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Environmental Preference or Economic Concern? Public Perception of Ethanol Blending Policy in India: An Empirical Study

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ABSTRACT: India recently met its government target to roll out 20% ethanol-blended petrol (E20), five years ahead of schedule of the earlier plan of reaching E20 by 2030 as per National Policy on Biofuels, 2018. While this pushes India closer to its goal of phasing out fossil fuels and increasing energy security, it also poses fresh questions about its impact on fuel efficiency, vehicle compatibility and the legal regime regulating ethanol-blending. This paper assesses India's legal regime for Ethanol Blended Petrol (EBP) Program, drawing comparisons from the laws governing ethanol-blending in United States of America, Brazil and European Union(EU). India follows a framework of government policies and administrative actions, rather than having a separate law regulating ethanol-blending programs. As a supplementary study, we conducted a survey of 125 respondents on their awareness about E20 petrol and concerns relating to environment, economy, fuel efficiency, vehicles etc., along with their trust for government and other institutions dealing with ethanol-blended fuels. Our data suggests that concerns are primarily attributed towards implementation of the program, lack of awareness about it and lack of trust. Only minor concerns were attributed to ethanol-blending directly. With these conclusions, we propose that India adopt a separate Biofuels Act which clearly lays down timelines for rollout of ethanol-blending program, vehicle compatibility requirements, consumer protection requirements, independent testing and net-public disclosure of all information related to ethanol-blending programs along with price support and penal provisions to instill trust in the general public and have an improved legal regime for future endeavors.

1. INTRODUCTION

Biofuels provide cleaner energy for the transport sector. They cut carbon emissions relative to fossil fuels, they work with little or no modification to current vehicles. Biofuels are also considered useful for heavy vehicles, ships, and aircraft, where cleaner and affordable alternatives are still limited. Ethanol is one of the most widely used biofuels and is commonly blended with petrol to reduce fuel-related emissions.

Ethanol is a renewable biofuel produced from plant-based materials, commonly known as biomass. It is mainly made from crops such as sugarcane, maize, and other agricultural materials, including crop residues. Since these raw materials can be grown again, ethanol is considered a renewable source of energy and is widely used as an alternative to conventional fossil fuels. Ethanol blending refers to the process of mixing ethanol with petrol before it is supplied to consumers. The blended fuel is identified according to the percentage of ethanol it contains. For example, E10 contains 10% ethanol and 90% petrol, while E20 contains 20% ethanol and 80% petrol.

Many countries are adopting cleaner sources of energy to reduce greenhouse gas emissions and address the challenges of climate change. Ethanol-blended petrol has been one of the promising substitutes for regular petrol as it reduces vehicular

pollution and reliance on fossil fuels. Here sustainable development criteria ensures that economic growth does not overshadow environmental conservation and social well-being. India has taken various steps towards using renewable resources and scaling up ethanol blending in fuel to curb carbon emissions, enhance energy security and transition into a green economy.

Ethanol acts as an oxidizer which helps petrol burn more efficiently in engines since it comprises oxygen in its molecules. Ethanol requires less fuel to burn which reduces carbon emissions, making ethanol blending a vital step towards reducing air pollution and fossil fuel consumption.

One of the disadvantages of ethanol blending is that ethanol has low-energy content as compared to petrol which might lead to a marginal increase in fuel consumption. Also, high blends of ethanol are known to cause compatibility issues with older vehicles. Ethanol may degrade rubber parts such as tubes, seals, and gaskets as well as some metals not designed to be used with ethanol. These advantages and disadvantages are pivotal to ethanol blending policies in India and are discussed below.

Ethanol blending does provide environmental benefits. However, its true environmental benefit is conditional on how the ethanol is produced; the farming practices used to grow its feedstock; how land is used to produce it and what percentage of ethanol is used for blending. For an all-round view on its sustainability, the economic aspects of ethanol blending should also be taken into consideration.

2. RESEARCH METHODOLOGY

The research employs doctrinal as well as empirical research methods. The doctrinal research involves analysis of laws, policies, and regulations pertaining to ethanol blending in India and selected foreign countries. For comparative analysis three countries are chosen. The empirical research consists of the findings of a structured questionnaire survey conducted to understand public perceptions on E20 ethanol-blended petrol in India. The questionnaire primarily sought to understand if people prioritize environmental benefits over their personal monetary interests like cost of fuel/petrol and running cost of vehicles.

The questionnaire included 25 questions, which were divided into six main sections: awareness, environmental attitudes, personal experience with vehicles, trust in government and other institutions, price sensitivity, and knowledge of ethanol blending in other countries. The questions were prepared to assess both the respondents' level of knowledge and their personal opinions. It also included a direct choice question in which respondents had to decide whether they would prefer a cheaper fuel that causes more pollution or a slightly more expensive fuel that is better for the environment.

Data was collected from 125 participants using a structured online questionnaire prepared through Google Forms. The responses were received from participants belonging to different parts of India. Since the survey was conducted online, most respondents were educated and had access to the internet, which means the sample mainly represents urban and educated individuals. The online surveys have this common limitation and it needs to be considered while the findings are being interpreted.

Answers to questions with mutually exclusive choices are reported as percentages of respondents. For questions with non-mutually exclusive choices, respondents could select more than one answer. In these cases, the results are reported as percentages of respondents selecting each answer choice. Cross-tabulations were conducted where appropriate to explore relationships between, for example, awareness of ethanol blending and respondents' own experience with E20 petrol, as well as choice preferences.

This research had some limitations as well. Because of the use of convenience sampling, the results may not be generalizable to the whole population. The sample size was 125 respondents which is considered small and thus limits national generalization of the findings. Because this study used an online survey, self-selection bias may be present as only those with internet access and an interest in participating were able to be surveyed.

3. GREENER FUEL OR ENGINE HAZARD? THE TRUE COST OF ETHANOL BLENDING

India happens to be one of the largest consumers of fossil fuels in the world and transportation sector is one of the major contributors to air pollution & Greenhouse gas emission. Currently, fossil fuels satisfy about 98% of fuel demand in the road transport sector while Biofuels satisfy the rest of about 2% of the fuel demand. Also, India imports nearly 85% of its crude oil requirement. Therefore, there is a great need to improvise and propel alternative/renewable fuels like ethanol so that fossil fuel consumption can be curbed and imports can be reduced. Keeping these factors in mind, Government has been promoting Ethanol blending as an environment friendly substitute to fossil fuel-based Petrol. Ethanol blending helps in

reducing fossil fuel consumption and also ensures utilization of agricultural produce/biomass which would have been otherwise left unused or went into waste.

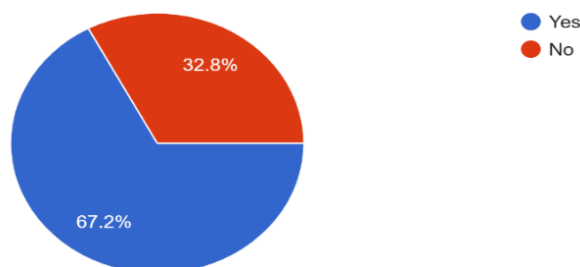
Blending ethanol reduces imports of crude oil thus saving foreign exchange thereby enhancing energy security of India, thereby offering benefits (environmental & economic). This will also support Atmanirbhar Bharat Abhiyan by reducing import dependency by moving towards indigenous renewable fuel. Rise in ethanol demand will increase farmers income through provision of another source of income and create employment opportunities for sugar mills, distilleries and other industries who produce ethanol thus supporting rural development.

