Ethanol Blending: A Path to Energy Security

This editorial is based on "Ethanol blending is proving messy" which was published in The Hindu Business Line on 10/11/2024. The article highlights the challenges India faces in its 90% flex-fuel vehicle push, including food security concerns, policy strain, and climate impacts, stressing the need for a thorough cost-benefit analysis.

For Prelims: Ethanol blending, Ethanol Blending Programme, Russia-Ukraine conflict , West Asian tensions, COP26, Renewable energy transition, Global Biofuel Alliance, Carbon Footprint, Global Biofuel Alliance, Palletisation Units in Punjab.

For Mains: Current Status of Ethanol Blending in India. Key Issues Associated with Ethanol Blending for India.

India's push for **90% flex-fuel vehicles,** inspired by **Brazil**, faces significant challenges despite achieving **15% ethanol blending in 2024**. While the **Ethanol Blending Programme** has saved ₹1.01 lakh crore in forex, diverting food crops like **sugarcane, rice, and maize for ethanol** raises concerns over food security. The program relies on constant policy adjustments, unlike **Brazil's market-driven model,** straining both OMCs and government finances. Climate change and unpredictable monsoons further complicate blending targets, underscoring the need for a comprehensive cost-benefit analysis before scaling up flex-fuel adoption.

What is the Current Status of Ethanol Blending in India?

- **About**: Ethanol is a type of **alcohol primarily produced from the fermentation of sugars**, often derived from crops like sugarcane, maize, or other biomass.
    - It is commonly used as a biofuel, solvent, and in various industrial applications.
    - **Ethanol Blending** refers to the practice of mixing ethanol with petrol to create an ethanol-blended fuel.
        - This **reduces the consumption of pure petrol,** decreases environmental pollution, and promotes the use of domestically produced biofuels, contributing to energy security and sustainability.
    - India, as the **world's third-largest energy consumer,** has turned to ethanol blending to reduce oil imports. Reforms in the **Ethanol Blended Petrol (EBP) Programme,** enhance energy security and support rural incomes.
        - India has reduced the GST on ethanol to **5%** and introduced an **interest subvention** scheme to boost production capacity.

