



Ethanol Production

For Prelims: [Curb on Sugar Diversion for Ethanol](#), [Ethanol Blended Petrol \(EBP\)](#), [Biofuels](#), [Feedstocks](#), [Crude Oil Import](#), [Food Security](#), [Global Biofuel Alliance](#)

For Mains: [Ethanol Production](#), Indian Economy, and issues relating to planning, mobilization of resources, growth, development, and employment.

Source: [LM](#)

Why in News?

Recently, India has achieved [higher ethanol production](#) from grains, particularly [maize](#), surpassing that from **sugar-based feedstock**.

What is Ethanol?

▪ About:

- Ethanol, also known as ethyl alcohol, is a [biofuel](#) produced from various sources such as [sugarcane](#), corn, rice, wheat, and biomass.
- **Molasses**, a **byproduct of sugar manufacture**, are generally the main source of production of ethanol (anhydrous alcohol) and rectified spirit. Molasses can be categorised into following:
 - **A Molasses (First Molasses):** An intermediate **by-product** from initial sugar crystal extraction, containing 80-85% dry matter (DM).
 - **B Molasses (Second Molasses):** Similar DM content as A molasses but with less sugar and no spontaneous crystallization.
 - **C Molasses (Final Molasses, Blackstrap Molasses, Treacle):** The **end by-product of sugar processing**, containing significant amounts of sucrose (about 32 to 42%). It does not crystallize and is used as a commercial feed ingredient in liquid or dried form.
- The production process involves the **fermentation of sugars** by yeasts or via petrochemical processes such as ethylene hydration.
- Ethanol is **99.9% pure alcohol** that can be blended with petrol to **create a cleaner fuel alternative**.

▪ Properties of Ethanol:

- Ethanol is a **clear, colorless liquid** with a characteristic wine-like odor and pungent taste.
- It is **fully soluble in water** and most organic solvents.
- In its pure form, it has a boiling point of 78.37 degrees Celsius and a melting point of -114.14 degrees Celsius.
- Ethanol is a **combustible material** and has a lower combustion temperature than gasoline, making it a cleaner-burning alternative.

▪ Applications of Ethanol:

- **Beverages:** Ethanol is the type of alcohol found in alcoholic beverages. It is consumed socially in various forms, such as **beer, wine, and spirits**.

- **Industrial Solvent:** Due to its ability to dissolve a wide range of substances, ethanol is used as a **solvent in the manufacturing** of pharmaceuticals, perfumes, and other products.
- **Medical and Laboratory Uses:** Ethanol is used as an **antiseptic, disinfectant,** and preservative in medical and laboratory settings.
- **Chemical Feedstock:** It serves as a **feedstock for the production** of various chemicals.
- **Fuel:** It is used as a biofuel and is often mixed with gasoline to produce ethanol-blended fuels.

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ETHANOL AS A FUEL

Drishiti IAS

About Ethanol

- One of the principal biofuels
- Also called ethyl alcohol (C₂H₅OH)

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.

Raw materials: Sugar, Starch, Cellulose

Process: Plant → Gas Station → Vehicle

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.

Challenges in Success

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

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

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 are the Measures to Promote Ethanol Production?

- **Feedstock Diversification:** Ethanol production in India was mainly based on 'C-heavy' molasses, with a sugar content of 40-45%, yielding 220-225 litres of ethanol per tonne.
 - Earlier, India explored direct sugarcane juice for ethanol production, increasing yield and efficiency.
 - However, India is using other methods also for increasing production. The country has diversified its feedstocks by including **rice**, damaged grains, **maize**, jowar, bajra, and **millets**.
 - It has been seen that Ethanol **yields from grains are higher** compared to molasses, with rice producing 450-480 liters and other grains 380-460 liters per tonne.
 - By 9 June 2024, India produced 3.57 billion litres of ethanol.

- Out of this, 1.75 billion litres were from **sugar-based feedstock** (sugarcane juice, B-heavy molasses, C-heavy molasses) and 1.81 billion litres were from grain-based feedstock with maize alone contributing 1.10 billion litres.
- **Grain-based ethanol** now constitutes nearly 51% of the total ethanol production for the current ethanol-supply year (November 2023-October 2024).
- The [National Agricultural Cooperative Marketing Federation of India Ltd \(NAFED\)](#) and the [National Cooperative Consumers' Federation of India Ltd \(NCCF\)](#) are procuring maize to promote its use in ethanol production.
 - Moreover, Leading sugar companies have installed distilleries that can operate on multiple feedstocks such as rice, damaged grains, maize, and millets throughout the year for continuous production.
- **Government's Differential Pricing Policy:** The government has fixed different prices for ethanol derived from C heavy molasses, B heavy molasses, sugarcane juice/sugar/sugar syrup, and damaged food grains or rice.
 - For example, from 2018-19, the Indian government began fixing **higher prices for ethanol produced from B-heavy molasses** and whole sugarcane juice/syrup.
 - This policy has helped increase the supply of ethanol for the Ethanol Blended Petrol (EBP).
 - **E20** fuel is a blend of 20% ethanol and 80% petrol. The E20 was launched by the Prime Minister of India in February 2023 in Bengaluru.
 - This pilot covers at least 15 cities and will be rolled out across the country in a phased manner.
- **Setting up Ambitious Targets:**
 - India has set up a very ambitious target to increase Ethanol production in the country. For Instance, India plans to start using 20% ethanol blended petrol (E20) from 2025.
 - As of 9 June 2024, India achieved a 12.7% ethanol blend with petrol, targeting 15% for the current year.
 - Achieving the **E20 target** by 2025-26 will require 10.16 billion litres of ethanol, according to NITI Aayog estimates.
- **International Commitments:**
 - At the 64th [International Sugar Organization](#) meeting, India reaffirmed the commitment to achieving 20% ethanol blending by 2025-26, predicting that grain-based ethanol production will exceed sugar-based ethanol in the 2023-24 supply year.
 - In September 2023, India, the US, the UAE, and Brazil launched the [Global Biofuel Alliance](#). The countries agreed to provide financial and technical support to national programmes to promote the sustainable production and use of biofuels.
- **Other Policies:**
 - [National Policy on Biofuels 2018](#)
 - [E100 Pilot project](#)
 - [Pradhan Mantri JI-VAN Yojana 2019](#)
 - [Repurpose Used Cooking Oil \(RUCO\)](#)

