



## India's Ethanol Revolution: Energy and Agriculture

This editorial is based on [“Ethanol push turns India into corn importer, shaking up global market”](#) which was published in The Economic Times on 04/09/2024. The article highlights India's shift from a leading corn exporter to a net importer due to its push for corn-based ethanol production, causing domestic shortages and impacting various sectors, while also reshaping global supply chains.

**For Prelims:** [Ethanol](#), [Ethanol blending](#), [India's oil imports](#), [Greenhouse gas emissions](#), [GOBAR-DHAN scheme](#), [Third-generation \(3G\) ethanol](#), **Flex-fuel vehicles**.

**For Mains:** Significance of Ethanol Production for India, Key Issues Related to Ethanol Production.

India's ambitious push for [ethanol blending in gasoline](#) has led to an unexpected shift in its agricultural landscape and global trade position. Once **Asia's top corn exporter**, India has now become a **net importer for the first time in decades**, primarily due to the government's decision to promote **corn-based ethanol production**. This policy change, aimed at reducing carbon emissions and ensuring **ample sugar supply for domestic consumption**, has created a significant corn shortage, compelling the country to import a record **1 million tons in 2024, mainly from Myanmar and Ukraine**.

The ripple effects of this transition are being felt across multiple sectors. While the move supports India's climate goals and aims to decrease reliance on sugarcane for ethanol, it has inadvertently **squeezed local poultry producers** and **starch manufacturers** who are now grappling with soaring feed costs. The corn prices in India have risen far above global benchmarks, leading industry associations to **demand duty-free corn imports** and even a **reconsideration of the ban on genetically modified corn**. As India appears set to become a permanent net importer of corn, this shift is not only reshaping domestic agricultural priorities but also scrambling global supply chains, with traditional export markets now turning to South America and the United States for their corn needs.

### What is Ethanol?

- **About:** Ethanol is a **colorless, flammable liquid organic compound** with a chemical formula  $C_2H_5OH$ .
  - It is a primary alcohol produced naturally by the fermentation of sugars by yeasts, and is also produced industrially.
  - Ethanol is a **volatile, colorless, and flammable liquid** with a characteristic alcoholic odor.
- **Production of Ethanol**
  - **Fermentation:** Yeast converts sugars (from grains, fruits, or other sources) into ethanol and carbon dioxide.
  - **Distillation:** The fermented mixture is heated, and the ethanol vapor is separated from the other components.
    - The ethanol vapor is condensed, resulting in a higher concentration of ethanol.

- **Dehydration:** To produce anhydrous ethanol (ethanol with a water content of less than 1%), a dehydration process is often used.

#### ▪ Major Ethanol Blends

- **E10:** Contains 10% ethanol and 90% gasoline.
- **E20:** Contains 20% ethanol and 80% gasoline.
- **Flex Fuel Vehicles:** Vehicles designed to run on a range of ethanol-gasoline blends, including E85.

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**ETHANOL AS A FUEL**

**About Ethanol**

- One of the principal biofuels
- Also called ethyl alcohol (C<sub>2</sub>H<sub>5</sub>OH)

**Produced**

- Naturally by fermentation of sugar (or corn, rice etc)
- By petrochemical processes (ethylene hydration)

World Biofuel Day is celebrated on 10 August to raise awareness about the importance of non-fossil fuels.

Sugar, Starch, Cellulose → Plant → Gas Station → Car

**Ethanol Blending**

*Blending ethanol with petrol to burn less fossil fuel while running vehicles.*

**Blending Target**

- 20% ethanol blending in petrol (E20) by 2025
- **Currently, ethanol makes up 10% of the petrol used in vehicles.**

**Significance**

- Reduce oil imports
- Equivalent efficiency at a lower cost than petrol
- Burns completely and cleaner than petrol
- Ethanol produced from farm residue to boost farmers' income

**Challenges in Success**

- High land requirement for sugarcane (+ consequent food prices issue)
- High water requirement of biofuel crops