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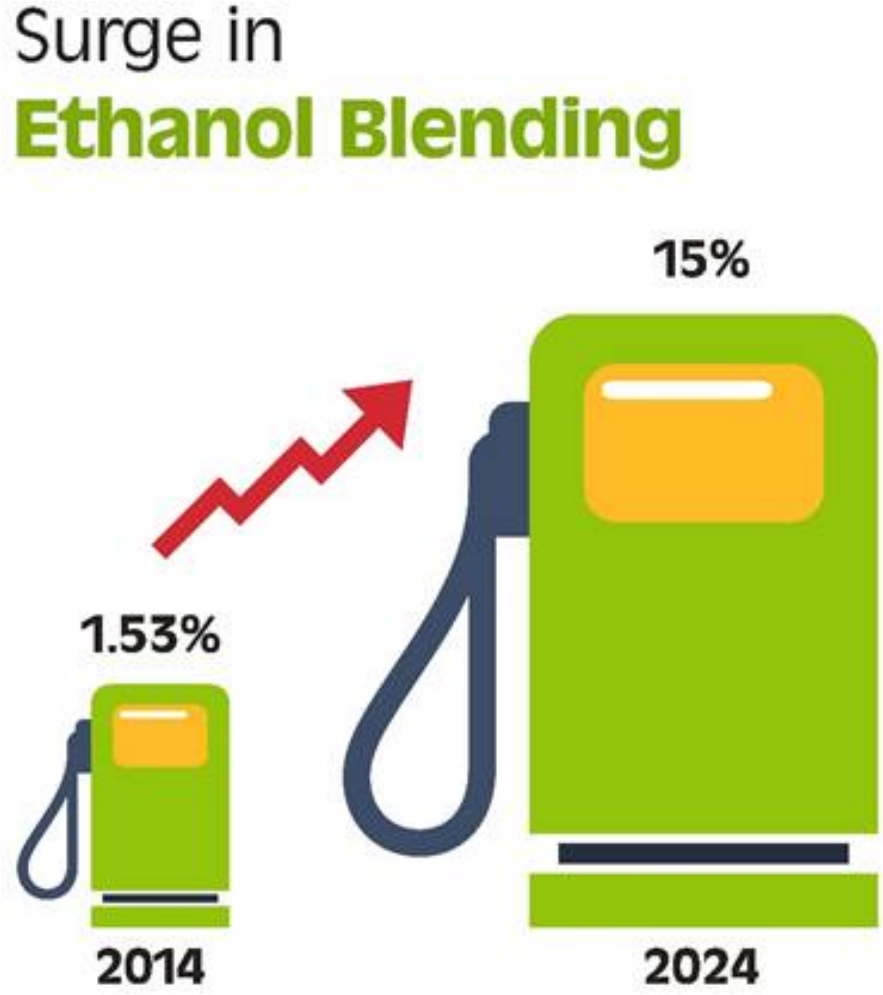
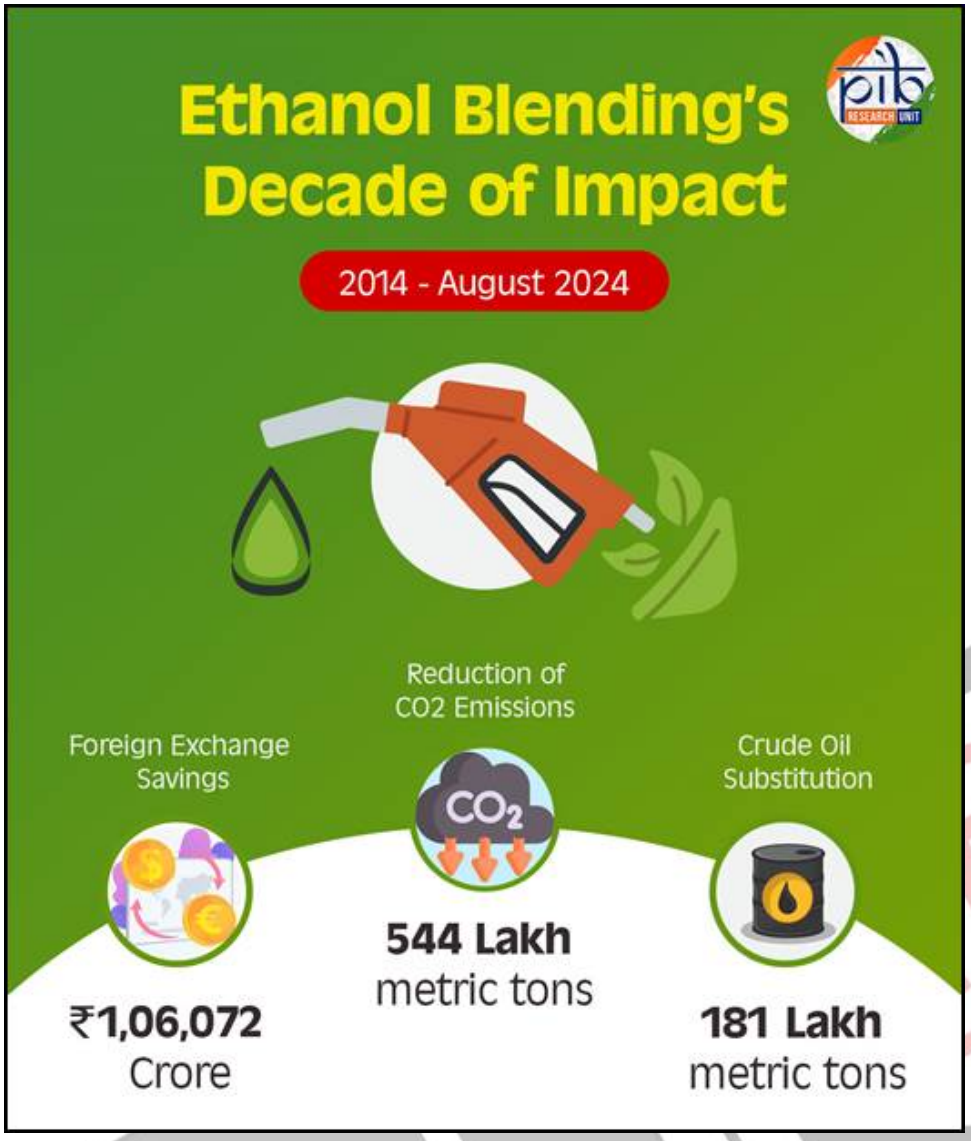


