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Report Highlights:

India's bio-fuel strategy continues to focus on use of non-food sources for production of bio-fuels: sugar molasses for production of ethanol for blending with gasoline, and non-edible oilseeds for production of bio-diesel for blending with petro-diesel. The government's current target of five percent blending of ethanol with petrol has been partially successful in years of surplus sugar production, but falters when sugar production declines. The commercial production of bio-diesel for blending with petro-diesel has been very small due to inadequate feed stocks.

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BIO-FUELS POLICY OVERVIEW

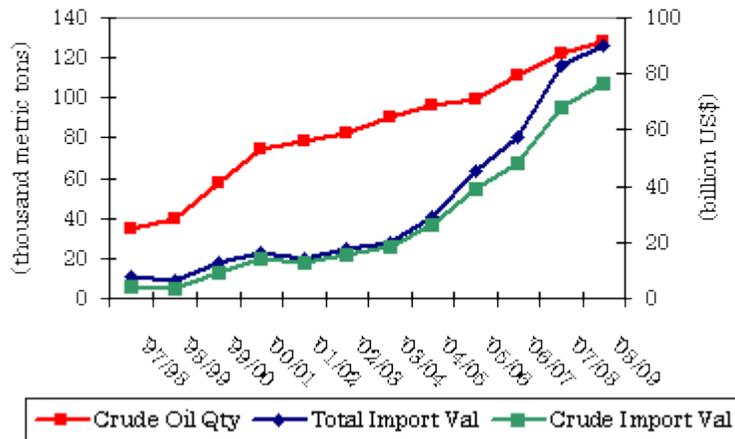
India's Bio-fuel Drivers

- The cornerstone of India's energy security strategy is to focus efforts toward energy self-reliance and developing renewable energy options like bio-fuels vis-à-vis fossil fuels.
- Adoption of environmentally friendly bio-fuels to meet improved vehicle emission norms.
- Developing an alternative usage for crops like sugarcane and its byproducts as feedstock for bio-fuels to support farm income.
- Improve utilization of wastelands and other unproductive land for cultivation of bio-fuel feed stock.
- Enhance rural employment and livelihood opportunities by promoting production and marketing of bio-fuel feed stocks

With a rapidly growing economy [1] and rising population [2] , India is the fifth largest and one of the fastest growing petroleum oil consumers in the world [3] . With limited domestic crude oil reserves, India meets over 72 percent of its crude oil and petroleum products (diesel, aviation fuel, etc.) requirement through imports. Energy demand in the transport sector is growing relatively high due to the growing economy and rising private vehicle ownership, particularly four-wheelers. Due to rising oil consumption and relatively flat domestic production, India is increasingly dependent on imports to meet its petroleum demand.

Fig 1: India's Import of Crude Oil & Petroleum Products

(Quantity in million metric tons & Value in billion US\$)



Source: Petroleum Planning and Analysis Cell, GOI

India's oil import expenditure has grown nearly three fold since 2004/05 due to high global oil prices and growth in domestic consumption of petroleum products, which is a serious concern to the Government of India (GOI). Consequently, the GOI is looking at ways to promote production and use of bio-fuels to contain rising oil imports and substitute fossil fuel for future energy use.

The current growth in transport activity is a significant environmental concern given the fact that India's carbon emissions are growing at an average of 3.2 percent per annum, making it

one of the top five global contributors to carbon emissions. The GOI transport policy targets Euro-III and Euro IV norms for vehicles, which will require clean quality fuel, thus necessitating the adoption of bio-fuels.

India is one of the world's leading producers of sugarcane and sugar. Sugar molasses [4], a byproduct of the sugar industry, is used for production of most of the rectified spirits (alcohol) produced in India, including ethanol for fuel. Due to the cyclical nature of sugarcane and sugar production in India, sugarcane farmers and the processing industry experience periodic market gluts of sugarcane, sugar and molasses production impacting prices and farm incomes. The GOI has been focusing on encouraging sugarcane juice/sugar molasses usage for ethanol production to bring stability in farm incomes.

Bio-diesel production efforts are focused on using non-edible oils from plants (*Jatropha curcas*, *Pongamia pinnata* and other tree borne oilseeds) and animal fats like fish oil. The focus is to encourage the use of wastelands and other unproductive land for the cultivation of these relatively hardy 'new' bio-fuel crops. The GOI does not want bio-fuel feedstock crop cultivation to compete with food crops for scarce agricultural land and water. An estimated 55.3 million hectares are considered wasteland [5] in India, which could be brought into productive use by raising bio-diesel crops. The GOI policy is also driven by the fact that bio-fuel crop cultivation in wastelands would provide additional employment to the vast rural population in India. There is some question as to the definition of 'wastelands' as some grazing or less intensive dry land farming may be taking place on these 'wastelands'. Nevertheless, bio-diesel production from non-edible oilseeds, etc. is still in the research and development stage in India.