**Related Initiatives**

- Roadmap for Ethanol Blending in India (Report by NITI Aayog) (2021)
- E100 Pilot Project (Network for production and distribution of ethanol) (2021)
- Pradhan Mantri **JI-VAN** Yojana (to boost 2G ethanol projects) (2019)
- The National Policy on Biofuels (2018)

## What is the Significance of Ethanol Production for India?

- **Energy Security and Import Reduction:** India's push for **ethanol production** is a strategic move to reduce its [heavy dependence on oil imports](#).
  - By blending ethanol with petrol, India aims to cut its oil import bill, which could widen to USD 101-104 billion in the current fiscal from **USD 96.1 billion in 2023-24**.
  - The government's target of **20% ethanol blending by 2025-26** could potentially save the country USD 4 billion annually in foreign exchange.
    - This shift not only improves energy security but also provides a **buffer against volatile global oil prices**, enhancing India's economic stability.
- **Agricultural Diversification and Rural Economy Boost:** Ethanol production offers a significant opportunity to diversify India's agricultural sector and boost rural incomes.
  - The recent policy shift to promote **corn-based ethanol** alongside sugarcane has created a new market for farmers.

- In 2024, about 3.5 million tons of corn were used to produce **1.35 billion liters of ethanol**, quadrupling from 2023.
- This diversification not only **provides alternative income sources** for farmers but also helps in **managing crop surpluses**, potentially stabilizing agricultural commodity prices and improving farm incomes.
- **Environmental Impact and Climate Change Mitigation:** Ethanol blending is a key component of **India's strategy to reduce [greenhouse gas emissions](#)**.
  - A study on **E20 (20% ethanol blending in petrol)** showed that carbon monoxide emissions decreased by about 50% in two wheelers and **about 30% in four wheelers by using E20 compared to E0**.
- **Technological Innovation and Industrial Growth:** The ethanol production drive is spurring technological innovation in India's biofuel sector.
  - Companies are investing in advanced biofuel technologies, including **[second-generation \(2G\) ethanol production](#)** from agricultural residues.
  - For instance, Indian Oil Corporation has set up the **country's first 2G ethanol plant in Panipat** with a capacity of 100 kiloliters per day.
  - This push is **not only creating a new industrial sector** but also promoting research and development in biotechnology and chemical engineering, potentially positioning India as a leader in sustainable fuel technologies.
- **Geopolitical Leverage and Global Positioning:** India's ethanol program has significant geopolitical implications.
  - By **reducing oil imports**, India can potentially decrease its vulnerability to global oil politics. Furthermore, **as one of the world's largest ethanol producers**, India is positioning itself as a key player in the global biofuel market.
  - Also, the ethanol blending program saved **Rs 24,300 crore foreign exchange in 2022-23**.
  - This not only enhances India's trade position but also aligns with its aspirations for global leadership in sustainable development.
- **Waste Management and Circular Economy:** Ethanol production is becoming a crucial component of **India's waste management strategy** and circular economy initiatives.
  - The use of agricultural residues and food waste for ethanol production addresses the critical issue of stubble burning, particularly in northern India.
  - The government's **[GOBAR-DHAN scheme](#)**, which aims to convert biodegradable waste into biogas and ethanol, exemplifies this approach.

## What are the Key Issues Related to Ethanol Production?

- **The Corn Conundrum:** India's shift to corn-based ethanol has dramatically altered its corn trade dynamics.
  - Once **Asia's top corn exporter**, India is now set to import a record **1 million tons in 2024**.
  - This reversal has caused domestic corn prices to soar above global benchmarks, severely impacting poultry and starch industries.
  - For instance, in 2024, India's corn exports are expected to plummet to **450,000 tons from the usual 2-4 million tons**.
  - This shift not **only affects domestic industries** but also disrupts established trade relationships with countries like **Vietnam and Bangladesh**, forcing them to seek alternative suppliers.
- **Food vs. Fuel Debate:** The diversion of food crops like corn and sugarcane for ethanol production has reignited the **food vs. fuel debate**.
  - With ethanol distilleries now competing for corn supplies, there's a projected shortfall of **5 million tons for traditional users**.
  - This competition is **driving up food prices** and potentially threatening food security.
  - For example, the farm gate price of **broiler chickens has risen to about 75 rupees**, while production costs have **surged to 90 rupees**, pushing poultry farmers into losses.
  - This scenario raises **critical questions about prioritizing fuel over food** in a country still grappling with malnutrition.
- **Water Woes:** Ethanol production, particularly from water-intensive crops like sugarcane, is exacerbating India's water crisis.