- **Progress of Ethanol Blending in India:**
  - **Initial Target**: 20% ethanol blending by 2030, later advanced to 2025.
  - **Production Growth:** Ethanol production capacity has **more than doubled, reaching 1,623 crore liters by September 2024.**
  - **Blending Increase**: Blending surged from **1.53% in 2014 to 15% in 2024**, with over 545 crore liters blended in 2023-24.
- **Achievements**: India's Ethanol Blended Petrol (EBP) Programme achieved remarkable progress, with blending increasing from **1.53% in 2014 to 15% in 2024**, targeting 20% by 2025.
  - This initiative saved **₹1.06 lakh crore in forex, cut CO_2 emissions by 544 lakh metric tons,** and boosted rural income significantly



Why Ethanol Blending is Crucial for India's Energy Transition?

- **Energy Security and Import Dependency**: India currently imports over **85% of its crude oil requirements,** making it vulnerable to global price volatility and geopolitical tensions.
  - The **recent Russia-Ukraine conflict and West Asian tensions** have highlighted this vulnerability, with oil prices fluctuating dramatically.
  - The ethanol blending program has already saved **₹1.06 lakh crore in foreign exchange** through reduced imports.
  - By achieving **15% blending in 2024**, India has demonstrated the program's potential to significantly reduce import dependency. With the 20% target by 2025, India could potentially save billions annually in forex reserves.
- **Economic Benefits for Agricultural Sector**: The EBP has created a sustainable revenue model for farmers and sugar mills, with **Oil marketing companies (OMCs)** paying **₹87,558 crore directly to farmers and ₹1.45 lakh crore to distillers.**
  - This additional income stream has helped address the chronic problem of sugarcane arrears, which had historically plagued the agricultural sector.
  - The program has stimulated private investment, with distillers establishing ethanol capacities of **16.2 billion litres by September 2024.**
  - The multiplier effect has boosted rural economies and created new employment opportunities in the biofuel sector.
- **Environmental Impact and Climate Commitments:** Ethanol blending significantly reduces vehicle emissions, with studies showing a **20% reduction in carbon monoxide emissions with E20 fuel.**
  - India's commitment at **COP26 to reduce carbon intensity by 45% by 2030** makes

ethanol blending a crucial tool in achieving climate goals.
    - Recent data shows that ethanol blending has already resulted in an estimated **reduction of CO2 emissions by 544 lakh metric tons.**
    - The program aligns with **India's broader renewable energy transition strategy,** complementing solar and wind initiatives.
- **Technological Innovation and Industrial Growth**: The push for ethanol blending has catalyzed **innovation in automobile technology**, with major manufacturers developing **flex-fuel engines.**
    - The **recent announcement of flex-fuel vehicles getting GST concessions** has accelerated R&D investments in this sector.
    - The program has spurred growth in biotechnology and chemical processing industries, with **new second-generation ethanol plants being established.**
    - The development of **grain-based distilleries** has created a new industrial ecosystem, generating employment and technological advancement.
    - The recent approval of **using rice straw and corn cobs for second-generation ethanol production addresses stubble burning issues.**
- **Strategic Geopolitical Positioning:** India's ethanol program strengthens its position in global climate negotiations and enhances cooperation with Brazil and other biofuel-producing nations.
    - The recent **Global Biofuel Alliance signed in 2023** facilitates technology transfer and expertise sharing.
    - The program demonstrates **India's commitment to sustainable development,** attracting green investments and international partnerships.
    - India's leadership in biofuel adoption positions it as a **model for developing nations in energy transition.**
- **Market Development and Price Stability:** The establishment of a guaranteed ethanol market has **created price stability in the sugar sector**, historically known for volatility.
    - The program has created a predictable demand curve for agricultural produce, helping in better crop planning.
    - The **fixed pricing mechanism**, while different from Brazil's model, provides certainty for investments in the sector.

