Beyond rice and wheat: Why Indiaâ??s next agricultural revolution may come from forgotten crops

15 June 2026 | News

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In an exclusive interview with *AgroSpectrum*, **Dr. Padma Ishwarya S., Senior Scientist (Plant-based) at the Good Food Institute India**, argues that Indiaâ??s agricultural future must move beyond calorie security toward nutrition security, climate resilience, and biodiversity-led growth. She highlights how the countryâ??s continued dependence on imported pulses and oilseeds reflects deeper structural imbalances in agricultural incentives, research priorities, and market systems.

The discussion explores the untapped potential of indigenous and orphan crops such as horse gram, winged bean, bambara groundnut, and amaranth as climate-resilient, protein-rich alternatives capable of powering Indiaâ??s emerging smart-protein economy. Dr. Ishwarya also emphasizes the transformative role of genomics, AI, and computational biology in accelerating crop improvement and commercialisation, while stressing the need to bridge crop science, food science, and industry requirements. She concludes that with targeted policy support, processing infrastructure, and value-chain investments, Indiaâ??s rich crop diversity could become a major economic, nutritional, and geopolitical advantage in the rapidly expanding global plant-protein market.

India is the worldâ??s largest rice producer, yet remains import-dependent for pulses and oilseeds. Does this expose a deeper imbalance between calorie security and nutritional security in Indiaâ??s agricultural model ?

India's focus on rice and wheat during the Green Revolution era was a need-based intervention that ensured caloric sufficiency and food security. Subsequently, cereals became deeply embedded in Indiaâ??s agricultural infrastructure, markets, and farmer decision-making. Today, Indiaâ??s priorities are shifting toward nutrition security, with an emphasis on

crop diversification and biofortification as strategies to address longstanding protein and micronutrient deficiencies among the Indian population.

There are several reasons for Indiaâ??s import dependence on pulses and oilseeds. Over the decades, cereals benefited from sustained investments in research and development, productivity enhancement, cropping incentives, assured procurement, and market support mechanisms. In contrast, pulses and oilseeds production has faced greater market volatility and relatively less access to quality seeds, mechanisation, irrigation, and value chain development. As a result, domestic production has not always kept pace with growing demand, contributing to continued import dependence.

But diversification toward millets and pulses is steadily increasing in several states, driven by growing recognition of the benefits like resource-use efficiency, soil health, and climate resilience. Recent national missions on pulses, oilseeds, and millets will accelerate this diversification towards crops that are both nutritionally and environmentally beneficial, supporting agricultural R&D and stronger market incentives for farmers.

Your whitepaper highlights orphan crops such as horse gram, winged bean, lupin, and bambara groundnut. Why have nutritionally rich indigenous crops remained economically invisible in mainstream agriculture for decades?

Many of these crops were traditionally cultivated in rainfed, tribal, hilly, or marginal agroecologies, often by smallholder farmers for household consumption rather than large-scale commercial trade. Gaps in crop modelling, germplasm characterisation, and value-added product development, could be the reasons for challenges in wider commercial adoption. Despite their climate resilience, low productivity and yields, alongside strong off-flavours, have hindered their large-scale adoption in mainstream agriculture. This is further constrained by a lack of established supply chains and post-harvest processing units for both primary and advanced food applications.

However, the landscape is now changing. Over the past few years, the Government of India is paying significant attention toward millets, pulses, and oilseeds through initiatives linked to the International Year of Millets 2023, the National Mission on Edible Oils-Oilseeds and the six-year Mission for Aatmanirbharta in Pulses. According to GFI Indiaâ??s latest whitepaper on crop optimisation, addressing the current gaps will require targeted R&D integrating crop physiology, genetics and agronomy with end-use functionality. With efficient processing to extract proteins and other high-value ingredients, these crops could become highly functional and attractive inputs for commercial food processing.

As climate volatility intensifies, could orphan crops emerge not merely as nutritional alternatives, but as strategic climate-resilient assets for Indiaâ??s agricultural future?

Indiaâ??s agricultural systems are increasingly exposed to climate variability, further exacerbated by input-intensive cultivation of cereals like rice that have contributed to soil nutrient depletion and groundwater stress. Diversifying into indigenous and orphan crops offer a comparative advantage as they are naturally adapted to local agro-climatic conditions and perform well under more marginal or variable environments.

Indigenous pulses and legumes, for instance, are hardy nitrogen-fixing crops that typically require fewer external inputs such as synthetic fertilisers and intensive irrigation. Both millets and pulses are drought- and heat-tolerant, while their deeper root systems and longer growth periods improve soil biodiversity and structure. However, further agricultural research is needed to identify traits that deliver stable protein and nutrient yield under climate stress, as well as the develop and breed climate-adaptive varieties.

Much of the global plant-protein industry still depends on soybean, pea, and wheat. How significant is the opportunity for India to build a differentiated smart-protein ecosystem rooted in indigenous biodiversity?

