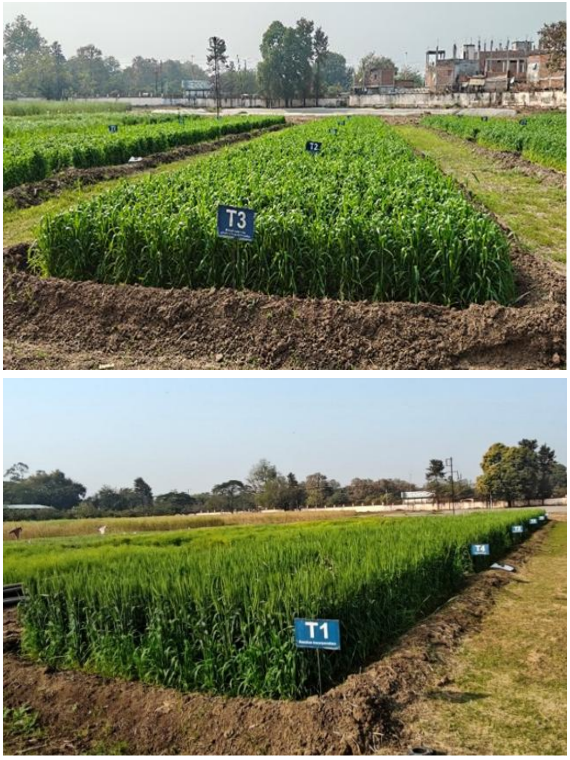

Figure 3 A view of wheat crop under treatments using EKCEL decomposer at ICAR-IISS Bhopal field trial

Another study assessed the synergetic effect of Excel decomposer combined with a rapid composting unit installed in the Deoghar district of Jharkhand to recycle the large volume of disposable plates made from Sal (*Shorea robusta*) leaves, discarded daily after the ceremonial feast at Satsang Ashram. With technical support from ICAR–IISS Bhopal, Krishi Vigyan Kendra (KVK) Deoghar, and Dr. Rajendra Prasad Central Agricultural University, Samastipur, the Ashram installed a rapid composting unit comprising the IISS EKCEL-ShredR and EKCEL-CompostR (ICAR-IISS, 2019) EKCEL decomposer culture was used to accelerate the waste decomposition process (Fig. 5 a–d). Lignocellulolytic microbial consortia, comprising both mesophilic and thermophilic strains of bacteria and fungi, were introduced at different stages of composting. Maintained at a temperature of 55–70 °C, decomposition was accelerated through the combined action of heat and lignocellulolytic enzymes produced by the microbial community, shortening the composting period from 180 days to just 90 days. The compost generated through this technology was applied in the gardens of Satsang, KVK, Airport, and AIIMS, contributing to revenue generation. Over three years, the Ashram produced 67 tons of compost, ensuring effective management of organic residues.

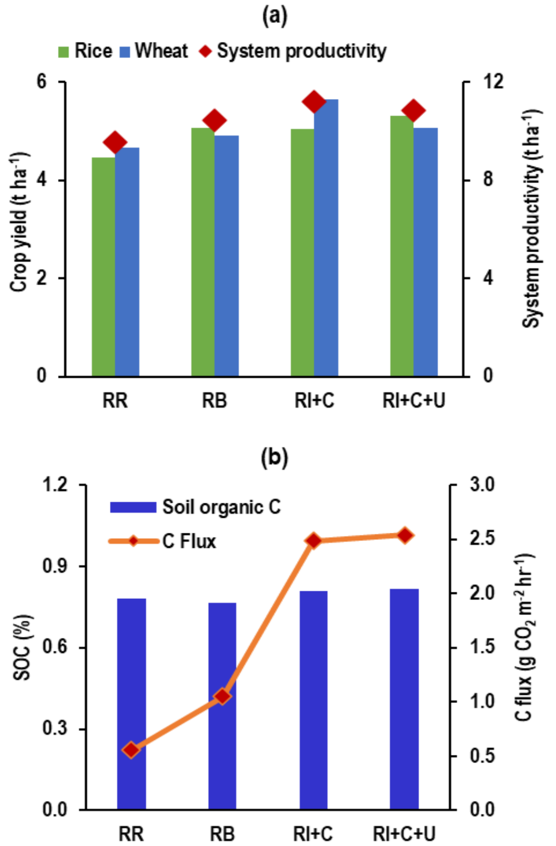

Figure 4 Effect of EKCEL decomposer application on **(a)** rice yield and system productivity and **(b)** soil health

Figure 5 a Biodegradable food staff/ Organic waste

Figure 5 b Application of microbial consortia

Figure 5 c CompostR -Rapid Composting Machine

Figure 5 d Final product - Compost

SUMMARY

The EKCEL Decomposer capsule, developed by the ICAR–Indian Institute of Soil Science (IISS), Bhopal, contains a consortium of four fungal species that accelerate crop residue degradation. This eco-friendly and low-cost solution converts residues into humus-rich organic matter. Enzymes secreted by the fungal consortia enhance decomposition, delivering soil and environmental benefits, as demonstrated in pilot stage. At the community scale, the technology has also been successfully applied to convert large volumes of organic waste into valuable compost within a few weeks. Although current applications remain at the preliminary trial stage, the promising results strongly warrant comprehensive long-term evaluation under diverse environmental and ecological conditions.

ACKNOWLEDGEMENT

The authors are thankful to ICAR and Director, ICAR-IISS, Bhopal for providing the necessary facilities and support for development and evaluation of the ICAR-IISS Excel decomposer capsule.

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Article Received on: 27 January 2026