Industry stakeholders are also involved, with automobile manufacturers beginning to design engines compatible with higher blends of ethanol. Negative issues have also come from ethanol use on vehicles. Analysts have noted that fuel containing higher blends of ethanol may degrade rubber components, seals, gaskets, and some metals on older vehicles not built to use these fuels. Some argue that ethanol blends have vehicle consumable components that warrant consideration against the environmental and economic benefits of ethanol blending. Concerns have been raised about the impact of ethanol blends on vehicle performance and maintenance as well as supporting infrastructure. For these reasons, it is critical to take into account the environmental, economic, technological and policy implications of ethanol blending.

The concerns raised above are echoed in responses to the current survey as well. Of the 125 respondents, 67.2% felt that fuel economy had dropped since E20 petrol became available and 40.5% experienced car problems they believed related to use of E20 fuels such as engine problems or seal damage. Of the respondents who had formed an opinion about E20 fuels, 66.1% relied on social media or family/friends when forming their opinion which was greater than relied on personal experience (54.2%) or science/scientific literature (34.7%). These results indicate that perceptions about ethanol blending can be influenced not only by personal experience but also by what people hear from various information channels and thus public perception may play a role in the success or failure of the program.

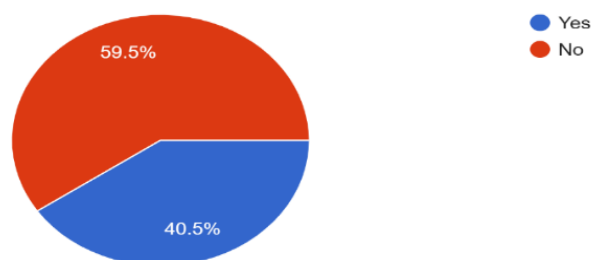
Have you personally noticed a drop in mileage since E20 petrol became available at your nearest pump?

122 responses



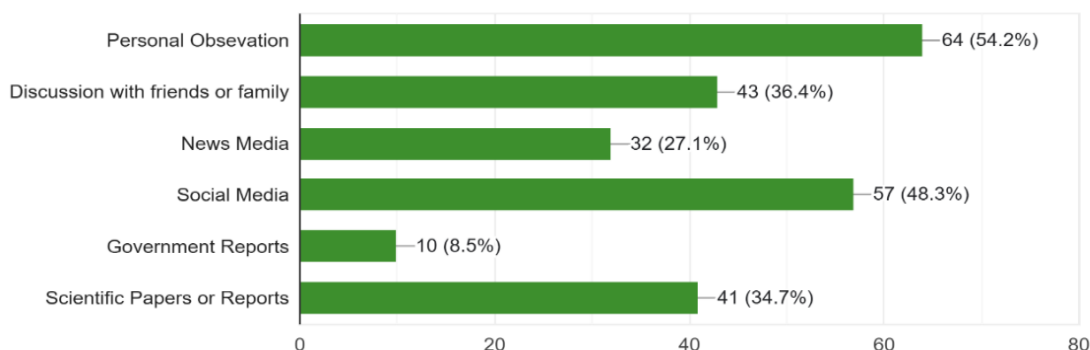
Have you faced any vehicle maintenance issues — such as engine trouble, rubber seal damage, or starting difficulty — that you believe are related to E20 petrol?

121 responses



Why do you think the ethanol blended petrol is bad for your vehicle? (You can select more than 1 option)

118 responses



A. The Benefits of Ethanol-Blended Fuel

India is heavily dependent on imported crude oil in order to meet its energy requirements which has increased in the recent years. According to the Petroleum Planning and Analysis Cell (PPAC) under the Ministry of Petroleum and Natural Gas, more than 88% of the country's crude oil requirement was met through imports during 2024–25, and the dependence increased further in 2025–26. This high level of oil imports places a significant burden on the country's foreign exchange reserves.

In this situation, the Ethanol Blended Petrol (EBP) Program has become an important initiative to reduce the consumption of imported crude oil. By replacing a part of petrol with domestically produced ethanol, the program helps lower import requirements and saves foreign exchange. Government data indicates that, since the introduction of the program, ethanol blending has resulted in foreign exchange savings of more than ₹1 lakh crore and has reduced the need for a substantial quantity of crude oil imports. These results here depict the economic importance of ethanol blending in improving India's energy security and thereby, reducing its dependence on imported fossil fuels.

Ethanol has oxygen in its chemical composition which aids petrol burn more efficiently inside engine. Efficient burning of fuel leads to lesser pollutants being emitted through exhaust, thus reducing emission of carbon monoxide (CO) and hydrocarbons (HC), improving the quality of air⁸. The Roadmap for Ethanol Blending in India 2020–2025 report by the Expert Committee constituted by NITI Aayog and Ministry of Petroleum and Natural Gas states that E20 fuel had cut carbon monoxide emissions by about 50% in two-wheelers and 30% in four-wheelers while hydrocarbon emissions were about 20% lower than conventional petrol engines. The carbon monoxide and hydrocarbon emission for E10 fuel were observed to have reduced by about 20% for two-wheelers and four-wheelers.

Ethanol contains higher rating of octane than petrol making it more resistant to the engine knocking. Because of this property, ethanol-blended petrol can perform better in engines designed for higher compression ratios. A higher compression ratio allows the fuel to burn more efficiently, which can improve engine performance and fuel combustion. Adding ethanol to petrol can increase the octane rating of the fuel and may also improve combustion efficiency, engine torque, and overall engine performance under suitable operating conditions. However, the extent of these improvements depends on factors such as the percentage of ethanol in the blend, engine design, and operating conditions.

A review of ethanol blending and vehicle emission standards in India found that the use of E10 fuel reduced emissions of volatile organic compounds (VOCs), total hydrocarbons (THC), and carbon monoxide when compared with conventional petrol. In addition, studies conducted in other countries have shown that ethanol–petrol blends improve combustion and lower carbon monoxide and hydrocarbon emissions in spark-ignition and flex-fuel vehicles. These findings indicate that the environmental benefits of ethanol blending are not limited to India but have also been observed under different vehicle technologies and driving conditions.

The use of ethanol can help reduce greenhouse gas emissions when its environmental impact is assessed over its entire life

cycle, including the cultivation of raw materials, production, transportation, and final use as a fuel. However, the extent of emission reduction depends on the type of feedstock used to produce ethanol. Studies using the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model developed by the Argonne National Laboratory have shown that ethanol generally produces lower life-cycle greenhouse gas emissions than conventional petrol. Corn ethanol has been estimated to lower life-cycle greenhouse gas emissions by approximately 40%. Ethanol made from cellulosic biomass feedstocks, such as crop residues and dedicated energy crops, may reduce emissions by considerably more. Likewise, analysis of greenhouse gas emissions from Brazilian sugarcane ethanol have shown reductions compared to petrol. Such studies suggest that ethanol's environmental performance is highly dependent on feedstocks and production processes.

