Chapter 6
Sugarcane Production and Its Utilization as a Biofuel in India: Status, Perspectives, and Current Policy

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6.1 Introduction

Global demand for fuel efficiency, environmental quality, energy security, and the rise of oil prices has elicited worldwide attention to alternative fuels from renewable sources. In this context, the world is searching for alternatives of fossil fuels which could provide energy in a reliable, constant, and sustainable manner. One of the alternatives for fossil fuels is biofuels. Many countries have adopted to move from conventional fuels to biofuels considering them sustainable substitute. Biofuels are

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renewable liquid fuels produced from biomass (biological raw materials). They are cost-effective, ecofriendly, and have potential to be a good replacement for transportation fuels like petroleum, diesel, and jet fuel (Bandyopadhyay 2015). Moreover, biofuels are also favorable alternatives because they can be produced domestically saving the foreign exchange in import of gasoline. Therefore, developing countries like India are emphasizing on substitution of petroleum products through biofuels (Union Ministry of New & Renewable Energy [MNRE] 2009; Government of India [GoI] 2016).

Biofuels are also gaining more interest to ensure energy security and tackle fossil fuels' related health hazards and global warming (Goldemberg et al. 2008). Worldwide, about 40% of the biofuel production is derived from sugarcane (Talukdar et al. 2017). Sugarcane ethanol is an alcohol-based biofuel which is produced by the fermentation of sugarcane juice and molasses. Sugarcane, as a potential energy feedstock, can maintain the ecological balance by strengthening the industries and contributing to diversification of energy sources around the globe (Eric Lam et al. 2009).

Brazil and USA are the leading ethanol producers as they have adopted vigorous policies for boosting ethanol engenderment to reduce dependence on fossil fuels. India needs to adopt similar policy measures as it targets to rapidly expand the use of cleaner, safe, and greener alternatives in transportation. India is the second largest producer of sugarcane and is ranked fourth in ethanol production after the United States of America (USA), Brazil, and China, with ethanol production of about 1900 million liters and a distillation capacity of 2900 million liters per annum (Gonsalves 2006; GoI 2016).

Sugarcane (*Saccharum* spp.) is a perennial grass (Fig. 6.1) which stores its carbohydrate reserves as sucrose. This crop supplies about 70% of the sugar needs of the world's population. It is indigenously grown in India and is primary source of sugar, khandsari, and gur. About two-third of the total sugarcane cultivated in the country is used for making khandsari and gur and the remaining one-third goes to sugarcane mills. It is also used as raw material for manufacturing local liquors. Additionally, as commented earlier, sugarcane also serves as a biofuels source in India. This chapter details the current status of sugarcane production, national policies regarding biofuels, blending requirements, future perspectives, and the challenges related to the same, in India.

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Fig. 6.1 With standing sugarcane crop of Balrampur village in West Medinipur district of West Bengal Province of India

6.2 Status of the Sugarcane Crop in India

Sugarcane is a principal commercial crop that is grown in the subtropical and tropical regions of the country. India has the largest area under the sugarcane cultivation throughout the globe and is second largest producer next only to Brazil. In India, sugarcane production and sugar industry play an important role in socioeconomic development in rural areas by utilizing resources and creating job opportunities and higher income as well. About 8.0% of the agricultural population and about 45 million sugarcane farmers, their dependents, and oversized population of agricultural labor are associated with sugarcane cultivation, harvesting, and accessory activities in India. Sugarcane accounts for the largest value of production in the country and holds top position among other commercial crops. It is a popular choice for cultivation among farmers wherever geographical and climatic conditions favor its growth. In India, nine states are growing sugarcane on a large area with different varieties depending on the properties of the soil and agroclimatic conditions. A number of varieties are available and developed commercially for sugarcane cultivation keeping in view these factors for various states of the country (Table 6.1). For instance, as proposed by Indian Institute of Sugarcane Research (IISR 2018) and Sugarcane Breeding Institute Coimbatore (SBI 2018), the best suitable varieties of sugarcane are CoC671 and Co86032 and Co86032 for Maharashtra and Tamil Nadu states, respectively, released for higher productivity and sugar recovery.

