

ETHANOL FOR SUSTAINABLE FUTURE

India's Ethanol Blending Programme: Progress, Concerns and Sustainability Measures

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Executive Overview

India's Ethanol Blending Programme (EBP) has become a major instrument for energy security and transport decarbonisation, reaching the **E20 milestone** ahead of the original schedule. The source, however, stresses that the post-E20 phase must address **food security, water sustainability**, vehicle compatibility and the environmental footprint of feedstock production while shifting toward **advanced biofuels**.

Indicator	Source Detail
Average ethanol blending	1.53% in ESY 2013-14 to approximately 20% in 2025
Grain-based ethanol supply	Around 624 crore litres by August 2026, nearly 70% of ESY 2025-26 supplies
Ethanol production capacity	Approximately 518 crore litres in 2017 to over 1,800 crore litres by mid-2025
FCI rice allocation	Approximately 44 lakh tonnes for ethanol production by June 2026
Foreign-exchange savings	Over Rs. 1.97 lakh crore since 2014-15, according to government estimates cited by the source
Retail availability	E20 described as standard petrol across roughly 90,000 retail outlets by 2026

Key Developments Shaping India's Ethanol Blending Programme

Early Achievement of the E20 Milestone

Average ethanol blending rose from only **1.53%** in ESY 2013-14 to **approximately 20% in 2025**, reaching the original 2030 target nearly five years early. The source therefore describes the programme as entering a **post-E20 phase** focused on blends beyond 20%, feedstock sustainability and vehicle compatibility.

Transition to a Multi-Feedstock System

Ethanol production has moved beyond C-heavy molasses to include sugarcane juice, B-heavy molasses, damaged foodgrains, surplus FCI rice and maize. By August 2026, grain-based sources reportedly supplied around **624 crore litres, nearly 70%** of total ethanol supplies in ESY 2025-26. Maize emerged as the largest individual feedstock during the first half of that ethanol supply year.

Expansion of Distillation and Storage Capacity

Assured procurement, interest-subvention schemes and long-term supply contracts stimulated investment in standalone and integrated distilleries. Ethanol-production capacity increased from approximately **518 crore litres** in 2017 to **more than 1,800 crore litres** by mid-2025. Oil Marketing Companies also invested in dedicated tanks, blending terminals, quality-testing facilities and ethanol-compatible pipelines.

Flexible Feedstock Allocation

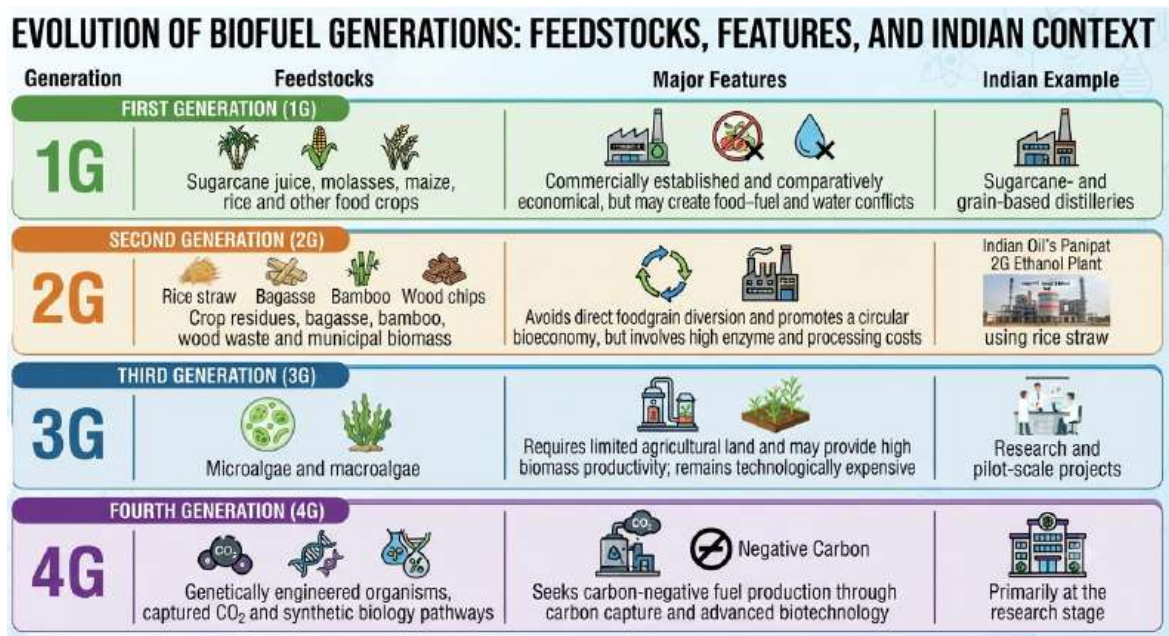
The government adjusts feedstock use according to sugar, rice and maize availability. Restrictions on sugarcane juice and B-heavy molasses during the weak 2023-24 sugar season were later relaxed, while approximately **44 lakh tonnes** of FCI rice had been allocated for ethanol production by June 2026.

E20-Compatible Vehicle Ecosystem

BIS fuel specifications, corrosion-resistant components, revised engine calibration and ethanol-compatible fuel systems are supporting the transition to E20-compatible vehicles. The source identifies the legacy fleet as the next challenge because vehicles designed primarily for E10 may face mileage loss or deterioration of seals, hoses and other components when operated on E20.