Ethanol blending is also viewed in India as a key way to mitigate carbon emissions from the transportation sector. The Government of India stated that India's Ethanol Blended Petrol (EBP) Program has avoided millions of tons of carbon dioxide emissions and decreased reliance on fossil fuels. This indicates that ethanol blending can help India meet its climate goals and have a cleaner transportation sector, however benefits can differ by ethanol type and how it was produced. The following data was reported by the NITI AYOOG:

Vehicle Category	Fuel Blend	Carbon Monoxide (CO)	Hydrocarbons (HC)	Oxides of Nitrogen (NOx)
Baseline (All Vehicles)	Gasoline (Pure Petrol)	Baseline	Baseline	Baseline
Two-Wheelers	E10*	20% lower	20% lower	10% higher
	E20*	50% lower	20% lower	No significant trend
Four-Wheelers	E10*	20% lower	20% lower	No significant trend
	E20*	30% lower	20% lower	Same

The production of ethanol not only supports environmental goals but also contributes to economic development. Using maize as a feedstock for ethanol production can generate higher economic benefits than some other feedstocks.

Boosting ethanol production strengthens India's economy and agricultural sector by driving industrial output, national income, and job creation—all while lowering water consumption and greenhouse gas emissions. Mixing feedstocks like maize with sugarcane smooths out ethanol supply and avoids placing undue stress on food prices. For sugar mills, it also guarantees a consistent demand providing stable revenues that smooth sugar prices, soak up excess crop and give sugarcane farmers timely, predictable payments.

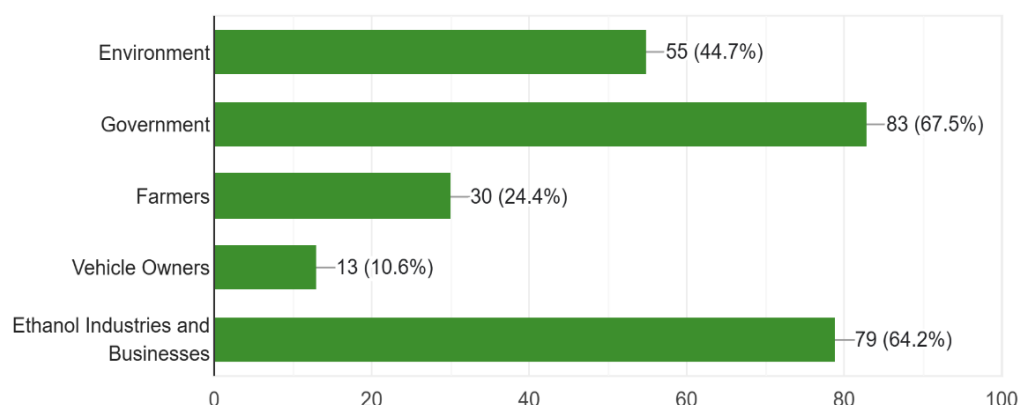
Ethanol blending can also improve air quality by reducing harmful emissions from vehicles. Since ethanol contains oxygen, it allows fuel to burn more completely inside the engine, resulting in lower emissions of carbon monoxide, hydrocarbons, and particulate matter. Lower emissions help reduce air pollution, particularly in urban areas where road transport is a major source of pollution. Improved air quality can decrease risks of developing respiratory disease including asthma and bronchitis and can reduce risk of diseases caused by long-term exposure to dirty air. Ethanol blending has great potential to support cleaner transportation because of benefits such as these.

Another question asked people who they thought benefited most from the ethanol blending program. Of respondents who answered (125 respondents), 67.5% said that Government benefits the most from ethanol blending. Only 10.6% said vehicle

owners benefited the most from ethanol blending. This is in contrast to the 44.7% who said that the environment benefits the most. It is concluded that many individuals think that ethanol blending benefits the government more than providing benefits directly to consumers. This could also contribute to why people do not want to pay more for ethanol blended fuel or accept reductions in miles per gallon. Thus, if the Government better informs the public of ethanol blending's benefits to the environment and long-term economic benefits, it may help gain the public's trust in this program.

Who do you think benefits most from the ethanol blending program – farmers, the government, vehicle owners, or the environment? (You can select more than 1 option)

123 responses



India imports crude oil to fulfill its energy demands. Ethanol blending, by substituting a part of petrol with domestically produced ethanol, cuts down on the import of crude oil. Helps to increase energy security of the nation and minimize volatility in international crude oil prices that occur due to market conditions or geopolitical tensions. Further, blending ethanol produced domestically would help realize India's vision of becoming Atmanirbhar in energy sector as well as reduce fuel import bill.

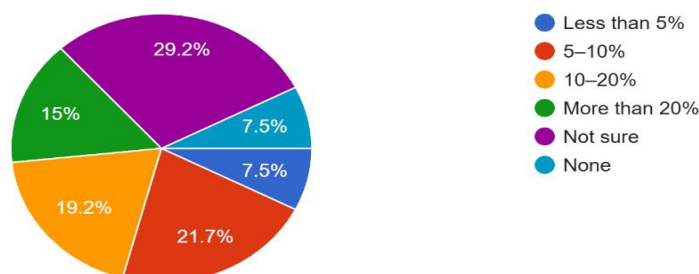
B. The Disadvantages of Ethanol-Blended Fuel

Ethanol has a lower energy content than petrol. As a result, when the proportion of ethanol in petrol is increased, the fuel contains less energy per liter. This means that vehicles may travel a slightly shorter distance on the same quantity of fuel compared to using pure petrol. The effect on fuel economy generally becomes more noticeable as the percentage of ethanol in the blend increases. A survey conducted by localcircles in June 2026 found that the effects of E20 petrol on older petrol vehicles became more noticeable within a short period. Compared with the previous month's survey, a larger number of owners of vehicles manufactured before 2023 reported a decline in fuel efficiency and an increase in vehicle wear and maintenance issues. These findings suggest that the impact of E20 fuel on older vehicles may become more significant over time.

However, The present survey (conducted on 125 participants) findings also highlight these concerns. Among the respondents, 67.2% said they noticed a reduction in fuel efficiency after using E20 petrol. Of these, 21.7% reported a loss of 5–10%, 19.2% reported a loss of 10–20%, and 15.0% believed the reduction was more than 20%. These figures are higher than the fuel efficiency loss reported in government reports and scientific studies. The reason for the potential difference shown here may be because many of the respondents use older vehicles or because fuel efficiency in everyday driving conditions differ from results obtained in the laboratory tests.

If yes, approximately how much mileage loss have you experienced?

120 responses



This survey also revealed how heavily public perception can be swayed with the information they are presented with. Out of respondents that held concerns with E20 fuel, 48.3% stated they were influenced by social media. Only 34.7% were influenced by scientific studies or technical reports. This suggests that there is a lack of clear and reliable public information about ethanol blending, and better awareness program are needed to address misconceptions and improve public understanding.

Ethanol produced from sugarcane-based feedstocks and food grains can be blended with petrol under the Ethanol Blended Petrol (EBP) Program. To promote ethanol production and ensure adequate supply, the Government of India has introduced a pricing mechanism under which the procurement price of ethanol is fixed according to the raw material used for its production. The list of raw materials for ethanol production include maize, damaged food grains, and other surplus grains. Although this helps increase the supply of ethanol, it has also raised concerns about food security. Using food crops for fuel may reduce the quantity available for human consumption and could affect the prices of essential food items, particularly if large quantities are diverted for ethanol production. Similarly, producing enough ethanol from sugarcane alone to achieve the E20 blending target would require a large area of agricultural land. This could reduce the land available for growing food crops and may create challenges for long-term food security. Therefore, it is important to maintain a balance between the production of biofuels and the availability of food crops.