Sugarcane is grown primarily in the two distinct agroclimatic zones of the southern hemisphere, i.e., tropical and subtropical. Tropical regions (Andhra Pradesh, Gujarat, Goa, Madhya Pradesh, Karnataka, Tamil Nadu, Kerala, Pondicherry, and Maharashtra) shared about 55% of the total sugarcane cultivation area and

Table 6.1 Commercially developed sugarcane varieties for cultivation in different states of India

States	Released suitable sugarcane varieties
Andhra Pradesh	Co-8504, CoA07706, CoA-8801, CoA89082, CoC-85038, and CoV-92103
Assam	Cajor-1 and 2, Co- 8315, Co BLN-9102, Co BLN-9130, Co-1008, Co-1132, and Co-6907
Bihar	Bo-104, Bo-106, Bo-109, Bo-128, Bo-90, Bo-99, C0S-87268, and CoS-767
Gujarat	Co-671, Co-8021, Co-85004, Co-86032, CoC-86008, and CoLK8001
Haryana	Co-7717, Co-975, CoJ-58, CoJ-64, CoJ-83, CoLK-8001, CoS-767, and CoS-8436
Karnataka	Co-8011, Co-86032, Co-87044 Co-91002, and CoC-671
Maharashtra	Co-8014, Co-85004 Co-86032, and CoC-671
Tamil Nadu	Co-86032, Co-86249, CoC-671, CoC-93076, CoC-95071, and CoJ-86141
Uttar Pradesh	CoPlant-84211, CoS-687, CoS-767, CoS7918, CoS-802, CoS-8315, CoS-8432, and CoS-87216

Sources: SBI (2018) and IISR (2018)

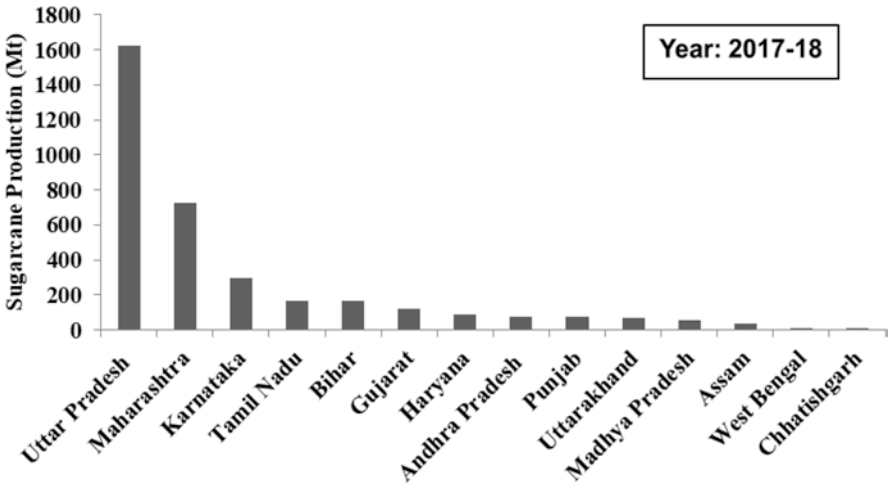


Fig. 6.2 Statewise sugarcane production in 2017–2018. (Bar diagram modified from DSD 2018)

production, whereas subtropical regions (Uttar Pradesh, Bihar, Haryana, and Punjab) accounted for 45% of total cultivation area and production of sugarcane in the country. Statewise production indicates that more than 80% of sugar comes from only four states, viz., Uttar Pradesh, Maharashtra, Karnataka, and Tamil Nadu (Directorate of Sugarcane Development [DSD] 2018). Uttar Pradesh province of the country representing the lead production of sugarcane (Fig. 6.2) was estimated to have the highest area of sugarcane with 23.40 M ha in 2017–2018 as per report of *The Economic Times* (Bhosale 2018). According to the production capacity of sugar, the states are classified into three groups as presented in Table 6.2.

Table 6.2 Classification of sugar-producing states in India

Groups	Types of production capacity	Examples
First groups	High sugar producing	Maharashtra and Uttar Pradesh
Second groups	Medium sugar producing	Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, and Haryana
Third groups	Low sugar producing	Bihar and Assam

In the year 2017–2018, sugarcane production was 355.09 million tonnes out of this 234.975 million tonnes that were harvested by the two largest producers, viz., Uttar Pradesh and Maharashtra (Table 6.3). The lowest sugarcane production was 0.122 million tonnes by Kerala. However, sugarcane productivity was highest in Kerala which recorded per hectare yield of 116.2 t (DSD 2018). In the year 2014–2015, the total production, i.e., 362.33 million tonnes, was recorded, whereas in the year 2015–2016, the estimate was 348.4 million tonnes, whereas total production of sugarcane in the current year 2018/2019 is expected to rise to 415 million tonnes on 5.2 M ha of area (Table 6.4). The sugarcane yield in India has increased to 79.81 tonnes ha^{-1} from 70.09 tonnes ha^{-1} during the period from 2010–2011 to 2018–2019 (Landry and Aradhey 2018).