Food vs. Fuel

Food security is a national priority for India due to its one billion plus population (about one-fourth are below the poverty line), rising domestic demand for food, stagnating agricultural productivity, and limited scope for expansion in area under crop cultivation. Consequently, the GOI can not afford to allow/promote the use of food feedstock for bio-fuel - cereal grains for ethanol production or edible oils for bio-diesel production - as is done in other bio-fuel producing countries. India is one of the leading importers of vegetable oil in the world as growing demand from Indian consumers outstrips domestic production. Furthermore, production of grains like wheat, corn and coarse cereals has been growing slowly in recent years raising concerns about potential scarcity. High global prices for food has been a major concern for the government, which does not want to further aggravate the crisis by promoting the use of food commodities for bio-fuels.

In summary, India's strategy for promoting bio-fuels is two pronged:

- Promote the use of ethanol derived from sugar byproducts of molasses/juice for blending with gasoline.
- Promote the use of biodiesel derived from non-edible oils and oil waste for blending with diesel

Ethanol Policy

The commercial production and marketing of ethanol-blended gasoline started in January 2003, when the Ministry of Petroleum and Natural Gas launched the first phase of the ethanol blended petrol (EBP) program that mandated blending of five percent ethanol in gasoline in nine states (out of a total of 29) and four union territories (UT) (out of a total of 6). The program was implemented only partially as ethanol was not consistently available from the sugar industry for petroleum companies [6] due to a decline in sugarcane/sugar production in sugar marketing years 2003/04 and 2004/05. Ethanol supplies available to oil companies came to a virtual halt by September 2004.

The strong recovery in sugar and molasses production during Indian sugar marketing year (MY) 2005/06 (October/September) resulted in a renewed interest in the ethanol program. In August 2005, the government completed an agreement between the sugar industry and petroleum companies to enable the purchase of ethanol, and the ethanol program restarted in a limited number of designated states and union territories. With a strong resurgence in sugarcane/sugar production in MY 2006/07, the GOI announced the second phase of the EBP program in September 2006 that mandated five percent blending of ethanol with petrol (gasoline) subject to commercial viability in 20 states and eight Union territories. In late September 2006, the petroleum companies floated open tenders for procurement of over 1.8 billion liters of ethanol from domestic producers over a period of three years. After a series of negotiations with domestic producers, the petroleum companies contracted for over 1.4 billion liters of ethanol for the EBP program at Rs. 21.50 per liter over a period of three years starting in November 2006.

The implementation of the EBP in many states was delayed as petroleum companies and ethanol suppliers negotiated with state governments over high state taxes, excise duties, and levies, which made the ethanol supply for blending commercially unviable in several states. While the ethanol supply for the EBP program gathered momentum towards the end of MY 2006/07, lower than anticipated sugar production during MY 2007/08, and the consequent short supply of sugar molasses, led to a slowdown in ethanol supplies for the EBP program in most states. High molasses prices made the supply of ethanol at the negotiated prices economically unviable to most suppliers. Industry sources report that ethanol supplies for the EBP program have come to a virtual halt in most states since October 2008. Industry sources estimate that only about 540 million liters of ethanol have been supplied for the EBP program by the end of April 2009, during the first two and a half years of the 3-year contract period.

The GOI had initially planned to launch the third stage of the EBP from October 1, 2008, wherein (i) the ethanol blend ratio was to be raised from 5 percent to ten percent and (ii) 5 percent blending was to be made mandatory across the country in all states. However, due to the short supply of sugarcane and sugar molasses in MY 2008/09 and forecast short supplies in MY 2009/10, the government has deferred the proposed implementation of the third phase of the EBP. Currently, the government does not allow use of imported ethanol for the EBP program as the focus is on developing domestic production capacities.

Efforts to produce ethanol from other feed stocks like sweet sorghum, sugar beet, sweet potatoes, etc. are at an experimental stage in India. The government supports research for identifying sweet sorghum cultivars suitable for semi-arid wasteland that can be used for ethanol production. Some public and private sector research organizations have also initiated research into the utilization of second generation biofuel feed stocks like crop cellulose waste for the production of ethanol.

The government does not provide any direct financial assistance or tax incentive for the production or marketing of ethanol or ethanol-blended petrol. However, the GOI offers subsidized loans (2 percent below market rate) from the government-held Sugarcane Development Fund for up to a maximum of 40 percent of the project cost to sugar mills for setting up an ethanol production unit. The government does research and development of ethanol production undertaken by both public and private sector organizations.

Bio-diesel Policy

In April 2003, the GOI launched a National Mission on Bio-diesel that identified *Jatropha curcas* as the most suitable tree-borne oilseed for the production of bio-diesel [7] , and focused on promoting plantations of *Jatropha* on "wastelands". The GOI's Planning Commission set an ambitious target of 11.2-13.4 million hectares to be planted with *Jatropha* by 2012, in order to produce sufficient bio-diesel to blend at 20 percent with petro-diesel.

