Beyond food-versus-fuel debate: Rethinking Indiaâ??s ethanol economy

18 May 2026 | News

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In an exclusive interview with *AgroSpectrum*, **Dr. C.K. Jain, President of the Grain Ethanol Manufacturers Association (GEMA)**, argues that Indiaâ??s ethanol programme must be viewed through the broader lens of energy security, rural income generation, and agricultural surplus management rather than as a simplistic â??food versus fuelâ• debate. He challenges widely cited claims around ethanolâ??s water footprint, asserting that modern grain-based ethanol plants operate with significantly lower process-water consumption while increasingly shifting toward diversified feedstocks such as maize, agricultural residues, and second-generation biofuels.

Dr. Jain also highlights how ethanol blending has reduced crude-oil dependence, generated foreign-exchange savings, and created additional market opportunities for farmers by utilising surplus and damaged grain stocks. While acknowledging the commercial and logistical challenges facing second-generation ethanol, Jain maintains that Indiaâ??s long-term biofuel future will depend on balancing sustainability, feedstock diversification, farmer welfare, and energy resilience within a larger clean-energy transition.

The ethanol industry argues that the â??10,000 litres per litreâ• figure is misleading because it conflates rainfall, crop cultivation and industrial water use. But for an ecologically stressed country like India, shouldnâ??t the public care about the total water footprint regardless of where that water is consumed? Are you drawing a technical distinction that may not matter on the ground?

Indiaâ??s water security concerns are valid and deserve serious attention. However, the widely cited â??10,000 litres of water for one litre of ethanolâ• figure is misleading because it combines rainfall, agricultural activity, and industrial process water

into a single number. It does not reflect the actual water consumed within ethanol plants. Modern grain-based ethanol plants in India typically consume around 3 to 5 litres of process water per litre of ethanol, supported by recycling systems and process-efficiency technologies.

It is equally important to separate agriculture from ethanol production. Rice and paddy in India are cultivated primarily for food consumption and food security. Ethanol production does not drive paddy cultivation. The industry largely utilises surplus rice, broken rice, damaged food grains, ageing stocks unfit for human consumption, and milling by-products that already exist within the agricultural system.

India regularly faces grain surplus and storage-management challenges. Productive utilisation of excess grain helps reduce wastage while creating an additional source of income for farmers. In a country where agriculture remains central to livelihoods and rural growth, ensuring farmers receive economic value from surplus produce is an important policy objective.

Further, a significant share of paddy cultivation in India is rain-fed. Ethanol production is also gradually shifting towards maize, which is comparatively less water-intensive. The larger debate, therefore, cannot be reduced to a simplistic â??ethanol versus waterâ?• argument. Ethanol should be viewed within the broader context of agricultural surplus management, farmer welfare, energy security, and rural economic growth.

Grain ethanol has overtaken sugar-based ethanol in ESY 2023â??24, and GEMA positions maize as a more sustainable feedstock. But if ethanol demand scales aggressively under future E85 and E100 ambitions, what prevents maize itself from becoming the next water-intensive or food-security flashpoint? Are we simply shifting the pressure from one crop to another?

Maize is fundamentally different from highly water-intensive crops like sugarcane and is increasingly being viewed as a more sustainable feedstock within Indiaâ??s ethanol roadmap. In India, a large share of maize cultivation is rain-fed, which reduces dependence on groundwater.

At the same time, it is important to separate food production from ethanol production. Indiaâ??s ethanol programme is not based on diverting food away from people. The policy framework prioritises surplus grain, damaged grain, broken rice, and excess agricultural output that would otherwise create storage pressures or risk wastage.

India has periodically faced significant surplus rice stocks after meeting food-distribution and buffer-stock requirements. As per Food Corporation of India data, rice stocks crossed 530 lakh tonnes in 2024, nearly four times the required buffer norm for that period. Productive utilisation of such surplus helps strengthen farmer incomes while reducing pressure on public storage systems. Companies purchasing surplus or damaged grain for ethanol production create an additional economic avenue for farmers that may otherwise not exist.

Importantly, the future ethanol ecosystem will not depend on a single feedstock. The sector is already moving towards greater diversification through maize, agricultural residues, crop waste, biomass, and second-generation ethanol. The larger objective is to build a balanced biofuel ecosystem that supports rural incomes, improves utilisation of agricultural surplus, and strengthens Indiaâ??s energy resilience.