6.3 The Sugar Industry of the Country

Sugar industry is one of the most important agro-based industries and has a significant contribution toward the socioeconomic development of India. It is considered as the 2nd largest agricultural-based industry following only the cotton and textile industry. Indian sugar industry is playing major role in economic development of the rural population through utilization of domestic resources and creation of employment opportunities. Approximately 0.5 M people of the country are dependent completely on sugar factories for their livelihood, while ~50 M farmers and 7.5% of the total rural population are associated with cultivation, harvesting, production, and ancillary activities of sugarcane crop (Ghanekar 2014).

Most of the sugar mills are situated in main sugarcane-growing states including Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, and Gujarat. About 25% of the overall sugar production is done by Maharashtra, while Uttar Pradesh contributes by 24% (Bhosale 2018). Currently, there are 703 sugar factories in the country. Among them, 325 mills are operated by the cooperative sector, 335 by private sector, and 43 by public sector. Half of the operational sugar mills are situated in Maharashtra. The motto of these factories is to upgrade the rural areas of the nation, which they are excellently contributing for (Indian Sugar Mills Association 2008; Landry and Aradhey 2018).

The sugar industry has great relevance to the economy of India, as it saves huge amounts of foreign exchange by domestically fulfilling the sugar requirements of

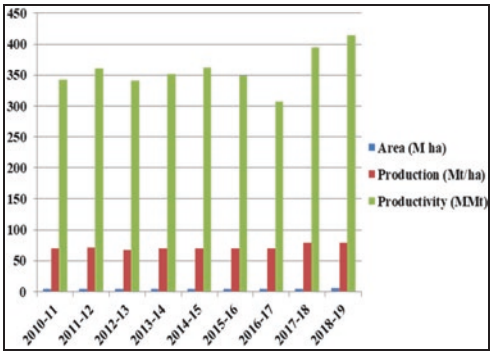
Table 6.3 Region-wise status of major sugarcane-producing states of tropical and subtropical regions in India

Sugarcane-producing states	2015–2016			2016–2017			2017–2018		
	Area (×00000 ha)	Production (×00000 tonnes)	Productivity (tonnes ha^{-1})	Area (×00000 ha)	Production (×00000 tonnes)	Productivity (tonnes ha^{-1})	Area (×00000 ha)	Production (×00000 tonnes)	Productivity (tonnes ha^{-1})
A. Tropical region									
Andhra Pradesh	1.22	93.53	76.70	1.03	78.30	76.00	0.99	79.48	80.30
Gujarat	1.57	111.20	70.80	1.69	119.50	70.70	1.84	122.34	66.50
Karnataka	4.50	378.34	84.10	3.97	273.78	69.00	3.70	299.02	80.80
Kerala	0.01	1.38	101.40	0.01	1.14	114.00	0.01	1.22	116.20
Madhya Pradesh	1.03	52.81	51.30	0.92	47.3 0	51.40	0.98	54.30	55.40
Maharashtra	9.87	736.80	74.70	6.33	522.62	82.60	9.02	726.37	80.50
Tamil Nadu	2.52	254.94	101.10	2.18	189.88	87.10	1.83	165.62	90.10
B. Subtropical region									
Assam	0.29	10.38	35.30	0.32	12.07	37.70	0.30	37.20	11.15
Bihar	2.44	126.49	51.80	2.40	130.36	54.30	2.43	165.11	67.90
Chhattisgarh	0.36	0.68	1.90	0.21	8.48	40.40	0.30	12.47	41.60
Haryana	0.93	66.92	71.90	1.02	82.23	80.60	1.14	87.29	76.60
Jharkhand	0.10	7.09	69.50	0.07	5.13	73.30	0.07	5.23	69.80
Odisha	0.09	5.77	64.40	0.05	3.44	68.80	0.05	3.41	64.40
Punjab	0.90	66.07	73.40	0.88	71.52	81.30	0.93	75.33	81.00
Rajasthan	0.06	5.31	86.50	0.07	4.89	69.90	0.05	4.04	74.50
Uttar Pradesh	21.69	1453.85	67.00	21.60	1401.69	64.90	22.34	1623.38	72.70
Uttarakhand	0.97	58.86	60.80	0.93	64.77	69.60	1.02	71.42	70.00
West Bengal	0.17	20.75	119.20	0.21	15.50	73.80	0.17	12.94	76.10