- Sugarcane, which covers only **3% of India's cropland**, consumes about **70% of irrigation water in some states**.
  - The push for increased ethanol production could further strain water resources in already water-stressed regions.
- For instance, Maharashtra, a major sugarcane-producing state, faced severe droughts in recent years, **with over 20,000 villages requiring water tankers in 2018**. The continued expansion of sugarcane cultivation for ethanol could worsen this situation.
- **Green Fuel with a Gray Lining**: While ethanol is promoted as a cleaner fuel, its production process raises environmental concerns.
  - The **intensive use of fertilizers and pesticides** in sugarcane and corn cultivation leads to soil degradation and water pollution.
    - Moreover, the **conversion process of crops to ethanol is energy-intensive**, potentially offsetting some of the emissions benefits.
  - A study by the **Institute for Energy Economics and Financial Analysis (IEEFA)** suggests that the **lifecycle emissions of corn ethanol could be 24% higher than gasoline** when considering land-use changes and production emissions.
- **Economic Ripple Effects**: The ethanol push is causing significant disruptions across various industries.
  - The [poultry sector](#), which relies heavily on corn for feed, is facing a crisis due to skyrocketing costs.
  - The All India Poultry Breeders Association has demanded the import of 5 million tons of **duty-free corn to alleviate the situation**.
  - Similarly, the **starch industry**, another major corn consumer, is grappling with supply shortages and price hikes.
    - This **economic reshuffling is leading to job losses** and potential food price inflation, impacting the broader economy.
- **Policy Patchwork**: The rapid push for ethanol production has led to a patchwork of policies that sometimes conflict with other agricultural and environmental goals.
  - For instance, the **abrupt curb on using sugarcane for fuel** following a drought has led to confusion and supply chain disruptions.
  - The **ban on [genetically modified \(GM\) corn](#)** severely limits import options, exacerbating supply shortages.
  - These policy inconsistencies create an uncertain regulatory environment, potentially deterring long-term investments in the sector and hampering sustainable growth.
- **Infrastructure Inadequacies**: India's ambitious ethanol blending targets are outpacing the development of necessary infrastructure.
  - The **country lacks adequate blending facilities, storage capacities, and transportation networks** to handle increased ethanol production and distribution.
  - This infrastructure gap could lead to inefficiencies, increased costs, and potential supply disruptions, **challenging the feasibility of meeting the 20% blending target by 2025-26**.

## What Steps can be Taken to Ensure Ethanol Production is More Sustainable and Economically Viable?

- **Diversifying Feedstock**: To reduce pressure on food crops, India should aggressively **promote the use of alternative feedstocks for ethanol production**.
  - This includes scaling up second-generation (2G) ethanol production from agricultural residues and [third-generation \(3G\) ethanol from algae](#).
  - The government could set targets for 2G and 3G ethanol production and provide incentives for private sector investment in these technologies.
- **Maximizing Yield, Minimizing Impact**: Implementing precision agriculture techniques can significantly **improve the sustainability of ethanol feedstock cultivation**.
  - This involves using **IoT sensors, drones, and AI-driven analytics** to optimize water usage, fertilizer application, and pest control.
  - For example, the **Maharashtra government's project to use drones for precision farming in sugarcane cultivation** has shown water savings of up to 25%.
  - Scaling such initiatives nationally could dramatically reduce the environmental footprint of ethanol production while improving yields.