The Ministry of Rural Development was designated as the nodal ministry for the Mission that will launch the demonstration phase wherein 400,000 hectares area will be brought under *Jatropha* planting over a five-year period (2003-2008). The demonstration phase will involve identifying suitable *Jatropha* cultivars, developing nurseries and providing subsidized planting material to farmers in various agro-climatic regions. Several state governments and official entities have been proactive in the adoption of the bio-diesel program, but with varying degrees of success. Besides the state governments, the Indian Railways, a government owned entity, has launched an ambitious *Jatropha* plantation project on railway land adjoining railway tracks. The demonstration phase will be followed by a self-sustaining expansion of *Jatropha* cultivation on 11.2-13.4 million hectares. Several government, international and private research organizations are involved in research and development of *Jatropha* – collecting and identifying elite germplasm; evaluation trials for growth, seed yields and oil content;

hybridization; developing location specific agronomic practices; and farmers training.

In October 2005, the Ministry of Petroleum and Natural Gas announced a "bio-diesel purchase policy," in which oil companies would purchase bio-diesel and blend it with high-speed diesel (HSD) at a five percent blending ratio. This was to take place in 20 procurement centers spread across major producing areas in the country, effective January 2006. The bio-diesel was to be procured at a pre-determined price (reviewed every six months by the ministry), which currently is Rs. 26.5 (55 U.S. cents) per liter. Market sources report that the cost of production of bio-diesel is 20 to 50 percent higher than this purchase price, resulting in no sales of bio-diesel at these centers.

The government does not provide any direct financial assistance for the production of bio-diesel or for investment in plants and necessary facilities. Although the central government has exempted bio-diesel from the central excise tax (4 percent) and some state governments provide excise tax exemptions, most state governments do not provide any sales tax exemptions for bio-diesel or bio-diesel blended diesel. However, the central government and several state governments provide fiscal incentives for supporting planting of Jatropha and other non-edible oilseeds.

Ministries Involved in the Bio-fuels Sector

India has been pursuing a two-fold strategy for promotion of bio-fuels by: a) providing budgetary support for research, development and demonstration of technologies; and b) promoting private investment through fiscal incentives. Several ministries are involved in policymaking, regulation, promotion, and development of the bio-fuels sector in India.

Ministry	Role
Ministry of New and Renewable Energy	Overall policymaking role for promoting development of bio-fuels. Also support research and technology development for production of bio-fuels.
Ministry of Petroleum and Natural Gas	Responsible for marketing bio-fuels as well as development and implementation of pricing and procurement policy
Ministry of Agriculture	Research and development for production of bio-fuel feedstock crops (sugarcane/sweet sorghum, etc. for ethanol; and Jatropha and other non-edible oilseed species for bio-diesel)
Ministry of Rural Development	Responsible for promotion of Jatropha plantations on wastelands
Ministry of Science and Technology	Supports research in bio-fuels crops, especially in the area of biotechnology

In addition, various state governments [8] have drafted policies and set up institutions for promoting bio-fuels in their respective states. Several states have also formed rules for allocation of wastelands to various entities for the plantation of biodiesel feedstock crops.

New Bio-fuel Policy Still On Its Way

A draft National Bio-fuel Policy formulated by the Ministry of New and Renewable Energy had been approved by the Cabinet Committee in September 2008, but has not been formally announced. The proposed Bio-fuel Policy outlines the approach, strategy, targets, fiscal and financial incentives of various aspects of bio-fuel research, development, purchase policy, capacity building and legislation for encouraging the use of bio-fuels.

Key features of the proposed new policy are:

- An indicative target of 20 percent blending of petrol and diesel with bio-fuels by 2017.
- Promote biodiesel production from non-edible oilseeds in waste/degraded/marginal lands.
- Discourage plantations in fertile, irrigated premium farm land.
- Focus on domestic production of bio-diesel feed stock and not permit imports.
- Recommend minimum support prices for bio-fuel crops like Jatropha and other non-edible oilseeds with provisions of periodic revisions.
- Recommend a minimum purchase price for the purchase of ethanol based on the cost of production and import price. The biodiesel price will be based on the prevailing price of diesel.
- Take steps to ensure unrestricted movement of bio-fuels within and outside states.
- Removal of taxes and duties on bio-diesel.
- Set up of an inter-ministerial National Bio-fuel Coordination Committee under the Chairmanship of the Prime Minister and a Bio-fuel Steering Committee under the Chairmanship of the Cabinet Secretary for high level coordination and policy guidance or review on various aspects of bio-fuels development in India.