Sources: Modified from DSD (2018)

Table 6.4 Year-wise status of area, production, and productivity of sugarcane in India since 2010

Year	Area (Million ha)	Production (Metric ton ha^{-1})	Productivity (Million Metric ton)
2010-11	4.89	70.09	342.38
2011-12	5.08	71.07	361.03
2012-13	5.06	67.38	341.20
2013-14	5.01	70.26	352.14
2014-15	5.14	70.44	362.33
2015-16	4.96	70.25	348.40
2016-17	4.38	70.02	306.70
2017-18	4.95	79.80	395.00
2018-19	5.20	79.81	415.00



Source: Landry and Aradhey (2018)

the country. The sugar industry also acts as a leading representative in the national and international trade as India produces 15% of the global sugar (from its 25% share of the global sugarcane production). The sugarcane sector of the country harvests approximately 300–350 million metric tonnes (MMts) sugarcane, 30–36 MMts white sugar, and 6–8 MMts jaggery and khandasri, annually. Moreover, the Indian sugar industry is producing 2300 MW power, and 2700 ML of alcohol and other allied products from this crop (Venkatesh and Venkateswarlu 2017).

Sugarcane is a rich source of sucrose, cellulose, fuel, and numerous chemicals. Various products and coproducts of sugar industry include sugar, bioethanol, electricity, paper, biomanure, and board, besides other ancillary products. Hence, the by-products of sugar industry like bagasse, molasses, and press mud also play important role toward national economy by promoting a number of supplementary industries (Gangwar 2014). About 45–55% total sugar content is found in molasses which is used as a raw material for manufacturing many value-added products such as ethanol, acetone-butanol, citric acid, lactic acid, lysine, oxalic acid, etc. Apart from industrial products and by-products, the green leaves, tops, and trash from sugarcane crop are important cattle feed and preferred for the purpose in rural areas in India.

Bagasse is a fibrous residue that is left after the crushing of sugarcane. It can also be used as fuel in the boilers of sugar factory for fulfilling the steam requirements for power generation, whereas its raw material may be used as an alternative for wood pulp. The ethanol demand of the country is already high, and increasing day by day. The contribution of sugar industry is about 1% in the GDP of Indian economy. The annual turnover of the Indian sugar industry was estimated to be US$5.669 billion, while the amount of taxes collected from this sector by the government was estimated to be US$ 345.685 million for the year 2017 (Venkatesh and Venkateswarlu 2017).

6.4 Current Status of Cane Bioenergy Production in India

Initiatives have been taken in many countries of the world to use energy from renewable biomass sources for energy security, socioeconomic benefits, and environmental advantages. Biofuels not only have the potential to meet energy requirements indigenously, but they also have positive impacts on elimination of lead compounds present in petrol and on reduction of toxic emission of dangerous GHS gases (Goldemberg et al. 2008). Against the fossil fuels, there are many renewable alternatives available; however, ethanol has emerged as one of the preferred options for the transportation purposes in India (Gopinathan and Sudhakaran 2009).

Till date, in India, several initiatives have been taken toward energy security. India meets 70% of its fuel needs through imports. Bioenergy constitutes an appropriate alternate energy source for developing countries like India as huge amounts of raw material (biomass) are available (Mishra 2006). Apart from fuel ethanol, India has also developed bioenergy-based technologies that could fulfill the electricity and cooking energy requirements through small biomass gasifiers. Being a developing economy, India offers a tremendous potential to explore eco-friendly, sustainable, and cost-effective bioenergy technologies (bioenergy and biofuels) (Sudha et al. 2003).

Sugarcane is a key player for food security because nearly 75% of the world's sugar comes from sugarcane plantation (De Souza et al. 2008). The sugar extracts obtained from sugarcane can also be used in fermentation process for ethanol production and other value-added products, whereas bagasse can be utilized by sugar mills for steam and power generation (Talukdar et al. 2017). Currently, about 1.3 billion liters of ethanol are produced by India from cane molasses, while it has an installed capacity of 3.2 billion liters for the same. Annually, about 121 GJ fuel ethanol is produced from sugarcane (Blanchard et al. 2015). Hence, sugarcane (molasses and juice) is an important feedstock for sugar and ethanol production, and electricity generation in India, apart from being a major cash crop of the country (Fig. 6.3).