- **Water-Smart Policies:** Introducing strict water management policies in ethanol production is crucial.
  - This could include **mandating water recycling in distilleries**, promoting drip irrigation in sugarcane cultivation, and incentivizing water-efficient crops for ethanol production.
  - The **success of Madhya Pradesh's 'Kapildhara' scheme**, which has helped install drip irrigation systems, could be replicated in other states.
- **Flex-Fuel Vehicle Push:** Accelerating the adoption of **flex-fuel vehicles (FFVs) can create a stable, long-term demand for ethanol**.
  - The government could think of mandating that all new vehicles sold after a target year be flex-fuel compatible.
  - **Brazil's successful FFV program**, where over 80% of new cars sold are flex-fuel, serves as a model.
  - This shift would not only **ensure consistent ethanol demand but also provide consumers with fuel choice flexibility**, potentially stabilizing ethanol prices.
- **Zonal Ethanol Production:** Implementing a **zonal approach to ethanol production** can optimize resource use and reduce transportation costs.
  - This involves **identifying ideal eco-regions** for specific feedstocks and encouraging localized production and consumption.
  - For instance, **promoting sorghum-based ethanol in drought-prone regions** of Maharashtra and Karnataka, while focusing on rice residue-based ethanol in Punjab and Haryana.
- **Integrated Biorefinery Complexes:** Developing **integrated biorefinery complexes** can significantly enhance the economic and environmental viability of ethanol production.
  - These complexes would **combine ethanol production with other value-added processes like biogas generation, bioplastics manufacturing**, and CO<sub>2</sub> capture for industrial use.
  - The **Godavari Biorefineries in Maharashtra**, which **produces ethanol along with specialty chemicals and electricity**, exemplifies this model.
- **Smart Blending Infrastructure:** Investing in **smart blending infrastructure** is crucial for achieving higher blending targets efficiently.
  - This includes deploying **automated blending systems at fuel depots** and implementing blockchain-based tracking of ethanol from production to retail.
- **Crop Insurance for Ethanol Feedstocks:** Introducing specialized crop insurance schemes for ethanol feedstocks can encourage farmers to shift to these crops.
  - This could include **weather-indexed insurance products tailored for sugarcane, sorghum, and other ethanol feedstocks**.
  - The success of the Pradhan Mantri Fasal Bima Yojana could be leveraged to design a sub-scheme specifically for ethanol crops.
- **Circular Economy in Distilleries:** Promoting a circular economy approach in ethanol distilleries can significantly enhance their sustainability.
  - This involves mandating the **use of distillery waste for biogas production, using the resulting slurry as organic fertilizer**, and capturing CO<sub>2</sub> for industrial use.
  - The **Dalmia Bharat Sugar and Industries' zero liquid discharge plant** in Uttar Pradesh, which converts all its waste into valuable products, serves as an excellent model.

**Drishti Mains Question:**

Assess the impact of India's ethanol production policy on its agricultural sector, domestic economy, and global trade. Analyze the challenges and benefits associated with this policy shift, and propose strategies to enhance the sustainability and efficiency of ethanol production

**UPSC Civil Services Examination, Previous Year Questions (PYQ)**

**Q. Given below are the names of four energy crops. Which one of them can be cultivated for ethanol? (2010)**

**(a) Jatropha**

**(b)** Maize

**(c)** Pongamia

**(d)** Sunflower

**Ans: (b)**

**Q. According to India's National Policy on Biofuels, which of the following can be used as raw materials for the production of biofuels? (2020)**

1. Cassava
2. Damaged wheat grains
3. Groundnut seeds
4. Horse gram
5. Rotten potatoes
6. Sugar beet

**Select the correct answer using the code given below:**

**(a)** 1, 2, 5 and 6 only

**(b)** 1, 3, 4 and 6 only

**(c)** 2, 3, 4 and 5 only

**(d)** 1, 2, 3, 4, 5 and 6

**Ans: (a)**

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