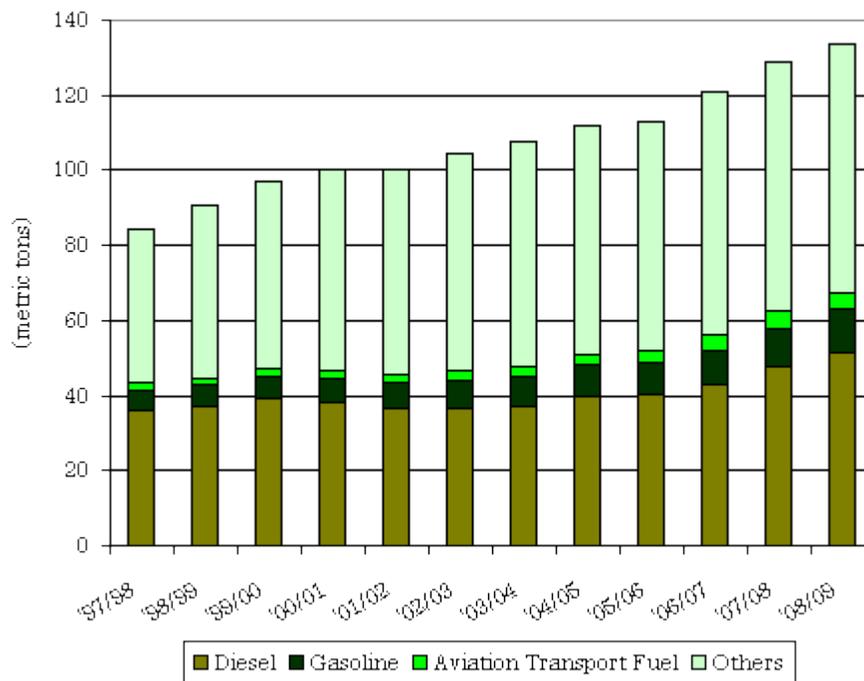
Industry sources expect that the Bio-fuel Policy may be once again reviewed by the new government in the light of international crude oil price movement and limited domestic supplies of bio-fuel. The National Bio-fuel Policy would further require approval by the new Parliament, which may take some time.

BIO-FUEL MARKET CONDITIONS

Motor Vehicle Petroleum Based Energy Market

India's petroleum-based energy demand by the transport sector is the fastest growing energy consuming sector and will continue to grow steadily in the coming years due to strong growth in the economy, rise in income levels, and an increase in the availability and choice of vehicles. Petroleum product consumption has gone up from 100 million tons in Indian fiscal year (IFY) 2001/02 (April/March) to 134 million tons in IFY 2008/09 [9] . Energy demand by the transport sector is expected to grow by 6-8 percent per year during the 11th five-year plan (2007-2012). Diesel and gasoline (petrol) contribute 98 percent of the energy consumed in the transport sector.

Fig 2: India's Consumption of Petroleum Products
(Quantity in million metric tons)

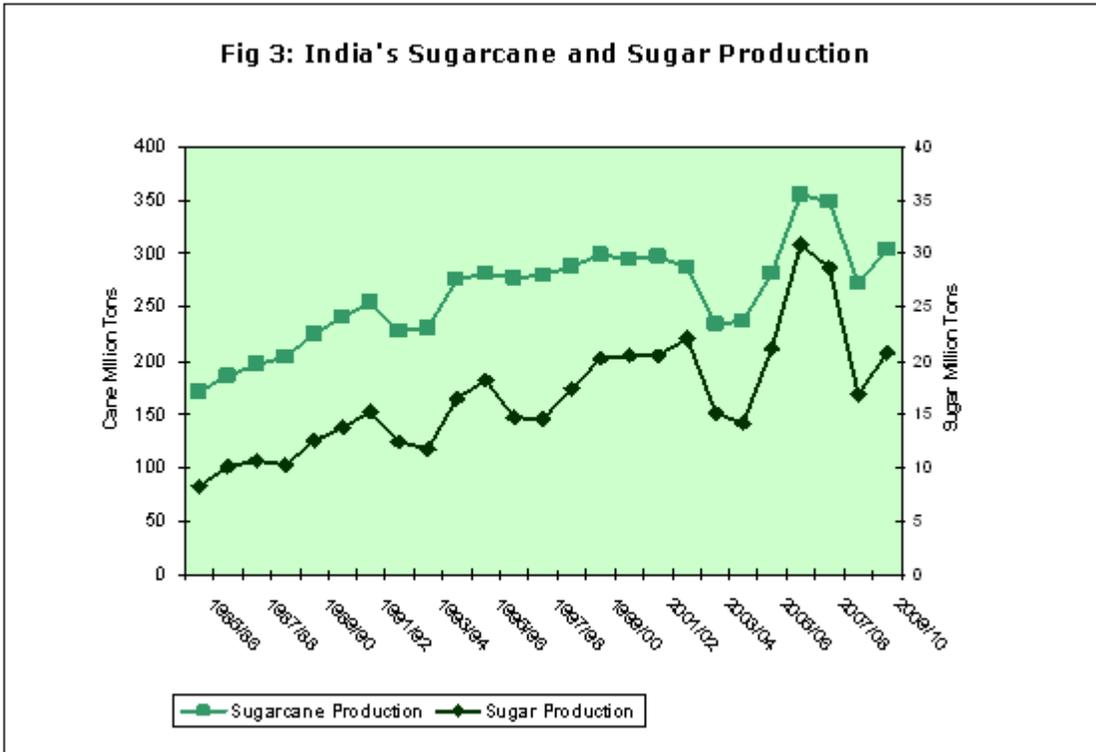


Over 80 percent of passengers and about 60 percent of freight are transported by road in India. With the growth in the economy and the rise in personal incomes there is increasing dependence on personal modes of transport such as cars and two wheelers. Industry sources report that the total number of vehicles has increased more than five fold, from 21.3 million (including 14.2 million 2-wheelers) in 1991 to 109 million in 2008 [10] . The motor vehicle population grew by 10-12 percent in the last few years, and is expected to continue to grow around 8-10 percent in the next few years.