Water use in ethanol production includes the water needed to grow feedstock for ethanol production and water used in the actual production process. Water usage varies by feedstock, production pathway and geographic climate. Currently in the United States nearly all ethanol is made from corn grain and produced by dry mill plants. Corn is combined with water to form a mash which is converted to sugars by enzymes. Fermentation of sugars by yeast creates ethanol which is distilled off for purification. The remaining by-product, Distillers Dried Grains with Soluble (DDGS) is typically used for animal feed. On average, depending on whether corn is irrigated or not, corn will use approximately 785 gallons of water per gallon of ethanol produced just to grow the corn. Ethanol plants use water during the manufacturing process as well. Today's ethanol plants recycle a majority of their process water. However, on average they will still use about 3–4 gallons of water to produce one gallon of corn-based ethanol for cooling and boiler use. Another type of ethanol currently in production is cellulosic ethanol. This ethanol can be made from many different feedstocks including agricultural residues like corn stover, wheat straw, wood, and energy crops like switchgrass. Although the production process is more complex, it reduces dependence on food crops. The amount of water required varies with the technology used. Biochemical methods may require around 6 gallons of water per gallon of ethanol, whereas advanced thermochemical methods can reduce water use to approximately 1.9 gallons per gallon of ethanol.

Sustainable production of both biofuels and petrol requires effective measures to reduce water consumption. Better irrigation practices are especially important in regions where water resources are limited. Developing drought-resistant crop varieties that can maintain good yields with less water can also improve the sustainability of ethanol production. In the case of cellulosic ethanol, selecting feedstocks that naturally grow in a particular region can reduce the need for irrigation and improve resource efficiency. Similarly, in the petroleum industry, using produced water (water generated during oil extraction) and saline water for oil recovery can help conserve freshwater resources. Overall, efficient water management and the adoption of suitable technologies are essential for reducing water use and ensuring sustainable fuel production.

Despite its environmental and economic benefits, the Ethanol Blended Petrol (EBP) Program faces several challenges that require careful consideration. Ethanol production generates by-products such as spent wash, vinasse, and acetaldehyde, which can cause water and environmental pollution if they are not properly treated. Although the Central Pollution Control Board (CPCB) has made Zero Liquid Discharge (ZLD) mandatory for distilleries, effective implementation and monitoring remain essential. Ethanol blending also has only a limited and inconsistent effect on reducing nitrogen oxide (NO_x) emissions, as the results vary depending on the vehicle type, engine design, and blending ratio. Another concern is the large-scale cultivation of single crops such as sugarcane and maize for ethanol production, which may lead to soil degradation, loss of biodiversity, increased water use, and pressure on agricultural land. While the promotion of crop residues and second-generation (2G) biofuels can help address these issues, their adoption is still limited. In addition, the expansion of ethanol blending requires adequate storage facilities, transportation networks, pipelines, and blending infrastructure, which are still developing in many parts of the country. Uncertainty regarding the availability of feedstocks, annual government pricing policies, and weather-related fluctuations can also affect ethanol production and discourage long-term investment. Finally, the sudden push from E10 to E20 has left some consumers, especially owners of older vehicles, worried and confused about E20. This demonstrates that there needs to be more public awareness, vehicle compatibility checks, and infrastructure in place before transitioning to higher blends of ethanol.

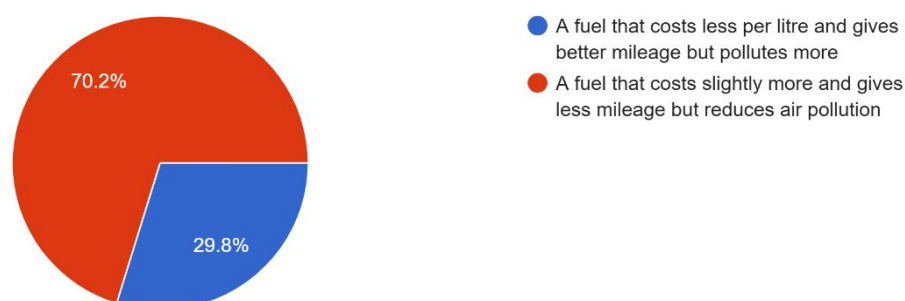
The survey further questioned respondents if they would

voluntarily choose environmental gain at a personal cost to themselves. When asked if respondents would rather use fuel that costs less and gives them better mileage but causes more air pollution or use fuel that costs slightly more but helps reduce pollution, 70.2% respondents favored cleaner fuel. When further broken down by those respondents that reported lower mileage after filling up with E20 petrol, support dropped to 56.1% amongst those affected. While there is general support amongst respondents for cleaner burning fuel, they are less likely to support it when faced with higher fuel prices or lower performing vehicles. The future success of the ethanol blending program will be linked not just to its environmental impacts but also its ability to lessen the load on vehicle.

The survey findings show that the price of E20 petrol has a strong influence on public acceptance. Although E20 is currently sold at the same price as regular petrol, 48.4% of respondents said they would support it if it were available at a lower price. Among them, 19.7% said they would fully support E20, while 28.7% said they would be more willing to accept it despite some concerns. However, 31.1% of respondents said that even a lower price would not change their opinion because they were worried about reduced fuel efficiency and possible damage to their vehicles. These findings suggest that lower prices can encourage greater public acceptance, but concerns about vehicle performance and the need for reliable information must also be addressed for the ethanol blending program to gain wider public trust.

If you had to choose, which would you prioritize?

121 responses



Currently, E20 petrol is sold at roughly the same price as conventional petrol. If E20 were sold at a significant discount, would that change your overall view of the ethanol blending program?

122 responses



C. Government's Response to Concerns on Ethanol Blending in India

Government of India has published technical tests & studies on ethanol-blended petrol and clarifies misconceptions/questions surrounding E20 ethanol-blended petrol with evidences from technical and scientific studies/reports. Government says, claims of E20 ethanol-blended petrol leading to loss of mileage by 30% is baseless. It states that although ethanol has lower energy content than petrol, resultant reduction in mileage due to blending is very marginal and influenced by driving habits/maintenance of vehicle, tyre pressure and traffic conditions.

In addition, the Government has claimed that E20 will not harm vehicle engines. ARAI, Society of Indian Automobile Manufacturers (SIAM), Indian Oil Corporation (IOCL) and vehicle manufacturers performed thorough testing of E20 before its planned nationwide launch. The Government claims E20 to be safe for all approved vehicles based on testing done. Additionally, the Government has said that E20 will have no effect on vehicle warranties or insurance claims because vehicle manufacturers and insurers have honored warranties for vehicles running on regular E20 fuel.

Responding to concerns on vehicular performance, Government has stated ethanol is a high-octane fuel compared to petrol that burns better and ensures efficient combustion thereby contributing to smoother vehicular performance for vehicles optimized for E20. Government has further stated ethanol blended with petrol is not fresh sugarcane juice but fermented, distilled and purified fuel which undergoes several industrial processes as per Bureau of Indian Standards (BIS) norms.