Advanced and Second-Generation Biofuels

India is seeking to reduce dependence on food crops through 2G ethanol produced from agricultural residues and lignocellulosic biomass. Indian Oil's **Panipat 2G Ethanol Plant** has a designed capacity of about **100 kilolitres per day** and uses rice straw, while the bamboo-based biorefinery at Numaligarh, Assam, demonstrates a non-food biomass pathway.



Source infographic: Evolution of biofuel generations, feedstocks, features and Indian context (page 6 of the supplied PDF).

Ethanol: Sources and Generations

Fuel ethanol is anhydrous ethanol, generally containing **over 99% ethanol**. The source groups feedstocks into sugar-based, starch-based, lignocellulosic, waste-based and emerging sources.

- **Sugar-based feedstocks:** Sugarcane juice, sugar syrup, B-heavy molasses and C-heavy molasses.
- **Starch-based feedstocks:** Maize, broken rice, damaged foodgrains, cassava, sorghum and surplus foodgrains.
- **Lignocellulosic feedstocks:** Rice straw, wheat straw, bagasse, bamboo, cotton stalks, forest residues and other agricultural waste.
- **Waste-based feedstocks:** Municipal solid waste, industrial gases, food waste and other biodegradable waste.
- **Emerging sources:** Algae, captured carbon dioxide and engineered microorganisms may support future third- and fourth-generation ethanol.

Policy Framework Governing the EBP

- **National Policy on Biofuels, 2018:** Expanded permissible feedstocks and classified biofuels into basic and advanced categories.
- **National Policy on Biofuels Amendment, 2022:** Advanced the 20% ethanol-blending target from 2030 to ESY 2025-26.
- **Roadmap for Ethanol Blending in India 2020-25:** Set out a phased plan for ethanol supply, E20-compatible vehicles, fuel standards and infrastructure.
- **PM JI-VAN Yojana:** Provides financial assistance for 2G and advanced biofuel projects.

Key Concerns Associated with the Programme

Food-versus-Fuel Competition

The source argues that large-scale use of maize, rice and sugarcane for fuel can compete with human consumption, livestock feed and industrial uses. It reports a maize shortfall of **nearly 5 million tonnes** in 2024 and estimated imports of **1 million tonnes**, with poultry, dairy and starch industries facing higher input costs.

Cropping Patterns and Edible-Oil Security

Assured ethanol procurement and attractive maize prices may alter crop profitability. The source reports maize acreage increasing by **10.5%** between the 2024-25 and 2025-26 sowing periods while oilseed acreage declined by **2.22%**, potentially complicating edible-oil security.

Water Footprint and Spatial Sustainability

The source highlights the embedded water use of major ethanol crops. It gives indicative ranges of **500-900 litres** of water per kg of maize, **1,500-2,500 litres** per kg of sugarcane and **2,000-3,500 litres** per kg of rice, while stressing that actual water footprints vary by rainfall, irrigation and local cropping practices.

Climate and Air-Quality Trade-offs

Lower tailpipe carbon monoxide and hydrocarbon emissions do not by themselves make ethanol carbon-neutral. Fertiliser production, groundwater pumping, crop-residue burning, grain drying, distillation and transport consume fossil energy, while land-use change and some engine conditions may affect the net emissions outcome.

Mileage, Legacy Vehicles and Consumer Costs

The source states that the government acknowledged in Parliament in 2026 that E10-designed vehicles may experience a **3-5% reduction in fuel efficiency** when operated on E20. Older vehicles may also face material-compatibility issues involving rubber seals, gaskets, fuel hoses and metallic components.

Consumer Choice and Disclosure

By 2026, E20 is described as the standard petrol across **roughly 90,000 retail outlets**, with E10 or ethanol-free petrol unavailable to most consumers. The source calls for clearer disclosure of actual ethanol percentage, compatibility implications, mileage effects and warranty conditions.

Fiscal, Industrial and Logistics Concerns

The source cautions that foreign-exchange savings should be considered alongside administered procurement prices, concessional finance, subsidies, storage and transport costs, and foregone tax revenue. It also notes environmental risks from distillery wastewater, odour and air emissions, as well as the need for specialised storage and road-tanker logistics because of ethanol's water affinity and corrosiveness.

Measures Proposed for a More Sustainable EBP

- **Dynamic food-first feedstock allocation:** Link ethanol procurement to food stocks, fodder demand, crop prices and inflation, with separate limits for rice, maize, sugarcane and damaged grains.
- **Accelerate 2G and advanced ethanol:** Shift incentives toward lignocellulosic, residue-based and waste-derived fuels, with PM JI-VAN support for modular plants and domestic technology development.
- **Water-budgeted ethanol production:** Incorporate water carrying capacity into environmental clearance, disclose freshwater use per litre of ethanol and expand treated wastewater, condensate recycling and zero-liquid-discharge practices.
- **Consumer and vehicle safeguards:** Display verified ethanol percentage and compatibility information, maintain a transition option for legacy equipment and clarify warranty and mileage expectations.
- **Regional biofuel hubs and logistics optimisation:** Develop decentralised blending depots, rail-linked terminals and flexi-tank infrastructure, supported by GIS-based matching of production districts with nearby OMC terminals.

Strategic Outlook

The source concludes that early achievement of E20 has strengthened India's energy-security strategy but created a new set of trade-offs. Long-term sustainability depends on a more dynamic feedstock framework, faster deployment of 2G biofuels from agricultural waste, tighter water budgeting, stronger consumer safeguards and logistics systems that reduce delivered carbon intensity.