Banking on seeds

Seed conservation is an essential part of food security. But it's not just the state: researchers are conserving traditional crops, too.

PALLAB ROYGUPTA

Biotechnologist Bhagirath Choudhary remembers how he came across a sample of fennel seeds in a small town on the foothills of Mount Abu in 2021. Choudhary was in Sirohi in Rajasthan to host an agriculture camp organised by the Centre's Department of Biotechnology. At the camp, farmer Ishaq Ali and his father, from Kachholi village near Sirohi, showed him a handful of aromatic fennel seeds, used in food and herbal medicines. Choudhary was struck by the exceptional quality of the seeds. With his encouragement, a small gene bank was set up on Ali's farm, turning the village into a hub of agro-biodiversity and farmer-led innovation.

Choudhary, Founder-Director of the Jodhpur-based not-for-profit South Asia Biotechnology Centre (SABC), later discovered that the fennel variety had not been documented in India's official varietal records, despite having been cultivated for generations. This led him to explore the Protection of Plant Varieties and Farmers' Rights Authority (PPV&FR) Act, 2001, which allows for the recognition of farmers as breeders. Choudhary and his team helped document and register the variety — Abu Saunf 440 — with the authority.

Abu Saunf 440 (Abu is a reference to Mount Abu, and *saunf* is the local word for fennel) stands out for its bold, dark green seeds and strong aroma — attributes preserved by traditional drying methods. While most fennels sell for ₹70-100/kg, Abu Saunf fetches ₹400-500/kg because of its enhanced flavours. Choudhary's team is now seeking a Geographical Indication (GI) status for it. The SABC-supported 'Abu Saunf Community Gene Bank' in the Kachholi farm conserves 150 fennel varieties and serves as a training centre for farmers across Rajasthan.

Rejuvenating folk rice

Across the country, efforts are being made to preserve India's agricultural heritage. Take ecologist Debal Deb, who has been conserving indigenous or folk rice varieties from India and elsewhere. "Crop landraces were developed by traditional farmers to (get them to) adapt to local soil and climatic vagaries, and these are the best arsenals of climate resilience in the hands of marginal farmers. It's our responsibility to conserve these landraces for food and nutrition security, which industrial agriculture has failed to ensure for the poor in the face of climate crises," says Deb. who studied ecological economics at Berkeley and did his post-doctoral research in human ecology from the Indian Institute of Science, Bengaluru.

In 1997, he established a folk rice gene bank, Vrihi, in Bankura in West Bengal. Deb collected 1,480 folk rice varieties from South Asia and another 40 varieties from South-east Asia, Italy, and the U.S. In addition, 30 other crops are being grown on his conservation farm, Basudha, in Rayagada, Odisha, with zero external inputs such as chemical fertilisers. Vrihi — rice in Sanskrit —is now a part of Basudha in Rayagada.

Deb, who has been closely studying ancient cultivation practices, believes that earlier, farmers who grew or developed cultivars, knew the exact characteristics that a variety possessed, distinct from those of other landraces or cultivars. One such trait is photoperiod sensitivity — exposure to daylight. This enables farmers to know precisely when a crop will flower. This feature is found in most traditional South Asian rice varieties that bloom in winter, when the days are shorter. Deb says that farmers could identify a specific landrace by the flowering date. Farmers cultivated the photoperiod-insensitive varieties — those with unstable flowering dates — in hot seasons when the daylight period is longer than 12 hours.

Seed conservation is regarded as an essential part of food security — for the present, and the future.

K.S. BHARADWAJ

Fennel farmer Ishaq Ali (*left*) with biotechnologist Bhagirath Choudhary.

Farmers of earlier times also effectively tackled plant diseases by crossing a variety with wild rice (*Oryza rufipogon*) to incorporate genes for disease resistance. The next generation of the crossed rice would prove to be more disease-resistant, Deb says. This crossing was marked with a ceremony in eastern India, in a ritual called Nal Sankranti in October, when the short-day rice varieties started flowering. Deb adds that rice puddings and other sweet rice preparations mark such festivals, leading to the continuing cultivation of dozens of aromatic rice varieties in Bengal, Jharkhand and Odisha.