The Government has dismissed allegations that ethanol production involves wastage of huge amounts of water without any end safeguards. The Government said that most of the ethanol distilleries use latest technology like Zero Liquid Discharge (ZLD) to reduce water pollution, and only surplus food grains and rice which are approved by Department of Food and Public Distribution (DFPD) after ensuring requirement of the nation for food security purposes are being used for ethanol production. It has also rebutted claims made on social media that E20 brings insects or harms fuel tanks by clarifying that ethanol used as fuel grade ethanol contains zero sugar and new generation vehicles are not prone to water contamination.

Further, the Government has also said news reports which claimed that it told the Supreme Court that E20 was an "experiment" were inaccurate. The Ministry of Law and Justice responded that the case heard in the Supreme Court pertained to procurement and allocation of ethanol, and had nothing to do with the merits of the E20 program itself.

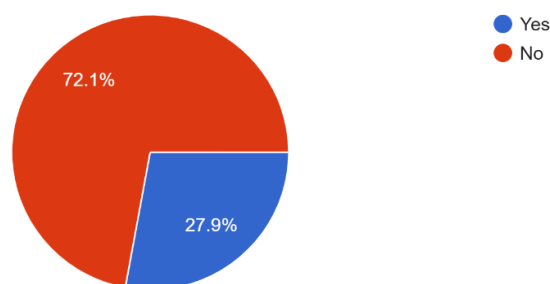
Major OEMs including Maruti Suzuki, Toyota Kirloskar Motor, Hero MotoCorp and Engineers India Limited have claimed that their real-time testing and servicing feedback has not reported any instances of any vehicle problems on large scale due to E20 fuel. They have also mentioned insignificant impact on mileage. According to them, E20 meets with BIS fuel quality norms and BS-VI emission standards. Summing up, the Government claims that E20 is environment friendly and has several other benefits. It further claims that E20 fuel has been scientifically tested, is safe to use and will increase farmers' income along with providing clean transportation, reducing our dependence on imported crude oil thus helping in energy security.

The results from the survey indicate that participants were still unconvinced by information and assurances provided by official outlets regarding E20 petrol. When asked how much trust they placed in assurances provided by the Government that E20 petrol will not damage vehicle engines only 27.9% answered that they trusted this information. Asked how much trust they placed in information given to them by vehicle manufacturers about E20 fuel, 33.3% answered that they trusted this

information. As manufacturers ranked only slightly higher than governmental outlets in participants' trust levels, participants were then asked how they preferred to be informed about the safety and efficacy of E20 petrol. Of the respondents, 65.3% selected direct communication from vehicle manufacturers as their preferred method of receiving information about E20 fuel, 52.9% selected independent research publications and 44.6% selected government awareness campaigns.

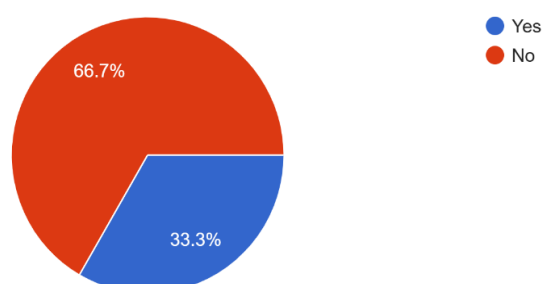
Do you trust the government's claim that E20 petrol does not damage vehicle engines?

122 responses



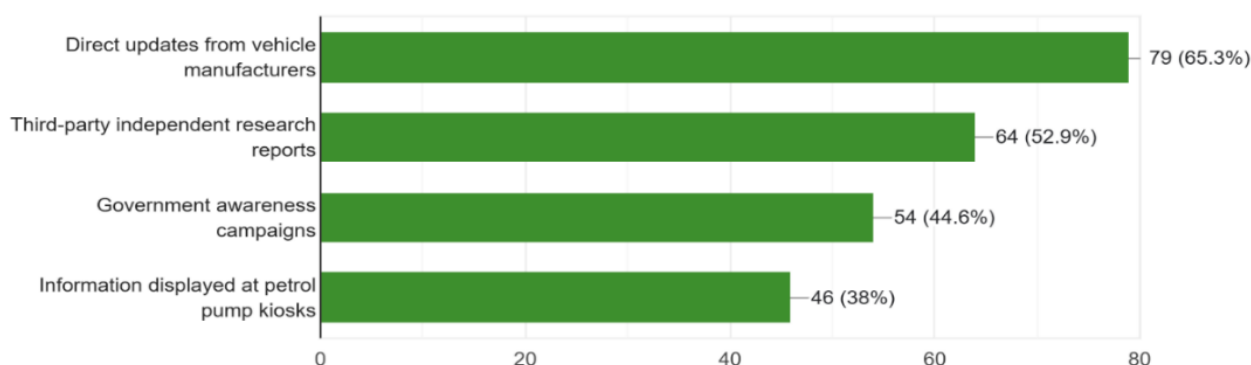
Do you trust automobile manufacturers' assurance that E20 is safe for their vehicles?

120 responses



How would you prefer to receive information regarding the safety and performance of E20 petrol?
(You can select more than 1 option)

121 responses



4. INDIA'S REGULATORY ARCHITECTURE

A. The Policy Instrument and Its Evolution

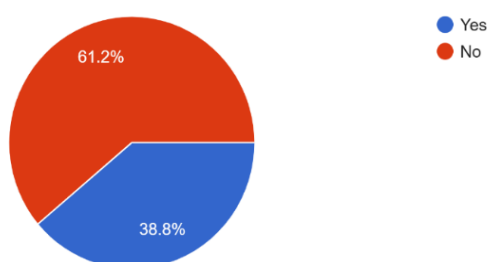
The blending of Ethanol in India is primarily governed through government policies rather than a separate law enacted by Parliament. The National Policy on Biofuels, 2018 introduced the objective of achieving 20% ethanol blending (E20) in petrol by 2030. Later, based on the recommendations of NITI Aayog's Roadmap for Ethanol Blending in India 2020–2025, the Government decided to advance this target to the Ethanol Supply Year (ESY) 2025–26. The amended policy also expanded the list of approved feedstocks to include maize, damaged food grains, and other surplus grains, thereby increasing the availability of raw materials for ethanol production. As a result of increased investment in distillation capacity and government support, India achieved the E20 blending target in 2025, earlier than originally planned.

The implementation of the program is carried out through the Ethanol Blended Petrol (EBP) Program, under which the public sector Oil Marketing Companies—Indian Oil Corporation, Bharat Petroleum Corporation Limited, and Hindustan Petroleum Corporation Limited—procure

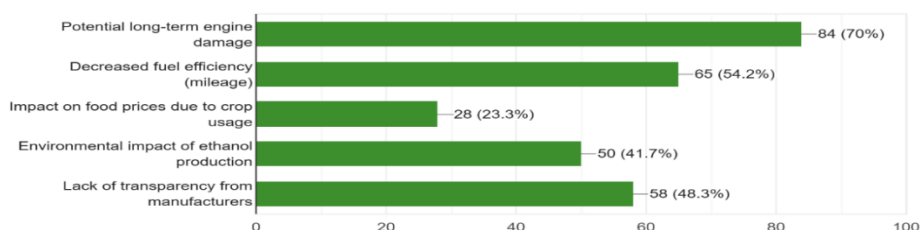
ethanol from approved suppliers and blend it with petrol according to the prescribed percentage. Government has also lowered the GST for ethanol supplied under this program. India has recently announced support for higher blends of ethanol such as E100 fuel and flex- fuel vehicles to further India's long-term goals of enhancing energy security, reducing crude oil imports and promoting clean transportation. India does not regulate biofuels under specific legislation like some countries. India's ethanol blending program has remained implemented primarily through government orders, pricing policies, and contracts between oil marketing companies and ethanol suppliers.