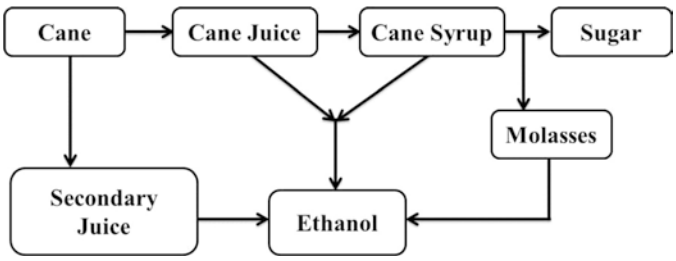


Fig. 6.3 Process flow diagram of ethanol production from sugarcane in India

6.5 Capacity, Potential, and Future Perspectives of Ethanol Production from Sugarcane in India

6.5.1 Ethanol Blending in India

Ethanol is an easily available by-product of integrated sugar mills. Currently, ethanol is mainly engendered from molasses in India. The ethanol produced at sugar mills can later be blended with petrol and gasoline. On average, it is estimated that one tonne of sugarcane yields 110 kg of fermentable sugar from the sugarcane juice. If the juice is directly fermented into ethanol, then the average yield is around 70 liters with a sugar loss of 2% in the spent wash (Shapouri et al. 2006).

The demand for petrol in India is increasing at a steady rate due to urbanization, infrastructural development, and the resulting increase in vehicle density. Therefore, it was observed that the ethanol demand heightened for the industrial sector and other uses by 3%, and for portable use by 3.3% from 2007 to 2012 (Shinoj et al. 2011). This trend is expected to rise over the next several years. Ethanol blending is one of the most viable ways to increase domestic availability of petrol in order to limit the dependence on crude imports. Keeping this in view, India is already showing keen interest toward using ethanol as an automobile fuel. A tremendous contribution has been made by many distilleries to use surplus alcohol as a blending agent or an oxygenate in gasoline in the country.

As per policies of the Indian Government, 5% ethanol blending with petrol was targeted for October 2008 (Tiwari et al. 2015). Later, in 2009, a national policy on biofuels was formulated by Union Ministry of New & Renewable Energy (MNRE 2009). This policy set a target of 20% ethanol blending by 2017. Further, in 2013, the union government initiated the Ethanol Blended Petrol program, which made it mandatory for all oil companies to sell 5% ethanol-blended petrol. The policy was significantly focused on India's scenario to exploit the opportunities in agricultural and industrial sectors aiming at boosting biofuel usage as well as reducing the dependency on imported fossil fuel. Currently, this program is being implemented in 21 states and 4 union territories with a target of realizing 5% blending. Further, the program targets progressively increasing the blending rate to 10%. The Government of India has made significant investments in improving storage and blending infrastructure as well (Prasad et al. 2018). Figure 6.4 depicts the total available sugarcane ethanol for blending purposes after fulfilling the demands of portable, industrial, and other major uses in the Indian states. Moreover, it also provides an overview of ethanol needs of the states to fulfill various blending targets. Moreover, the ethanol demand for meeting blending targets until 2030–2031 is projected in Fig. 6.5.

At current pace, India is estimated to achieve 10% ethanol blending by 2022. The requirement of the ethanol for the country is around 3.13 billion liters (BL) in this regard. However, currently, there are no strict policy measures to divert sugarcane directly to ethanol production. Recently, the government has shown increased commitment to boost the ethanol blending at different levels in order to save money