Among the currently available plant-based meat products in India, 30 per cent use soy as their source of protein, 20 per cent use a composite blend of soy and wheat protein, and 15.8 per cent contain pea protein. There is growing interest from industry in expanding this basket, driven by concerns of supply concentration, allergenicity, sustainability and limited product functionality. India is well-positioned to meet this demand with its rich diversity of indigenous crops and to build a more localised, resilient ingredient ecosystem that has otherwise remained heavily import-dependent.

Underutilised crops such as amaranth, winged bean, or finger millet boast high-quality, complete protein profiles, while several indigenous crops (e.g. mung bean) can provide functional properties like binding, emulsification and gelling, which are critical to achieving the desired taste and texture in plant-based alternatives without the need for additives. With targeted crop optimisation, processing innovation, batch-to-batch consistency and an in-depth understanding of functionality, these crops could expand the range of locally sourced smart protein ingredients that are both highly nutritious and functionally robust.

India possesses one of the worldâ??s richest repositories of plant genetic diversity through institutions like ICAR-NBPGR. Is the bigger challenge today scientific discovery, policy prioritisation, or commercialisation?

Indiaâ??s strengths lie in plant genetic resources, crop science, and public agricultural research. Significant progress has been made in policy support for agricultural innovation. The challenge lies in translating scientific advances into commercially relevant outcomes at scale. While crop improvement research and food product development have seen simultaneous progress, these are rarely integrated.

Crop scientists may focus on yield, disease resistance, and agronomic performance, while food scientists and industry stakeholders prioritise traits such as protein content, functionality, flavour, processing characteristics, and end-use applications. There is a need and opportunity to connect crop science, food science, and industry needs. When breeding objectives, processing requirements, and market applications are aligned, innovations can be translated from lab to market much faster.

The whitepaper calls for AI and machine learning to accelerate crop trait discovery. How transformative could computational biology and genomics become in unlocking the commercial viability of orphan crops?

Computational biology and genomics could be game-changers for orphan crops. These technologies help scientists identify desirable traits such as higher yield, better nutrition, climate resilience, and improved processing qualities much faster than traditional breeding methods. This can significantly shorten the time needed to develop commercially viable varieties.

Genomics can accelerate commercialisation through faster breeding and domestication, improving processor-relevant traits, and unlocking hidden genetic diversity. Computational biologyÂ tools can compensate for the relatively small datasets available for orphan crops by transferring insights from major crops and identifying promising breeding targets more efficiently. With these approaches, the smart protein sector can move from trial-and-error innovation to faster, data-driven crop and productÂ development.

Crop diversification often fails due to weak processing and supply-chain infrastructure. Can orphan crops realistically scale without parallel investment in ingredient manufacturing and food-processing ecosystems?

Market access and limited commercial linkages remain key constraints for wider diversification into orphan and indigenous crops. Addressing these constraints will require stronger investment in agricultural R&D focused on end-product functionality; closer collaboration between academia and industry to align crop traits with market requirements and set up; and greater support for downstream food processingâ??including pilot-scale validation. Together, these interventions can ensure orphan crops are converted into commercially viable ingredients for plant-based smart proteins and other value-added food products.

To establish scalable and localised supply chains for processing and ingredient manufacturing, NIFTEM-T and GFI Indiaâ??s report also notes the need for further funding and policy support for domestic, low-cost production of specialised smart protein manufacturing equipment.

As sustainability and food-security concerns reshape global protein markets, could Indiaâ??s indigenous crop diversity become a long-term geopolitical and economic advantage?

Systematically integrating orphan crops into food processing, public nutrition programmes, climate-resilient agriculture missions, and export-oriented value chains could significantly add to the countryâ??s economy over the next 5â??7 years. Just as millet-based food products and procurement values have already increased sharply following policy support and market development initiatives, other indigenous crops can follow a similar trajectory. India has a strong comparative advantage globally in climate-resilient nutri-cereals and speciality protein crops.

Value-added processing (protein isolates and concentrates, plant-based meat, egg and dairy products, ready-to-cook foods, functional foods) creates significantly higher economic returns than raw grain sales alone. The economic gains could come from higher farmer incomes, reduced nutrition and climate-related economic burdens, growth of Indiaâ??s plant-protein and smart protein sectors and export. With the global plant-based meat market growing anywhere from $ 88 billion to $ 368 billion by 2035, there is immense potential for India to become a major exporter of plant protein ingredients and smart protein end-products.

For decades, agricultural policy has prioritised yield maximisation around a narrow basket of staples. Does India now need a fundamentally new policy framework that values biodiversity, nutritional density, and resilience as much as production volumes?

Government support is already playing a catalytic role with its existing national priorities for indigenous crops like pulses, millets, and oilseeds, alongside investment into the food processing infrastructure. GFI Indiaâ??s whitepaper recommends the establishment of a â??smart crops for smart proteinsâ?? initiative, including academia-industry-policy linkages to align agricultural R&D with market requirements to leverage these crops to their fullest potential.

With continued research and investment, India can deliver affordable nutrition domestically through delicious alternatives and familiar formats alike, while becoming a competitive global supplier of plant-based protein ingredients, equipment and end products.

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