A final downside to lack of a stand-alone ethanol blending law relates to confidence. When asked if they would support increasing ethanol blends to E25 or E30 in the future, only 38.8% said yes while 61.2% said no. The reasons cited for concerns over higher ethanol blends were fear of long-term engine damage (70.0%), loss of fuel efficiency (54.2%) and feeling lied to by automakers (48.3%). This demonstrates that people will need consistent, credible information if they are going to buy into higher blends of ethanol. Legislation mandating independent testing and public release of results as well as ample consumer protection would help in gaining consumer trust.

Do you support India moving further to E25 or E30 blending in the next few years?
121 responses

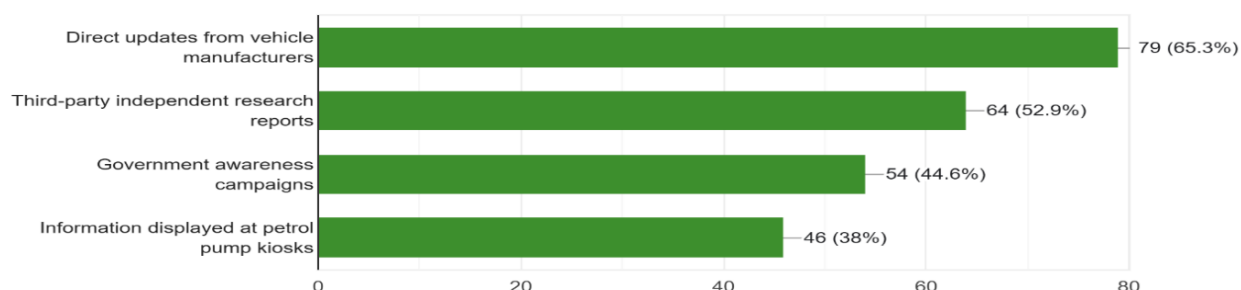


Which of the following concerns you most about increased ethanol blending? (You can select more than 1 option)
120 responses



How would you prefer to receive information regarding the safety and performance of E20 petrol?
(You can select more than 1 option)

121 responses



B. Environmental Clearance for the Ethanol Supply Chain

Ethanol blending is widely promoted because it helps reduce particulate emissions, lowers dependence on imported crude oil, and contributes to reducing greenhouse gas emissions. However, the environmental impact of ethanol depends not only on its use as a fuel but also on the way it is produced. Therefore, environmental regulation of distilleries plays an important role in ensuring that ethanol production remains sustainable.

In India, ethanol distilleries are regulated under the Environment (Protection) Act, 1986 and the Environmental Impact Assessment (EIA) Notification, 2006. Depending on their production capacity and the type of feedstock used, distilleries are required to obtain environmental clearance either from the State Environment Impact Assessment Authority (SEIAA) or from the Expert Appraisal Committee (EAC) of the Central Government.

To encourage ethanol production under the Ethanol Blended Petrol (EBP) Program, the Government amended the EIA Notification in June 2021. Ethanol manufacturing facilities based on grain that produce ethanol only for supply to the EBP Program and agree to implement Zero Liquid Discharge technology will fall under Category B2 under this amendment. Projects under this category will not have to prepare Environmental Impact Assessment Detailed Report nor hold public hearing subject to committing to supply ethanol only for blending program. Such approval route was made simple so that ethanol production can be ramped up in a faster manner and also ensuring that wastewater is mandatorily treated using ZLD system.

While these relaxations are necessary, certain environmental safeguards are important too. Distilleries produce spent wash, a wastewater with high amounts of organics and dissolved solids. It can cause water pollution in rivers, groundwater bodies, and agricultural land if it is untreated or inadequately treated. To prevent water pollution, the CPCB made Zero Liquid Discharge mandatory for distilleries. Even as diluted environmental clearances have helped India ramp up ethanol production faster, hit the E20 blending target earlier than planned, strict compliance regarding treatment of wastewaters generated, water use, and pollution must be monitored. Otherwise, pollution from ethanol-making will erase the climate benefits of ethanol.

C. Judicial Engagement

The Indian judiciary has generally supported the implementation of the Ethanol Blended Petrol (EBP) Program while also examining disputes arising from its implementation. In September 2025, the Supreme Court dismissed a Public Interest Litigation (PIL) that challenged the nationwide rollout of E20 petrol without providing consumers with an option to purchase ethanol-free petrol. The petition argued that older vehicles not designed for E20 could experience reduced fuel efficiency and maintenance issues. However, the Union Government submitted that the policy had been introduced after careful consideration and would benefit the country by reducing crude oil imports and supporting sugarcane farmers. The Supreme Court declined to interfere with the government's policy decision and allowed the program to continue.

A more significant legal dispute arose in 2026 regarding the allocation of ethanol supplies under the EBP Program. The Karnataka High Court had directed Oil Marketing Companies (OMCs) to reconsider the ethanol allocation made to a dedicated ethanol producer. Challenging this order before the Supreme Court, Bharat Petroleum Corporation Limited (BPCL) argued that changing the allocation after contracts had already been finalized could disrupt the national ethanol procurement

system. On 30 June 2026, the Supreme Court directed the parties to maintain the status quo on ethanol allocation for the Ethanol Supply Year (ESY) 2025–26 until the matter was finally decided.

After the hearing, certain media reports claimed that the Attorney General referred to E20 program as an "ongoing experiment". The Ministry of Law and Justice (Union Government) issued a clarification stating that the news reports were not true. It further stated that the Government has at no point referred to E20 policy as an experiment before Supreme Court of India. The statement asserted that importance of proper reporting of court proceedings of such major policies for public.

The cases highlight that while courts have not addressed the validity of the EBP Program itself, they have heard arguments pertaining to how the program is administered, contract requirements of the program, and administrative actions taken by the government agencies in charge of the program. The cases also exemplify that because the program is derived from government policy, procurement contracts, and administrative guidelines as opposed to its own statute, ethanol related legal disputes regarding allocation and implementation will most likely continue to be handled by judicially interpreted rulings.

5. COMPARATIVE FRAMEWORKS

A. United States: The Renewable Fuel Standard

The United States has one of the oldest and most comprehensive legal frameworks for promoting biofuels. The Renewable Fuel Standard (RFS) was first introduced through the Energy Policy Act, 2005 and was significantly expanded by the Energy Independence and Security Act (EISA), 2007. These laws amended the Clean Air Act and required that increasing amounts of renewable fuels be blended into transportation fuels. The legislation fixed annual blending targets up to 2022, with the long-term objective of reaching 36 billion gallons of renewable fuel. The law also created four categories of renewable fuels: renewable fuel, advanced biofuel, cellulosic biofuel, and biomass-based diesel. After 2022, the responsibility for determining annual blending volumes was transferred to the United States Environmental Protection Agency (EPA), which sets these targets in consultation with the Department of Energy and the Department of Agriculture through a rule-making process.