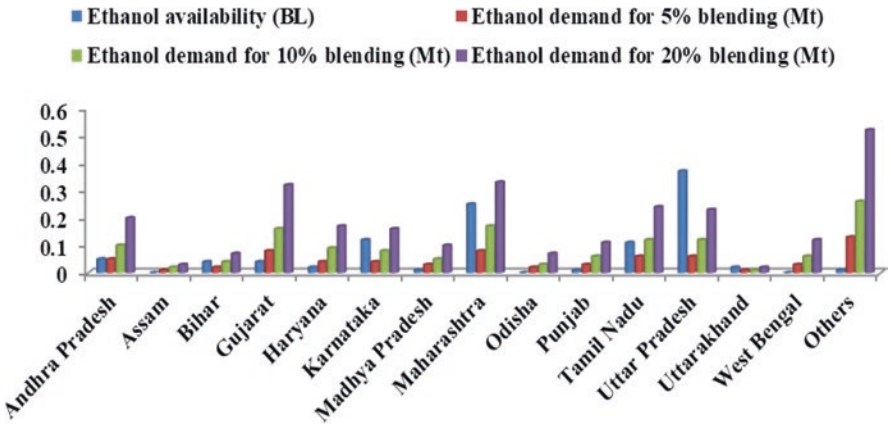


Fig. 6.4 Sugarcane ethanol availability and demand for meeting the ethanol blending targets across the different states of India [BL, billion liters; Mt., million tonnes]. (Modified from Purohit and Fischer 2014)

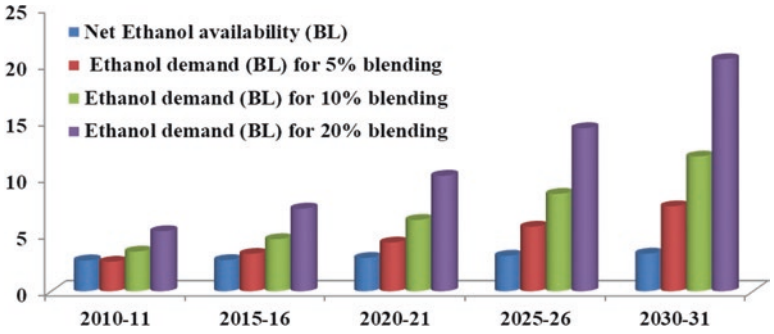


Fig. 6.5 Availability and demand of ethanol for meeting the blending targets. (Modified from Purohit and Fischer 2014)

spent on crude oil imports. Additionally, blended fuel and ethanol adoption is also being promoted at users' end as well. Design and engine modifications are planned to be introduced in the country for new vehicles which could run on 100% ethanol.

A large number of the distilleries in India are estimated to supply ethanol under the ethanol blending program. To date, India is producing over 4.5 BL of ethanol from its 330 distilleries. One hundred sixty-two distilleries in the country have capacity to distill conventional ethanol over 2.2 billion liters. India produces conventional ethanol mostly from sugar molasses—a by-product of the sugar industry—and not directly from sugarcane. Increased concentration on ethanol blending in gasoline has several benefits for farmers too including financial incentives, and more support to the agricultural sector. Additionally, ethanol blends lead to lesser pollution and reduction in import dependency. Figure 6.6 depicts the scenario of ethanol production, supply, and consumption in India (Sriram and Achur 2018).

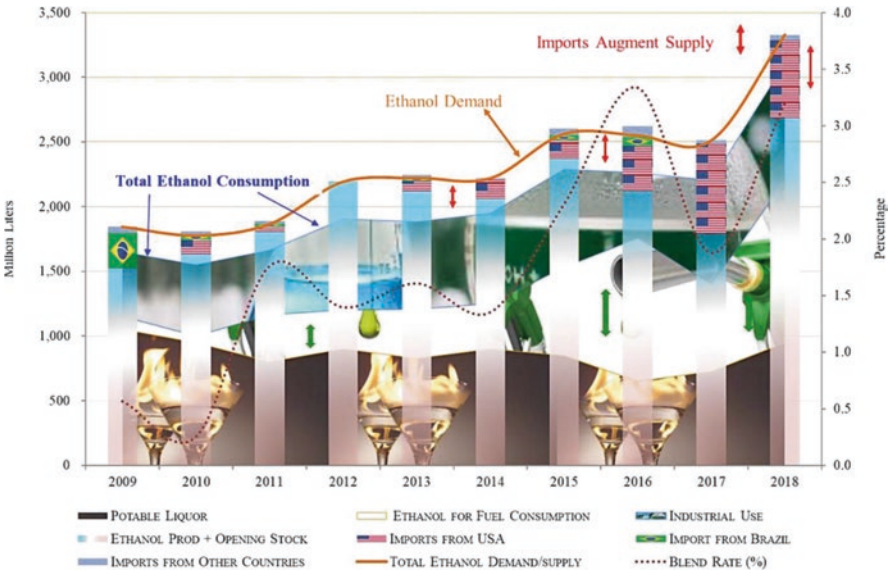


Fig. 6.6 Ethanol production, supply, and consumption in India. (Source: Wallace and Aradhey 2018)

For effective implementation of the EBP in the country, continuous supply of sugarcane feedstock (molasses, sugarcane juice, bagasse) is essential. However, sugarcane is a bumper crop that fulfills the needful demands of many sectors. In recent years, there has been a shortfall in sugarcane production due to which EBP has not been effectively implemented. Appropriate time span and research efforts would have to be employed in the automobile industry as well for manufacturing compatible engines which could use higher levels of blended fuel in future (Times of India 2018).