These varieties have, apart from cultural significance, great nutritional benefits. In a recent study (*bit.ly/Vitamin-source*), Deb and his team found that traditional indica rice landraces contain much higher levels of Vitamin B than modern varieties in the markets. The team analysed 309 traditional types of rice and reported significantly richer concentrations of thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, and biotin. The team also found two essential fatty acids required for infant brain development in some 40 varieties. "Those fatty acids are usually found in a mother's milk but not in formula foods for infants," says Deb.

Some traditional rice landraces, he adds, are resistant to drought, floods, salinity, pests and diseases. The team also noted various morphological variations, such as grain colours and sizes, leaf shades and angles.

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Food security

Seed conservation is regarded as an essential part of food security. The Central government announced in March 2025 that it would set up a second gene bank for safety duplicates. "Seed conservation is a crucial activity — not just for future food security, but also for our present food and nutritional security," says Kailash Chander Bansal, former Director, Indian Council of Agricultural Research (ICAR)-National Bureau of Plant Genetic Resources (NBPGR), New Delhi.

The Indian National Gene Bank — established in 1996 by ICAR-NBPGR — is one of the world's largest repositories. With 12 regional units, it currently conserves around 4.75 lakh seed samples (accessions), including 105,000 types of rice. The facility has world-class infrastructure and advanced cold storage systems, says Bansal.

In a gene bank, seeds are stored under two different conditions: medium-term and long-term storage. In medium-term storage, the seeds are kept in cold modules at 4°-8° Celsius with less than 30% relative humidity. The temperature is maintained for long-term storage between -18°C and -20°C. These different set-ups are necessary for conserving the seed's genetic material and distributing it to researchers and breeders. Under these controlled conditions, seeds can stay viable for 10-20 years or more, depending on the crop.

A second such bank, Bansal believes, will protect India's vast genetic wealth from natural disasters or other threats. As a member of the committee that recommended the setting up of another bank, he believes that seed conservation is vital for India's current and future food and nutritional security, especially when climate change adversely affects weather patterns and crop yields. Conserved genetic resources provide the foundation for breeding crops resilient to drought, salinity, heat, and flooding while supporting sustainable agriculture through higher yields with lower input and environmental impact.

There are three key pathways for utilising genetic material: conventional breeding, molecular breeding using gene markers, and genome editing with tools like CRISPR. Genome editing, he notes, allows precise improvements and faster domestication, cutting breeding time to 4-5 years — but requires strong functional genomics to identify useful genes.

During his tenure as Director of NBPGR, Bansal evaluated the entire gene pool of wheat — about 25,000 accessions – in a single season. His team assessed 22,000 wheat accessions across multiple agro-ecological zones in India. This ambitious project, conducted between 2011 and 2013, identified several promising lines showing heat tolerance — crucial for the crop's grain-filling phase, which increasingly coincides with rising temperatures from February to April. These lines showed no yield loss under heat stress, and although

not high-yielding themselves, they carry valuable genes that can be used in breeding resilient varieties.

The team also discovered resistance to diseases and traits for improved nutritional quality. Encouraged by its success, Bansal extended the experiment to chickpeas, screening 15,000-18,000 genotypes.

Superfood millet

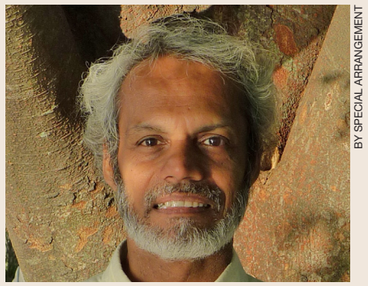
The decision to set up a second bank emerged from concerns about having a single storage site. After all, a precious collection in a seed bank in war-hit Syria was saved because of safety duplicates.

The ICAR formed a high-level committee in 2020, chaired by agriculture scientist Rajendra Singh Paroda, to plan a duplicate gene bank. "The report, submitted in 2021, recommended a Himalayan location to leverage natural cold and reduce energy costs," says Kuldeep Singh, head of the gene bank at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad. Singh calls the would-be facility a "safety duplicate" rather than a second gene bank. Construction and relocation of over 450,000 accessions could take 3-5 years, creating jobs and requiring a new scientific workforce.