You describe criticism of ethanol as an â??attribution error,â• arguing that Indiaâ??s water crisis predates the blending programme. But doesnâ??t the ethanol ecosystem now risk reinforcing exactly those unsustainable cropping incentives â?? particularly in politically sensitive states where procurement, subsidies and energy pricing already distort agricultural behaviour?

Indiaâ??s agricultural and water-management challenges are long-standing structural issues shaped by decades of cropping patterns, procurement systems, irrigation practices, and rural economics. These challenges existed well before the Ethanol Blended Petrol Programme and cannot be attributed solely to ethanol production.

It is also important to recognise that ethanol production does not determine what farmers grow for food consumption. Rice and grain cultivation in India are driven primarily by food-security requirements and agricultural policy. The ethanol industry largely utilises surplus grain, damaged grain, and ageing stocks that remain after food and buffer-stock needs are met.

What the ethanol ecosystem does provide is an additional market for surplus agricultural output. That creates incremental income opportunities for farmers, particularly in an agriculture-dependent economy where stable rural earnings are critical for broader economic growth.

The sector is also evolving towards more diversified feedstocks such as maize, agricultural residues, and second-generation ethanol. Sustainability concerns around crop planning and resource management should continue to be addressed through

better agricultural policy, irrigation efficiency, and regional planning. The answer is not to undermine ethanol, but to improve sustainability across the larger agricultural ecosystem while ensuring farmers benefit from productive utilisation of surplus output.

Ethanol blending has undeniably delivered foreign exchange savings and reduced crude imports. But how should policymakers weigh energy security against groundwater security? At what point does strategic fuel substitution become environmentally self-defeating in a country facing accelerating aquifer depletion?

Energy security and agricultural sustainability should not be viewed as competing priorities. For a country like India, both are essential to long-term economic stability and development.

India imports nearly 88 to 89 per cent of its crude oil requirements, making the economy highly vulnerable to external price shocks and geopolitical uncertainty. At the same time, the Ethanol Blended Petrol Programme has helped reduce petrol imports by replacing a portion of fossil fuel demand with domestically produced ethanol. According to government estimates, ethanol blending has helped India save more than Rs 1.1 lakh crore in foreign exchange between 2014 and 2024 while reducing crude-oil dependence and supporting rural economies.

Indiaâ??s broader agricultural system also continues to face storage-management and post-harvest challenges. Large quantities of surplus grain and damaged food stocks require productive utilisation after food-security obligations are met. As per Food Corporation of India data, rice stocks crossed 530 lakh tonnes in 2024, far above prescribed buffer requirements. Ethanol production provides one such avenue while generating additional income opportunities for farmers and reducing wastage.

The sector is also evolving towards more diversified and sustainable feedstocks, including maize, agricultural residues, and second-generation ethanol technologies. The larger policy challenge is to strengthen agricultural productivity, improve storage and supply-chain efficiency, and ensure better resource management across the rural economy.

Ethanol should therefore be viewed as one component within a broader strategy that supports energy resilience, rural development, and more efficient utilisation of agricultural surplus.

Indiaâ??s ethanol programme is increasingly being framed as both a climate solution and a rural economic stabilisation mechanism. But is there a risk that the programme survives politically not because it is the most sustainable energy pathway, but because it has become economically indispensable to powerful agricultural and industrial lobbies?

Indiaâ??s ethanol programme should be viewed within the broader context of energy transition, agricultural economics, and rural development rather than simply through the lens of sectoral interests. The programme has expanded because it addresses multiple national priorities simultaneously. It helps reduce crude-oil dependence, creates productive use for surplus agricultural output, and provides an additional source of income for farmers in a country where agriculture remains central to livelihoods and economic stability.

It is important to recognise that ethanol production in India is not based on diverting essential food supplies away from consumption. The sector primarily utilises surplus grain, damaged grain, broken rice, and ageing stocks that remain after food-security and buffer-stock requirements are met.

For farmers, this creates an additional market that improves value realisation and reduces the risk of produce going to waste or remaining locked in costly storage systems. In an agriculture-dependent economy, higher rural incomes contribute not only to farmer welfare but also to broader economic growth.