Can India Meet Policy Targets?

Ethanol Policy

Industry sources report that the EBP is not sustainable as the ethanol supply hinges on sugarcane and sugar production. Sugarcane and sugar production in India typically follows a 6 to 8 year cycle, wherein 3 to 4 years of higher production are followed by 2 to 3 years of lower production (refer to Indian Sugar Annual Report IN9049 for more details). The Indian sugar industry crushes about 70-80 percent of the sugarcane for sugar production, with the remaining cane used for local sweeteners (*khandsari* and *gur*), seed, feed and cane juice, chewing and waste. The byproduct of the sugar industry, sugar molasses, is used for production of alcohol and ethanol.



Since sugarcane and sugar production is cyclical, availability of sugar molasses and sugarcane juice for ethanol production varies depending on the sugarcane cycle. Lower sugar molasses availability and consequent higher molasses prices affect the cost of production of ethanol, thereby causing disruptions in the supply of ethanol for the EBP program at pre-negotiated fixed ethanol prices.

Table 1: India's Ethanol Requirement for 5 Percent Blending with Gasoline in Sugar Marketing Year (October-September)

(All units in million liters unless mentioned otherwise)

Item \ Year	2006/07	2007/08	2008/09
Sugar Production ¹ (Million Tons)	28.40	26.40	15.30
Molasses Production (Million Tons)	13.31	11.31	6.88
Potential Alcohol Production	3,195	2,700	1,650
Demand			
Industrial Use, Potable Liquor and Other Use	1,550	1,660	1,680
I: Ethanol for 5 Percent Blending	600	650	700
I: Total Demand (5% EBP)	2,150	2,310	2,380
I: Surplus/Shortfall	+1,045	+390	-730
II: Ethanol for 10 Percent blend with Gasoline	1,200	1,300	1,400
II: Total Demand (10% EBP)	2,750	2,960	3,080
II: Surplus/Shortfall	+445	-260	-1,430

Note /1: Mill Sugar Production in Crystal Weight Basis.

Source: FAS/New Delhi estimates based on information from trade sources

Unless the government initiates sugarcane production stabilizing measures or petroleum companies agree to link ethanol prices with raw material prices, the EBP will be successful only during excess sugar production seasons.

The proposed third phase of the EBP (10 percent blend ratio) will require additional area to be brought under sugarcane and the sugar industry to install facilities for ethanol production directly from sugarcane juice. However, there is a very limited scope for an increase in area under a 'water guzzling' crop like sugarcane as irrigation water availability is increasingly becoming a constraint in the Indian agriculture production system.

India has about 320 distilleries, with a production capacity of about 3.5 billion liters of rectified spirits (alcohol) per year, almost all of which is produced from sugar molasses [11] , and not from sugar juice, food grains or other cellulose feed stocks. More than 115 distilleries modified their distillation facilities to produce ethanol with total ethanol production capacity of 1.5 billion liters per year. Current ethanol production capacity is enough to meet the estimated ethanol demand for the five percent blending ratio with gasoline. However, for a ten percent EBP program, current ethanol production capacity have to be expanded by increasing the number of molasses-based ethanol plants, and by setting up sugarcane juice-based ethanol production units.

Bio-diesel Policy

Commercial production and marketing of bio-diesel in India is negligible due to the lack of availability of *Jatropha* seed and other non-edible oil feedstock. Most existing bio-diesel producers are using mixed feed stocks including non-edible oilseeds, non-edible oil waste, animal/fish fats/tallow as feed stocks. Although India's bio-diesel processing capacity is currently estimated at 200,000 metric tons per year, the majority of bio-diesel units are not operational during most of the year. Industry sources expect the bio-diesel blending program to gather momentum in the next 4-5 years, with expected improved availability of *Jatropha* seeds as more areas are brought under plantation and as the plantations mature.

The existing *Jatropha* plantations are at the very initial stage of development. The total *Jatropha* plantation area in the country is currently estimated at around 450,000 hectares, of which about 60-70 percent are new plantations (1-3 years old) and not yet into full production. The new *Jatropha* plantations are expected to come into maturity in the next 3-4 years.

There are growing concerns about the prospects of *Jatropha* plantations based on the Planning

Commission estimates of the seed density/yield/oil [12] needed to produce an economical yield. Although *Jatropha* plants can survive in wastelands/degraded lands, the fruiting and seed yield of the plant is highly dependent on availability of water (rain or irrigation) during critical stages. Consequently, there are insufficient *Jatropha* seeds to crush for bio-diesel production units for sale to petroleum companies for blending purposes.