ICRISAT is another trove of precious seeds. It holds the world's most extensive millet collection, with 79,000 accessions from over 100 countries. Since its inception in 1972, its gene bank in Patancheru, Hyderabad, has distributed 1.72 million seed samples globally. Renewed interest in millets — the United Nations named 2023 the International Year of Millets — has revived cultivation efforts. Millets are farmer-, consumer-, and environment-friendly, he says, pointing to the pearl millet's drought tolerance quality and high iron content, and the finger millet's calcium richness.

Singh explains that millet predated rice in many regions of India. Pearl millet was a major crop in Punjab till the 1970s and remains a staple in Rajasthan. Kodo millet, domesticated in Madhya Pradesh, is still cultivated by indigenous communities. Amaranth is another high-protein "potential crop". Grown in Gujarat and some other States, it is part of a network of 8-10 universities promoting underutilised crops such as amaranths.

He emphasises the growing role of gene banks and precision breeding in developing climate-resilient varieties. "With genomics, scientists can now isolate beneficial traits and introduce them into crops without compromising taste, adaptability, or yield."



BY SPECIAL ARRANGEMENT

Debal Deb (*top*) has been conserving indigenous or folk rice varieties from India and elsewhere; during his tenure as NBPGR Director, Kailash Bansal (*above*) evaluated the entire gene pool of wheat in a single season.

The new gene bank will conserve 10 lakh crop germplasms and provide conservation support to the public and private sectors for genetic resources.

Benefits of native crops

Some traditional crop varieties have high yields, too. Anupam Paul, former Assistant Director of Agriculture at Chakdaha, West Bengal, points out that some strains can yield up to 6 tonnes per hectare of rice without chemical fertilisers. The grains are nutritionally rich, containing iron, beta-carotene, and antioxidants.

Encouraged by Deb's experience, Paul started conserving local rice seeds in West Bengal during his tenure in the agriculture department. "In 2000, I came across a book by Debal Deb, which inspired me to conserve our traditional rice varieties," he recalls. He has so far collected 400 strains — including Odisha's *Kalabhat* (a highly nutritious black rice) and Purulia's *Raon* — of traditional rice varieties, many of which are high-yielding and climate-resilient.

Under the government-supported Rashtriya Krishi Vikas Yojana, he worked with farmers for four years in 16 districts in West Bengal, the State with the highest production of traditional rice varieties. He notes that more than 25 farmer-led seed banks now operate in the State, supplying seeds to other farmers.

Paul says that while traditional rice conservation is not officially integrated into national gene banks, many varieties are registered under PPV&FRA. However, he stresses that government repositories lack an open, field-based model where farmers can directly view, select, and cultivate from live specimens.

Spice route

The idea of preserving Indigenous crops led biotechnologist Chaudhary to establish the SABC, underlining the uniqueness of local crops and preserving them for the future. His work extends to spices as well. He cites the example of *Kasuri methi*, a fenugreek variety traditionally thought to have originated in Kasur, now in Pakistan. Post-Independence, it has been cultivated only in a few tehsils of Rajasthan's Nagaur district, where it is locally known as *Nagauri methi*. This variant — *Trigonella corniculata* —is valued for its aromatic leaves and limited geographical spread. "One of the most significant impacts of SABC's work — particularly in Rajasthan — has been positioning the State as the country's leading producer of spices. It's a remarkable achievement, especially considering the limited resources we had, and one that not many people are aware of," says Choudhary.

Conservation support

According to the government, the new gene bank will conserve 10 lakh crop germplasms for future food and nutritional security. The setting up of a second seed bank, the government said in a statement in March 2025, was aimed at "strengthening India's position as a leader in global biodiversity conservation". It will provide conservation support to the public and private sectors for genetic resources.

Bansal, however, points out that only 2-5% of stored genetic material is currently used in research or breeding. He calls for greater utilisation of these diverse resources, which have evolved over centuries and hold traits critical for future food systems. •