A unique feature of the U.S. system is the use of Renewable Identification Numbers (RINs). Instead of requiring every refinery to blend ethanol directly, the EPA allows refiners and fuel importers to comply with the law by purchasing tradable RIN credits generated when renewable fuel is produced or imported. This market-based mechanism provides flexibility while ensuring that the overall national blending targets are achieved.

The Renewable Fuel Standard also provides flexibility to the EPA through its waiver authority. If there is an inadequate supply of renewable fuel or if the blending

requirement is likely to cause significant economic or environmental harm, the EPA may reduce the required blending volumes. This waiver authority has been invoked on multiple occasions, most notably when cellulosic biofuel production did not meet expectations. When that has happened, the EPA has recalculated annual targets and granted cellulosic waiver credits so that refiners couldn't be punished for shortfalls they could not control.

In general, the U.S. program provides both statutory certainty and administrative flexibility. Although the Renewable Fuel Standard is mandated by Congress, the EPA can adjust the annual blending mandates by regulation as needed. This enables the program to adapt to market conditions and evolving fuel supplies while still incentivizing renewable fuel consumption.

B. Brazil: RenovaBio and the Blending Mandate

Brazil has one of the most developed biofuel programs in the world. Brazilian biofuel legislation is founded upon two mutually-supporting policies. The first policy is known as a mandatory ethanol blending requirement. Under this policy, any petrol sold in Brazil must contain a specific percentage of ethanol. Since 2015, Brazil has generally required 27% ethanol blending (E27), and the blending percentage is determined by the National Energy Policy Council (CNPE). This policy has helped Brazil reduce its dependence on fossil fuels while promoting the use of sugarcane-based ethanol.

In addition to the blending mandate, Brazil introduced the RenovaBio Program through Law No. 13,576 of 2017, which became fully operational in 2020. RenovaBio aims to reduce greenhouse gas emissions from the transport sector by encouraging the production and use of cleaner biofuels. Under this program, the National Agency of Petroleum, Natural Gas and Biofuels (ANP) sets annual decarbonization targets for fuel distributors. Certified biofuel producers earn Decarbonization Credits (CBIOs) based on the amount of greenhouse gas emissions avoided during biofuel production. Fuel distributors are required to purchase enough CBIOs each year to meet their assigned emission reduction targets. Unlike the U.S. Renewable Identification Number (RIN) system, CBIOs do not replace the mandatory blending requirement. Fuel distributors in Brazil

must comply with both the ethanol blending mandate and the CBIO obligation.

Brazil further strengthened its biofuel policy through the Fuels of the Future Law (Law No. 14,993 of 2024). This law retained the existing 27% ethanol blend (E27) while allowing the government to increase it to 35% (E35) if technical and environmental studies support such an increase. It also provides for a gradual increase in biodiesel blending in diesel fuel from 15% in 2025 to 20% by 2030, subject to approval by the National Energy Policy Council.

Brazil's biofuel policy has also been examined by the

courts. In 2024, two constitutional challenges were filed against the RenovaBio programme, arguing that mandatory decarbonization targets unfairly affected fossil fuel distributors. The Supreme Federal Court (STF) upheld the constitutional validity of the law. Later, the Superior Court of Justice (STJ) also ruled that fuel distributors could not avoid purchasing CBIOs by depositing money in court instead, as this would weaken the functioning of the carbon credit market. These decisions strengthened legal certainty along with confirming the validity of Brazil's carbon credit system.

Despite broad consensus about Brazil's successful biofuel program, some critics have noted that RenovaBio only measures emissions associated with biofuel production. Emissions associated with land-use change, like deforestation or pastureland converted to sugarcane, are not included. They suggest that including these indirect emissions would provide a more complete assessment of the environmental impact of biofuels.

C. European Union: The Renewable Energy Directive

The European Union (EU) regulates ethanol blending through the Renewable Energy Directive III (RED III) instead of a single mandatory blending percentage. Unlike countries such as India and Brazil, where the government prescribes a fixed ethanol blend, the EU allows each Member State to decide how it will achieve the renewable energy targets set under the Directive. RED III, which came into force in 2023, aims to increase the share of renewable energy in the European Union. It sets a target of at least 42.5% renewable energy in gross final energy consumption by 2030. In the transport sector, Member States must either achieve a 29% share of renewable energy or reduce the greenhouse gas (GHG) emission intensity of transport fuels by 14.5% by 2030. Within these targets, at least 5.5% must come from advanced biofuels and renewable fuels, including hydrogen, while at least 1% must consist of renewable fuels of non-biological origin, such as green hydrogen.

One of the main features of RED III is that it limits the use of food and feed crop-based biofuels. The Directive generally restricts the contribution of these conventional biofuels to the level consumed in 2020, with an overall maximum limit of 7% of transport energy consumption. Therefore, ethanol produced from crops such as wheat, maize, and sugar beet cannot exceed this limit. However, biofuels produced from waste materials, agricultural residues, and other advanced feedstocks listed in Annex IX of the Directive are not subject to this cap. This approach reflects the EU's objective of reducing competition between food production and fuel production while encouraging the use of more sustainable feedstocks.

Another important feature of the EU system is its strong emphasis on sustainability and traceability. RED III requires every participant in the biofuel supply chain, including producers, traders, and fuel suppliers, to maintain records showing the origin of the biofuel and compliance with sustainability requirements. Verified by certification schemes accredited by the European Commission, these records certify that biofuels meet sustainability and traceability criteria. Only biofuels which meet these criteria can be used to count towards an EU Member State's renewable energy target. This ensures that biofuels contribute to climate targets without significant harm to the environment.

As a result, the European Union's policy is different from that of countries like India and Brazil. Instead of setting targets for ethanol blending as a percentage of transport fuel, the EU approach is built around renewable energy targets, sustainability criteria, advanced biofuels and mandatory certification schemes

6. COMPARATIVE ANALYSIS

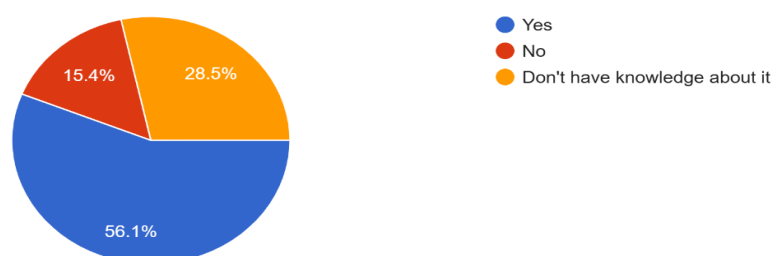
Comparing ethanol blending mandates enacted into law in India, United States, Brazil and European Union, it can be observed that India uses executive orders and fuel procurement contracts, which allows flexibility to change ethanol blending programs easily. However, in many cases legal disputes are settled by the courts. United States renewable fuel program works by statute through the Renewable Fuel Standard (RFS) and has blending requirements defined by law. U.S. EPA has the flexibility to increase or decrease the volume requirements if necessary. Brazil established both mandatory blending requirement as well as Renovabio carbon credit scheme, which provides both mandatory blending requirement and incentives for lower carbon emission. European Union regulates biofuels only through RED III (renewable energy directive) with emphasis on renewable energy targets, sustainability, and certification without mandating blending percentage.