Government and industry sources have been overly optimistic about *Jatropha* plantation prospects with estimates for expected area being projected from 7.0 million hectares to 11.2 million hectares. India's non-edible oilseed *Jatropha* based biodiesel production policy is facing following constraints –

- Lack of good quality planting material and management practices leading to poor seed yields (vary from 0.5 to 1 kg per plant per annum).
- Research on developing quality seeds and agronomic practices is still at a very nascent stage.
- Ownership issues with community or government-owned wastelands. While government records may identify wastelands and marginal lands, most of these government and community owned lands are under some kind of economic activity and/or temporary ownerships, and not available for *Jatropha* plantation.
- Lack of bank financing for *Jatropha* plantations, which is discouraging growers from undertaking plantation activities since the crop has a long gestation period (2-3 years) compared to annual crops.
- Lack of marketing and pricing support for *Jatropha* or other non-edible oilseeds growers.
- *Jatropha* plants face severe insect, microbial and fungal pest problems.
- Monoculture practices which raise environmental concerns about the impact on soil health and the water table.

While there may be sufficient scope for expanding area under *Jatropha* and other bio-fuel feed stocks, considerable research is still required to identify appropriate germplasm and seed varieties for agro-climatic conditions in different regions of the country. The government will also have to offer fiscal incentives to growers to encourage them to follow appropriate agronomic practices during the initial two to three years of plantation development.

Current Production Scenario

Ethanol Production

The ethanol supply for the EBP program during MY 2008/09 has been severely impacted by the short supply of sugar molasses and continued strong demand for alcohol from other competing industries. Consequently, ethanol for blending with petrol in Indian sugar marketing year 2008/09 (October/September) is estimated at 100 million liters, against the target of 600

million liters. With market prices of alcohol ranging between Rs. 26 to Rs. 30 per liter since October 2008, most ethanol suppliers preferred diverting their supplies to the potable liquor and chemical industries instead of supplying ethanol at the current price of Rs. 21.50 per liter for the EBP program.

Despite the forecast improvement in the sugarcane and sugar production in MY 2009/10, a sharp drawdown in carryover stocks and expected strong demand from the chemical and potable liquor industry will constrain alcohol supplies. Consequently, supply of ethanol for fuel is forecast lower at 50 million liters. However, ethanol supplies to the EBP program may improve if petroleum companies agree to a major hike in the procurement price from the current negotiated price.

Table 2: India's Production & Distribution of Molasses and Alcohol/Ethanol in Sugar Marketing Year (October/September)

(All units in Million Liters unless mentioned otherwise)

Item \ Year	2006/07	2007/08	2008/09	2009/10 (F)
Total Molasses Production (Million tons)	13.11	11.31	6.88	8.60
Molasses for:-				
Alcohol Production (Million tons)	9.50	7.90	4.30	5.90
Animal Feed & Other Uses (Million tons)	3.61	3.41	2.58	2.70
Total Alcohol Production	2,280	1,890	1,032	1,420
Opening Stocks	700	1,269	1,254	706
Imports	39	5	200	200
Total Supply	3,019	3,164	2,486	2,326
Alcohol Use for :-				
Industrial Use	650	700	700	720
Potable Liquor	800	850	880	950
Ethanol for Blended Gasoline	200	280	100	50
Other Use)	100	110	100	110
Carryover Stock of alcohol	1,269	1,254	706	496
Total Distribution	3,019	3,194	2,486	2,326

Source: FAS/New Delhi Estimates based on information from Trade Sources

The progress of the second phase of the EBP has been slow as ethanol usage is subject to commercial viability. Besides irregular molasses availability, a plethora of high taxes and levies has adversely impacted ethanol blending in several states, particularly sugar/alcohol deficit states. Most states have a labyrinth of rules and regulations (inter-state movement, high excise duties, storage charges, etc.) to control alcohol for the potable liquor industry, and these regulations are equally applicable to ethanol for blending purposes. The GOI is actively engaged in working with state governments to resolve the underlying issues constraining adoption of the EBP program in other states.

The current shortage in supplies of ethanol has been due to high prices of sugar molasses which makes it unviable to supply ethanol to petroleum companies at the negotiated prices [13] . The sugar industry continues to pressure the government to ask the petroleum companies to raise the negotiated sales price, while the petroleum companies have opposed increases in ethanol prices, especially given that crude oil prices have eased since mid-2008.

In years of bumper sugarcane production, the sugar industry may prefer to produce ethanol directly from sugarcane juice to avoid the sugar market glut and declining prices. There is considerable scope for increasing sugarcane yields from the existing acreage, which can also offer additional sugarcane for production of ethanol directly from juice. There is limited scope to increase area under sugarcane as the crop is water intensive and India's irrigation water supplies are increasingly limited.

Since the production of ethanol directly from sugarcane juice requires additional investments for technological modifications, most mills are closely assessing the market demand for ethanol and the efficacy of the government's ethanol policy before making the necessary investments. Industry reports suggest that a petroleum marketing company has acquired two sugar mills for production of ethanol from sugarcane juice on an experimental basis, and with commercial production expected in MY 2009/10. There are currently no foreign players in the Indian sugar industry, as it is one of the most controlled agribusiness-sectors in the country (see policy section of Sugar Annual IN9049). However, the increased consumption of ethanol by oil companies, and the production of ethanol from sugarcane juice by local companies may attract foreign investment in the future.