What are the Benefits and Challenges of Ethanol Production?

- **Benefits:**
 - **Reduced Dependence on Oil Imports:** India **imports a significant portion** of its [crude oil](#) needs. A [NITI Aayog](#) report estimates that a successful ethanol blending program can save the country billions of dollars annually by reducing this reliance.
 - **Boost to Agricultural Income:** Increased ethanol production **creates demand for crops** like sugarcane and grains used in [fermentation](#). This can lead to higher income for farmers according to a report by the International Renewable Energy Agency (IRENA).
 - **Greenhouse Gas Reduction:** Ethanol **absorbs carbon dioxide** during its

production, **offsetting combustion emissions** and supporting India's carbon footprint reduction goals.

- **Job Creation:** The ethanol blending program has the **potential to generate millions of jobs** in rural areas. New distilleries, expanded sugarcane cultivation, and associated logistics will require a significant workforce, boosting the rural economy.
- **Waste Management Solution:** The ethanol production can utilize molasses that often creates **waste disposal challenges**. By converting molasses into ethanol, the program promotes a more sustainable approach to waste management within the sugar sector.
- **Benefitting from the By products of Ethanol Production: Apart from being a fuel additive, ethanol production yields valuable byproducts like Distillers' Dried Grain with Solubles, and Potash from Incineration Boiler Ash that find applications across various industries.**

- **Distillers' Dried Grain with Solubles (DDGS):**

- DDGS is a byproduct of **grain-based ethanol** production.
- It is the residue left after the starch in grains is fermented and ethanol is extracted.
- DDGS is a valuable animal feed with **high protein content** and is used to supplement livestock diets.

- **Potash from Incineration Boiler Ash:**

- The ash remaining after Ethanol Production in the boiler contains up to 28% potash.
- This ash is a rich source of potash and can be utilized as a fertilizer.

- **Challenges:**

- **Food vs. Fuel:** A major challenge is the **competition for feedstocks** between food production and ethanol production. According to the **Environmental Protection Agency (EPA)**, corn-based ethanol production can lead to increased food prices and even contribute to deforestation in countries pressured to cultivate more land for crops.
- **Land and Water Use:** Large-scale ethanol production, particularly from corn, requires **significant amounts of land and water**. This can strain resources and lead to issues like soil erosion and depletion of freshwater supplies.
- **Limited Environmental Benefit:** While touted as a renewable fuel, the lifecycle **greenhouse gas emissions** of corn ethanol can be comparable to gasoline, especially when considering indirect land-use changes.
- **Costly Processing:** The current methods for processing feedstocks, particularly non-food crops like switchgrass, often require **energy-intensive treatments** to convert them into usable sugars for fermentation.
- **Infrastructure Challenges:** Ethanol has a **higher water content than gasoline**, which can lead to corrosion in pipelines and storage tanks.
- **Shortage of Raw Material: Though India has planned to achieve Ethanol Blending by 2025 but it often finds raw material shortage for ethanol production. For Example, due to a lower production of sugarcane, the government in December 2023 banned the use of cane juice and B-heavy molasses for ethanol production.**

Way Forward

- **Promoting Second-Generation (2G) Ethanol Technologies:** The potential of 2G technologies using **agricultural waste like straw and bagasse** for ethanol production can be harnessed to reduce competition for food crops and promote sustainability.
 - **India can leverage Global Fuel Alliance to develop and provide its members with technology that is both technically feasible and economically viable for producing ethanol from agricultural waste.**
- **Developing Alternative Feedstocks and Crop Diversity:** India can **emulate Brazil's ethanol success** by using non-food crops like sorghum and miscanthus to diversify feedstock and enhance food security.
- **Financial Incentives for Biomass Cultivation and Farmer Integration:** The **World Bank**

reports emphasize the need for financial incentives, contract farming models, and guaranteed buyback programs to encourage farmers to cultivate dedicated biofuel crops and ensure a steady feedstock supply.

- **Investing in Research and Development for Improved Efficiency:** Focusing on advancements in technologies like **cellulosic ethanol production**, along with increased research funding and international collaboration, can significantly improve ethanol yields.
- **Strengthening Infrastructure and Streamlining Logistics:** Data from government reports points to the **need for significant investments** in storage facilities and transportation networks for ethanol.
 - Public-private partnerships and **innovative logistics solutions** can ensure efficient distribution and program scalability.

Drishti Mains Question:

Q. Discuss the various measures India has taken to achieve its E20 program. Highlight the challenges associated with this initiative.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims:

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)

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)