At the same time, it would be incorrect to suggest that the programme survives only because of industrial or political interests. Its continued expansion reflects the fact that it delivers measurable economic and strategic value across multiple sectors, including energy security, rural income generation, and more efficient utilisation of agricultural surplus. Any large-scale national programme involving agriculture and energy will naturally create economic stakeholders, but that alone does not invalidate its broader public-policy relevance.

No single energy pathway can independently solve Indiaâ??s future energy and climate challenges. Ethanol is one component within a larger transition that will also include renewables, electrification, green hydrogen, and improvements in efficiency. Its long-term relevance will ultimately depend on continuously improving sustainability, feedstock diversification, economic efficiency, and its ability to deliver balanced value across both the energy and agricultural ecosystems.

Second-generation ethanol from crop residues is often presented as the long-term sustainable answer. Yet commercially, progress has remained slow despite years of policy support. What are the hard realities the industry rarely discusses: cost economics, feedstock logistics, technology viability, or policy inconsistency?

Second-generation ethanol holds significant long-term potential because it utilises agricultural residues and biomass that do not compete directly with food consumption. However, scaling 2G ethanol commercially is far more complex than often assumed.

One of the biggest challenges is cost economics. Compared to first-generation ethanol, 2G projects require significantly higher capital investment, more complex technologies, and higher operating costs. Feedstock logistics are another major hurdle. Agricultural residues are geographically dispersed, seasonal, bulky to transport, and expensive to aggregate and store. Building a commercially viable biomass supply chain at scale requires major infrastructure investment and long-term policy certainty. Technology maturity is also still evolving globally. Commercial-scale operations require further improvements in conversion efficiency, operational reliability, and feedstock flexibility before they become fully competitive.

That said, India has already taken important steps through policy incentives, pilot projects, and public-private participation. Initiatives such as the Pradhan Mantri JI-VAN Yojana were introduced to support commercial-scale second-generation ethanol projects using agricultural residues and biomass. Under this scheme, the government approved financial assistance for projects by Indian Oil Corporation in Panipat, Bharat Petroleum Corporation in Bargarh, HPCL in Bathinda, and Numaligarh Refinery in Assam.

India has also operationalised one of Asiaâ??s first large-scale 2G ethanol biorefineries in Panipat, Haryana. Built by Indian Oil Corporation at an estimated cost of over Rs 900 crore, the facility uses nearly 2 lakh tonnes of rice straw annually to produce around 3 crore litres of ethanol while also creating an economic use for agricultural residue that would otherwise contribute to stubble burning.

The long-term direction, therefore, remains clear. The future ethanol ecosystem will continue to diversify towards agricultural residues, crop waste, biomass, and advanced biofuels, while first-generation ethanol continues to support the productive utilisation of surplus grain and strengthen rural incomes.

The ethanol debate today appears trapped between two competing narratives, â??green fuel saviourâ• and â??water guzzling disaster.â• If you strip away industry advocacy and activist alarmism, what is the one uncomfortable truth both sides are still refusing to acknowledge about Indiaâ??s biofuel future?

Indiaâ??s energy transition must be viewed in the context of the countryâ??s scale, agricultural economy, and long-term development priorities. Ethanol has emerged as an important component within this transition because it simultaneously supports energy security, rural incomes, and more efficient utilisation of agricultural output.

The ethanol debate is often framed in overly simplistic terms, whereas the reality is far more interconnected. Indiaâ??s ethanol programme is not only about blending fuel. It is also about strengthening domestic energy resilience, reducing import dependence, and creating additional economic value within the rural economy.

India continues to face recurring challenges around grain-surplus management and storage capacity after meeting food-security and buffer-stock obligations. Ethanol production provides a productive economic avenue for such surplus while generating additional income opportunities for farmers and strengthening the agricultural value chain.

The sector is also steadily evolving through feedstock diversification, increased use of maize, agricultural residues, biomass utilisation, and second-generation ethanol initiatives. India has already taken important steps in this direction through policy incentives, commercial-scale 2G ethanol projects, and investments in biomass-based technologies. This transition reflects a broader effort to build a more resilient and diversified biofuel ecosystem that is aligned with Indiaâ??s long-term goals around energy security, reduced import dependence, rural development, cleaner fuel alternatives, and more efficient utilisation of agricultural resources.

Ultimately, ethanol should be viewed not as a standalone solution, but as one important component within a broader national strategy focused on energy resilience, farmer welfare, rural prosperity, and long-term economic growth.

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