Bio-Diesel Production

India's commercial production of bio-diesel is very small and what is produced is mostly sold for experimental projects and to the unorganized rural sector. While the government discourages the use of edible vegetable oil for production of bio-diesel, it is also not economically feasible to produce bio-diesel from vegetable oils due to high edible oil prices in the domestic market [14] . The small quantities of *Jatropha* and other non-edible oilseeds procured by traders are mostly crushed for oil, which is used for lighting lamps and other non-edible uses.

Several entrepreneurs have established small plants (less than one ton per day) to extract bio-diesel, but the product is mostly sold in the unorganized sector mainly for operating irrigation pumps and other agricultural uses. There are about 20 large capacity plants (one to fifty tons per day) that produce bio-diesel from edible oil waste (unusable oil fractions), animal fat and non-edible oil. Automobile and transport companies mostly buy bio-diesel for R&D trials on

their vehicles. Indian Railways and other state-owned transport companies have set up experimental projects for bio-diesel production. Reliable production information on Indian bio-diesel is not available as commercial production is yet to take off in an organized manner, with estimates ranging anywhere between 100 to 200 million liters per year.

Most *Jatropha* plantations are far from bio-diesel producing units, and lack of efficient marketing channels result in high inefficiencies leading to high production costs. Industry sources estimate current bio-diesel finished production costs at anywhere between Rs. 32 to 40 (67 cents to 83 cents) per liter, much above the government advised purchase price of Rs. 26.5 (55 cents) per liter. Consequently, there has been no commercial sale of bio-diesel at the GOI's bio-diesel purchase centers. Some of the state transport agencies and Railways procure biodiesel for experimental trials of their vehicles.

Many Indian corporations, including petroleum marketing companies, are venturing into bio-diesel production by having a memorandum of understanding with state governments to establish *Jatropha* plantations on government wasteland or contract farming with small and medium farmers. Several state governments have announced policies to encourage *Jatropha* cultivation, setting up bio-diesel plants and supply chains in their respective states.

Although the nascent bio-diesel industry has been lobbying the government to allow duty concessions on imports of vegetable oils (palm, soybean, etc.) and their derivatives to captive consumption for bio-fuel production at their units, there are no positive indications for approval of such proposals. Some local and foreign collaborative projects for production of bio-diesel for exports are being set up near the ports as export-oriented-units [15] that could boost the country's bio-diesel production capacity to 1.0 to 2.0 million tons per annum in the next few years.

There is no commercial production of bio-fuels from other biomass, except for some experimental trials by research organizations.

Bio-fuel Import Regime

Although there are no quantitative or SPS restrictions on imports of bio-fuels, high duties on tariff lines associated with bio-fuels (see below) make imports economically unviable. The GOI does not provide any financial assistance for exports of bio-fuels, both ethanol and biodiesel.

Given that the GOI's focus is on developing domestic bio-fuel production capabilities; there are no duty concessions for imports of bio-fuels or imports of feedstock (maize, oilseed, and vegetable oils such as palm oil etc) for the production of bio-fuels for the domestic market. Although some oil companies are pushing for imports of bio-ethanol at a concessional duty for blending with petrol/diesel, it is highly unlikely to receive government approval. However,

current trade regulations allows duty free imports of bio-fuel feed stocks for re-export by certified export oriented units.

Table 3: India's existing import duty on tariff lines associated with bio-fuels
(Percent ad valorem on CIF value)

ITC HS Tariff Number	Total Import Duty
2207.20 Denatured Ethyl alcohol & Spirits (including Ethanol)	28.64%
3824.90 Chemical products not elsewhere specified (including Biodiesel)	28.64%

Bio-fuel Trade

India does not import ethanol or other bio-fuels for fuel purposes. During years of low sugar production, and consequent molasses and alcohol shortages, India imports alcohol, mainly for industrial use and potable liquor production.

Market sources report that one of the recently commissioned bio-diesel export oriented units exported a few consignments of bio-diesel to the E.U. and the United States. However, relatively high international prices of vegetable oils and low biodiesel export prices due to softer crude oil prices have limited significant export opportunities.

IMPACT OF BIOFUEL FEEDSTOCK ON FOOD/FEED/TRADE

India does not produce any ethanol from cereal grains (maize, etc.), and thus, there has been no impact of the ethanol program on the domestic market for food, feed and trade of cereal grains and byproducts. Similarly, as the bio-diesel program is based on the use of non-edible vegetable oil, bio-diesel production should not have an impact on feed, food, and trade of oilseeds, vegetable oils and other edible products.