The survey findings also support this view. When respondents were asked whether vehicle engines in countries such as Brazil and the United States work differently from those in India, 26.4% said there was no major difference, while 37.2% said they did not know. When asked about the reason for the problems related to E20 petrol in India, 66.4% believed that the issues were caused by the way the transition was implemented, whereas only 28.7% felt that the fuel itself was responsible. These findings suggest that public concerns are mainly related to the implementation of the ethanol blending program rather than the technology itself. A clear legal framework articulated with phased implementation, vehicle

compatibility standards and strong consumer protection measures could act as a bridge to address these concerns and improve public confidence.

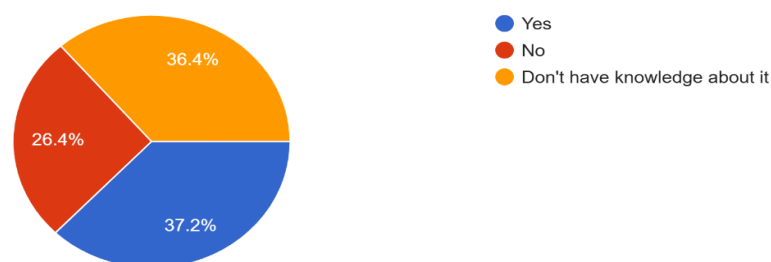
Were you aware that countries like Brazil, the United States, and European Union , have been using ethanol-blended petrol successfully for several decades?

123 responses



Do you believe that vehicle engines in countries like Brazil or the United States work on a fundamentally different mechanism than engines in... blending works there but causes problems here?

121 responses



The four systems also contrast on protection of the environment. The EU places a legal cap on food-based biofuels. Brazil incentivizes cleaner production through the monetization of greenhouse gas reductions through carbon credits. India widened the basket of feedstocks eligible for approval, allowing for ethanol production from food grains, among other feedstocks. India also reduced environmental clearances needed for ethanol production, limiting them only to distilleries that do not meet eligibility requirements. Although these changes have allowed India to reach blending targets faster than originally anticipated, they have not introduced a standalone legal provision to measure the environmental impacts of feedstock production as in the EU or Brazil.

It also revealed that simply lowering the cost of E20 fuel may not be sufficient to boost public acceptance. 19.7% of those surveyed stated that if E20 cost less they would support it, while 28.7% responded that they would "be more inclined to accept it". However, 31.1% answered that cheaper E20 would not change their minds because of concerns over reduced fuel economy and potential engine damage. This indicates that while incentives such as cheaper fuel may improve acceptance levels, they will not completely eliminate objections. Stronger legal guarantees, compatibility requirements for vehicles, independent testing and increased consumer protection would also help engender public trust.

Currently, E20 petrol is sold at roughly the same price as conventional petrol. If E20 were sold at a significant discount, would that change your overall view of the ethanol blending program?

122 responses



In general, this comparison would indicate that India has benefitted from having a flexible policy structure in order to enhance ethanol blending. However, implementing some form of stricter statutory framework that allows clear guidelines regarding environmental protections, sustainability requirements, and dispute settlements would help provide legal certainty and benefit the longevity of India's Ethanol Blended Petrol Program.

7. KEY FINDINGS OF THE SURVEY

Survey Finding	Result
Aware that pump fuel contained 20% ethanol	39.2% (49 / 125)
Concerned about air pollution in their city	93.5% (116 / 124)
Correctly identified vehicular emissions as major pollution source	83.2% (104 / 125)
Knowledge that vehicular emissions contribute ~20–35% of PM2.5	72.0% (90 / 125)
Knowledge that E20 reduces CO (up to 50%) & hydrocarbons (up to 20%)	49.2% (61 / 124)
Willing to accept mileage drop for significant emission reduction	55.2% (69 / 125)
Perceived beneficiaries of ethanol blending (multi-select)	Government (67.5%) Ethanol Industries (64.2%) Environment (44.7%) Farmers (24.4%) Vehicle Owners (10.6%)
Believe GHG reduction should be a national priority (even at personal cost)	65.3% (81 / 124)
Sources shaping negative view of E20 (multi-select)	Personal Observation (54.2%)

Survey Finding	Result
	Social Media (48.3%) Discussion with Friends/Family (36.4%) Scientific Papers/Reports (34.7%) News Media (27.1%) Government Reports (8.5%)
Personally noticed mileage drop with E20	67.2% (82 / 122)
Reported mileage loss severity breakdown	Not Sure (29.2%) 5–10% Drop (21.7%) 10–20% Drop (19.2%) More than 20% Drop (15.0%) Less than 5% Drop (7.5%) None (7.5%)
Reported vehicle maintenance issues attributed to E20	40.5% (49 / 121)
Chose cleaner fuel over cheaper polluting fuel (trade-off question)	70.2% (85 / 121)
Trust government claims on E20 engine safety	27.9% (34 / 122)
Trust manufacturer assurances on E20 safety	33.3% (40 / 120)
Preferred channels to receive E20 safety & performance info	Vehicle Manufacturers (65.3%) Third-Party Independent Research (52.9%) Government Awareness Campaigns (44.6%) Petrol Pump Kiosks (38.0%)
Aware of international ethanol blending experience	56.1% (69 / 123)
Believe Indian engines work differently from those abroad	36.4% (45 / 121)
Attribute E20 problems to transition management rather than fuel	66.4% (81 / 122)
Believe ethanol-blended petrol is overpriced in India	79.5% (97 / 122)
Shift in view if E20 were sold at a significant discount	Price-Sensitive / Receptive (48.4%) Unmoved due to Mileage/Damage Concerns (31.1%) Baseline Support Regardless of Price (12.3%) Non-Price Environmental Concerns (8.2%)

Survey Finding	Result
Primary concerns regarding increased ethanol blending	Potential Long-Term Engine Damage (70.0%) Decreased Fuel Efficiency (54.2%) Lack of Manufacturer Transparency (48.3%) Environmental Impact of Ethanol Production (41.7%) Food Price Impact from Crop Usage (23.3%)
Support moving further to E25 or E30 blending	38.8% (47 / 121)

8. CONCLUSION

The research paper studied India's legislation related to ethanol blending and compared it with the legislation in US, Brazil and European Union along with studying responses from 125 respondents on their opinion about E20 petrol. Conclusion drawn from the legislation review and observation of responses is nearly the same.

It was concluded that India had achieved E20 blending target earlier than anticipated. Unlike the US, Brazil and the EU, however India is blending primarily via government orders instead of having a specific law for it. Essential concerns such as consumer protection, vehicle compatibility, dispute resolution mechanism and compensation are therefore not well defined under a statute.

Survey results indicate that while most respondents were receptive to ethanol blending's environmental goals, many respondents had concerns regarding decreases in fuel economy as well as potential engine damage, transparency, and public awareness. Many survey respondents also felt that issues surrounding E20 have more to do with the program's implementation than the fuel itself. The results also indicate that confidence can be restored through clear communication, third party research, and stronger consumer protections.

Considering this analysis, the researchers conclude that India would benefit from creating a standalone Biofuels Act. The legislation should outline a transition timeline, compatibility standards for vehicles, independent testing, transparency of results, workable consumer protection and dispute resolution. These measures would increase consumer confidence, regulatory stability, and help ensure ethanol blending's continued viability and India meet its energy and climate objectives.

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