



## 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**

**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.

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.

**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 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)**