Various limitation and challenges are yet to be tackled for increasing ethanol-petrol blending. Strenuous efforts are necessary to increase the sugarcane yield in the country which has been stagnating at around 65–70 t ha^{-1} for years, and it is thought as if a yield plateau has been reached. Another option is to increase the number of biorefineries for ethanol engenderment. Increasing the area under sugarcane cultivation is not a viable option as it would mean land occupation of other food and staple crops which will give rise to food vs. fuel issues. Water requirements of sugarcane crop are also a limitation in this regard as approximately 20,000–30,000 cubic meters of water is needed for sugarcane cultivation per hectare. Such huge water requirements of an energy crop cast a question mark on sustainable production of the same in countries like India (Bhattacharya 2010; Shrivastava et al. 2011).

India has to either increase ethanol production by approximately three times or must opt for importing ethanol to achieve its targeted blending rates, without making a compromise to industrial, portable, and other requirements. Currently, ethanol is being produced from molasses only; however, blending requirements of the

country are increasing the demands to yield ethanol directly from cane juice; nevertheless, it increases the food security concerns (Purohit and Fischer 2014).

6.5.2 Status of Electricity Cogeneration at Sugar Mills

The power sector reforms of India opened new opportunities for cogeneration. With the increasing thrust on promoting renewable energy, sugar mills' bagasse cogeneration was considered as a potential resource. India is now conventionally using bagasse as a fuel for cogeneration in all of its sugar mills. Indian Government has established policies for setting up bagasse-based cogeneration projects as well as for the purchase of generated power. Such policies urged the sugar mills to set up high-efficiency cogeneration systems to generate surplus power for sale to the national grid.

Various valuable by-products such as molasses, bagasse, and syrup are generated during the sugar production process. Bagasse is lignocellulosic fiber that remains after the crushing of sugarcane. It has good calorific value and can be burnt as fuel. The sugar industry is using bagasse for electricity and steam in the milling operations. Bagasse is easily burnt in boilers for steam production which is further utilized in turbine generator for electricity production. The surplus bioelectricity thus yielded is available for sale to the national grid. Ministry of New and Renewable Energy (MNRE) has been providing incentives for surplus bioelectricity cogeneration at the sugar mills. The agency targets promotion of biomass-based cogeneration to yield electricity and encourages its sale.

A total of 213 sugar mills have already been supported for installing optimal cogeneration plants, which count for a total capacity of approximately 2332 MW. Uttar Pradesh is leading with its cogeneration-based electricity production capacity of 711 MW through 53 projects. Moreover, Maharashtra have a capacity of 581 MW electricity production from its 65 projects, whereas Karnataka, and Tamil Nadu have capacity of 404 MW (32 projects), and 327 MW (26 projects), respectively. Furthermore, 37 projects are installed in other states as well, which have a capacity to produce up to 310 MW of electricity. Nearly four million units of electricity per megawatt of bagasse cogeneration-based plant are generated per annum, and the price of electricity ranges from INR 3.50 to 5.50 per unit (Shailesh 2013).

6.5.3 National Policies Regarding Ethanol Blending in India

Numerous policies were launched for ethanol blending to fulfill the Indian blending targets and biofuels adoption. Recently, the Union Cabinet of India has approved National Policy 2018 on Biofuels so that the biofuel production within the country may be promoted. The objective of the National Policy on Biofuels has been to foster and strengthen the Ethanol Blending Petrol Program (EBPP) in the country. A timeline of national policies and developments for ethanol blending is presented in Table 6.5.