What are the Key Issues Associated with Ethanol Blending for India?

- **Food Security vs. Fuel Production Conflict**: Government recently lifted cap on sugar diversion for ethanol production starting in November 2024.
    - The December 2023 government directive **halting cane juice diversion to ethanol highlights the precarious balance**
    - The country’s net sugar consumption might touch an unprecedented **30 million tonnes** in the 2024-25 season and more diversion is expected towards ethanol.
    - This **food-fuel conflict becomes more acute during poor monsoon years**, raising questions about the program's sustainability.
- **Water Resource Strain:** Sugarcane, the primary ethanol feedstock, requires approximately **2,500 litres of water per kilogram of sugar produced**.
    - The increased cultivation for ethanol has led to severe groundwater depletion in major producing states like **Maharashtra and Uttar Pradesh.**
    - Recent studies have reported that the life cycle water footprint for ethanol production in India is betwee**n 230-7150 litres of water per litre of ethanol** depending on the residue and processing technology, adding to the strain on water resources.
- **Economic Viability and Price Mechanisms:** Unlike **Brazil's market-driven model,** India's administered pricing mechanism for ethanol creates artificial economics.
    - The recent increase in procurement prices from **₹43-59 to ₹49-66 per liter (FY19-FY23)** strains OMCs' finances.
    - The differential pricing for **various feedstocks (sugarcane juice, B-heavy molasses, grains)** creates market distortions.
- **Impact on Alternative Food Industries:** The diversion of **maize to ethanol has severely impacted the poultry and animal feed sectors,** with prices rising by 20%.
    - Recent demands for **duty-free maize imports from the poultry industry** highlight the supply chain disruption.
    - The **starch industry,** using **maize** as raw material, reports production cuts due to

feedstock shortages.
    - The projected diversion of maize annually threatens India's position as a net maize exporter.
        - India typically exports between **2 to 4 million metric tonnes of corn annually.** However, in 2024, exports are projected to plummet to just **450,000 tonnes,** while the country is set to import a record **1 million tonnes, primarily from Myanmar and Ukraine.**
- **Environmental Trade-offs:** While ethanol reduces vehicle emissions, the **entire lifecycle assessment shows complex environmental impacts.**
    - Recent studies indicate **increased water pollution from distillery discharge despite zero liquid discharge norms.**
    - The **carbon footprint of ethanol production**, including land-use changes and transportation, partially offsets emission benefits.
        - Recent studies show that **life cycle GHG emissions of ethanol production were found to be 123.10 kg CO2-eq/kg** of anhydrous ethanol.
        - The main source of GHG emission was the **electricity used in the process stage (97.83%) .**
    - Also, intensive sugarcane cultivation leads to **soil degradation and affects biodiversity in agricultural regions.**
- **Technological and Vehicle Compatibility:** The existing vehicle fleet requires significant modifications for higher ethanol blends beyond E20.
    - Current vehicles that are not specifically designed for E20 fuel can face issues like **increased corrosion of engine components,** potential damage to rubber seals and gaskets due to ethanol's corrosive nature, decreased fuel efficiency
    - **Consumer acceptance remains uncertain given the lower energy content** of ethanol-blended fuels.

What Steps can India take to Boost Ethanol Blending?

- **Diversification of Feedstock Sources**: Implement a comprehensive policy to promote **second-generation (2G) ethanol production** using agricultural residues and waste materials.
    - Establish collection centres for crop residues with automated baling and storage facilities at block levels, **similar to palletisation units in Punjab.**
    - Incentivize farmers with **direct payments for crop residue collection**.
    - Create public-private partnerships for establishing 2G ethanol plants, with the current successful example of **Panipat's paddy straw plant producing 100 kiloliters daily**.
- **Storage and Infrastructure Development**: Create a **dedicated ethanol pipeline network connecting major production clusters to consumption centers**, starting with high-priority corridors.
    - Establish regional ethanol storage hubs with modern facilities including **anti-corrosion technologies and safety measures.**
    - Develop specialized **railway wagons for ethanol transport.** Create emergency storage facilities to manage seasonal supply fluctuations.
- **Technology and Research Support**: Establish dedicated ethanol research centers in agricultural universities focusing on **developing high-yield, drought-resistant crops specifically for ethanol production.**
    - Invest in **developing enzymes and fermentation technologies** suited to Indian feedstock varieties and climatic conditions.
    - Support **automobile manufacturers in developing cost-effective flex-fuel technologies** through research grants and tax incentives.
- **Price Mechanism Reform:** Implement a dynamic pricing mechanism **linked to international crude oil prices and domestic feedstock costs.**
    - Create a **transparent formula-based pricing system** reviewed quarterly to ensure producer viability and consumer affordability.
    - Establish a **price stabilization fund to manage volatility**, funded through a small cess on petroleum products.
- **Supply Chain Optimization**: Create an **integrated digital platform for real-time tracking of ethanol movement** from distilleries to blending centers.

    - Establish **zonal storage and distribution hubs** to optimize transportation costs and reduce carbon footprint.
    - Implement **smart logistics solutions using AI/ML for demand prediction** and inventory management.
    - Develop specialized ethanol handling facilities at ports for export potential. Create emergency response mechanisms for supply disruptions.
- **Regulatory Framework Enhancement:** Establish a **single-window clearance system for ethanol projects** under a dedicated regulatory authority.
    - Streamline environmental clearance processes while **maintaining strict compliance standards**.
    - Create standardized quality control protocols for ethanol production and blending across the country.
- **Sustainable Agricultural Practices**: Promot**e crop rotation and intercropping systems** that support ethanol feedstock production without compromising food security.
    - Implement **precision farming techniques** for sugarcane cultivation to improve water use efficiency.
    - Develop **micro-irrigation systems specifically designed for ethanol feedstock crops.**
    - Create farmer producer organizations focused on sustainable feedstock production.
- **Capacity Building and Skill Development:** Establish specialized training centers for ethanol plant operators and maintenance personnel.
    - Create **certification programs for ethanol handling** and safety procedures.
    - Develop vocational courses in agricultural colleges focused on biofuel feedstock management.
- **International Cooperation:** Strengthen technical collaboration with countries like **Brazil and USA for technology transfer and best practices.**
    - Develop joint research programs with international institutions on advanced biofuel technologies.
    - Create bilateral agreements with Brazil for **knowledge exchange on flex-fuel vehicle technology.**
        - **Biofuels are part of Brazil's National Energy Plan** which helps set direction for energy supply and demand across the country. **India can significantly learn from this.**
- **Environmental Monitoring and Management:** Implement real-time monitoring systems for environmental impacts of ethanol production.
    - Develop **water recycling and zero liquid discharge systems** for distilleries with incentive mechanisms.
    - Establish **carbon credit mechanisms** for ethanol producers meeting sustainability criteria.

Conclusion:

India's **ethanol blending program**, while promising, faces challenges in **balancing food security, environmental sustainability, and economic viability**. A comprehensive approach involving feedstock diversification, technological advancements, and policy reforms is crucial to ensure the program's long-term success. India's journey towards a sustainable and energy-secure future hinges on a well-calibrated ethanol blending strategy.

Drishti Mains Question:

Discuss the significance of ethanol blending in India's energy security and environmental goals. What challenges does India face in achieving its ethanol blending targets?

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)