Table 6.5 Timeline of national policies for ethanol blending in India

Year	Act/policy	Features
1948	Power Alcohol Act	Blending of ethanol from molasses (alcohol) with petrol was emphasized for reducing the sugar prices and limiting waste production and the dependence on imported petrol (Basavaraj et al. 2012)
2001	Pilot projects (at Miraj, Manmad, and Bareilly)	Three pilot projects were launched: two in Maharashtra (Miraj and Manmad) and one in Uttar Pradesh (Bareilly). The purpose of the plants was to analyze the feasibility of ethanol blending with petrol
2003	EBP Program	The Ethanol Blending Program was initiated to target the production and sale of 5% ethanol-blended petrol in nine states and four union territories in the country (Ray et al. 2012)
2006	Resumption of EBP	The EBP was extended to 11 more states of the country (Ray et al. 2012)
2009	National Biofuel Policy	Five percent blending was made mandatory in India A target of 20% blending by 2017 was set both for biodiesel and ethanol (Ray et al. 2012)
2010	Provisional ad-hoc procurement price of ethanol	An ad-hoc provisional procurement price of INR 27 per liter of ethanol was set by the GoI
2012	Cabinet Committee on Economic Affairs (CCEA)	The cabinet committee decided that 5% ethanol blending should be mandatory and implemented all across the country. Moreover, it was also proposed that ethanol's purchase price would be decided between Oil Marketing Companies (OMCs) and the suppliers (Lagos and Aradhey 2013)
2014	Cabinet Committee on Economic Affairs	Ethanol prices were fixed based on the distance between the supplying mill/distillery and OMC
2015	–	Central excise duty of 12.36% was exempted on ethanol supplied specifically for blending purposes
2016	Cabinet Committee on Economic Affairs	The concession on excise duty was eliminated (Mukherjee 2016) The administered price of ethanol was adjusted to INR 39 per liter for the period 2016–2017

Biofuel production in India is aimed at playing important role in economy and contributes toward Indian Government's initiatives such as Make in India, Skill Development, and Swachh Bharat Abhiyan. Biofuel blending also deals with achieving the ambitious goals of doubling the farmers' income, employment generation, import reduction, and waste to wealth concept.

6.6 Future Perspectives of Cane Ethanol Production in India

It is evident from Indian Government's policies that the role of sugarcane crop in biofuels sector of the country is anticipated to increase even more. Currently, in spite of being second largest producer of this crop, even 5% blending targets of India are not being fulfilled by sugarcane because of high demand of ethanol in

other sectors such as liquor industry. The government is targeting even higher blending rates in order to reduce GHG emissions, promote agriculture, generate employment opportunities, and limit the oil import burdens. Thus, sugarcane production must be increased in the country either by increasing its per unit area yields or expanding its production to areas where sustainability concerns are not high. Another option is the production of ethanol from sugarcane juice directly, which would, however, increase the concerns about sugar prices.

A tremendous potential exists for sugarcane crop in India as a source of ethanol, sugar, and bio-products. In order to make ethanol production more cost-effective, installation of state-of-the-art techniques like molecular sieve technology for creating anhydrous ethanol can help. Enforcement of a stable blending program would encourage the investments, benefiting sugarcane farmers and the industry. Biotechnology applications can also help in enhancing the sugar contents of the sugarcane, leading to development of high-recovery cane genotypes. Moreover, biotechnological applications can play significant role in reducing the ethanol production costs as well.

In India, efforts should also focus on development of cost-effective processes for ethanol production from sugarcane by using cutting-edge technologies like the use of membranes and genetically modified microbes, improved key enzymes, elite strains of yeast for fermentation, and optimized fermentation processes. Several policy problems associated at national and state level have already been mentioned and an action set up for bioethanol engenderment, and its phase-wise expansion is counseled in the chapter. In conclusion, the sugarcane industry is predicted to make even important contributions to meet India's energy needs by supplying renewable, clean, nontoxic, and eco-friendly fuel.

6.7 Conclusion

India is second largest sugarcane grower, and one of the biggest producers of sugar and ethanol. However, most of the ethanol is consumed for applications in liquor and chemical industries. The surplus ethanol can hardly fulfill the present 5% blending demands of the nation. This blending level is obligatory and enforced in many of the states. Therefore, India is needing huge supplies of ethanol for meeting its blending goals, either through its major indigenous source, i.e., sugarcane, or by imports. The demands will be even higher once the blending program is enforced nationwide or if the blending ratio is inflated—as the government is already planning to enhance up to 20%. Sugarcane, being the main source of ethanol for the country, is playing significant role in this regard, and its position is expected to strengthen even more in the coming years.

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