As the production of ethanol for fuel is basically from sugar molasses, it has not had a significant impact on the production, prices and trade of sugar for food and industrial use. Despite a decline in production of sugarcane/sugar, and consequently sugar molasses, higher prices of alcohol vis-avis fixed ethanol prices have limited fuel ethanol production. If ethanol prices are allowed to be linked to sugar molasses prices, it may impact the availability of sugar molasses for use in cattle feed, and the use of alcohol for industrial and potable liquor. When Stage III of the EBP program is implemented, it may also impact availability of sugarcane juice and sugar molasses for alternative uses.

BIO-ENERGY USE IN OTHER AREAS

Biomass-based fuels support over 80 percent of home energy use (mostly for cooking and heating) in India, and consist of agricultural byproducts (crop residues, cow dung, etc.) and gathered fuel wood. Biomass is also used as industrial fuel by small and cottage industries in the organized sector. Total biomass energy in the household sector and unorganized sector accounts for almost one-third of India's total primary energy consumption needs (540 to 550 million tons oil equivalent in 2006/07) [16] .

India launched a National Project on Biogas Development in 1981-82 with the objective of utilizing cattle manure and human waste for fuel for rural households along with manure for agricultural fields [17] . Currently, there are about 4.1 million family type biogas plants, against an estimated target of 12 million biogas plants in the country. However, evaluation studies show that less than half of the installed plants are operational.

Biomass resources like crop residues, agro-industrial waste, fuel wood, etc., are also used for generation of electricity through biomass gasification. Some industries (sugar, paper pulp, rice mills, etc) are using the industrial waste for cogeneration of electricity and heat energy to meet their total/partial requirement, and/or sale of excess power to distribution grids. Industrial co-generation did not receive a great deal of attention in the past as cheap electricity and fuel were abundantly available. With the increasing electricity costs and unreliable supplies of electricity from the public distribution grids, several industries are increasingly developing co-generation. Currently, most of the cogeneration activity is sugarcane bagasse based [18] . However, there is significant potential in breweries, distilleries, rice mills, textile mills, fertilizer plants, etc. for undertaking cogeneration.

The GOI has initiated several programs and schemes for promoting renewable energy sources including biomass based energy sources, details of which can be accessed from their website <http://mnes.nic.in/>

Table 4: India's Biomass-based Commercial Energy Potential/Achievement

S No:	Source/System	Estimated Potential	Achievement (By Jan 31, 2009)
1	Bio Power (Agric Residues & Plantations)	16,000 MW ¹	683.3 MW
2	Sugarcane bagasse based Cogeneration	3,500 MW	1033.7 MW
3	Non-bagasse based biomass co-generation ²	-	150.9 MW
4	Biomass Gasifier	-	160.3 MW
5	Energy Recovery from Waste	2,700	89.9 MW
6	Family Type Biogas Plants	12 million	4.1 million

Notes: /1 – Megawatt

/2 – Cogeneration by other agro-industries like rice mills, pulp, etc.

Source: Ministry of New and Renewable Energy, GOI.

- [1] The Indian economy has grown between 6-9 percent per annum in recent years.
- [2] India is the world's second largest populous nation – one billion plus people growing at 1.8 percent per annum.
- [3] US Energy Information Administration (<http://www.eia.doe.gov/emeu/cabs/India/Full.html>)
- [4] Sugar molasses is mostly used for alcohol production and animal feed purposes.
- [5] Mostly government or local community owned.
- [6] Most of the petroleum marketing companies are government parastatals.
- [7] *Jatropha* Curcas is a widely occurring species growing practically all over India under a variety of agro climatic conditions. The government proposed that *Jatropha* plantation can be taken up as a quick yielding plant even in adverse land situations viz. degraded and barren lands under forest and non-forest use, dry and drought prone areas, marginal lands, even on alkaline soils and as agro-forestry crops.
- [8] Major states are Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Rajasthan, West Bengal, Uttaranchal, etc (<http://www.pcra-biofuels.org/whois.htm>)
- [9] Source: Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, GOI
- [10] The share of two wheelers is estimated at 74%, passenger cars/vehicles at 13 percent and commercial vehicles at 13 percent.
- [11] There have been some experimental projects for production of alcohol from food grains coarse cereal), sugarcane juice and other cellulosic feedstock, but the production levels are negligible.
- [12] The 2003 Planning Commission estimates are based on *Jatropha* oil yield of 1.0 to 1.2 tons per hectare with the target parameters of 2500 plants per hectare (2mx2m); seed yield of 1.2-1.4 kg per plant; and oil realization of 35 percent from seeds. Recent field studies indicate optimal plant population of 1100 per hectare (3mx3m); seed yield of 0.5 to 1.0 kg per plant; and oil yield of 25-30 percent from the seeds.
- [13] Petroleum companies have agreed to buy fuel grade ethanol from sugar companies at Rs. 21.50 per liter. The cost of production of ethanol depends on the price of molasses, which has increased nearly three fold since the beginning of MY 2007/08. Consequently, sugar companies who had tendered for supply of ethanol to the petroleum companies are no longer able to supply at the negotiated prices.
- [14] Spot prices of various vegetable oil in Mumbai on June 1, 2009 were:- RBD Palmolein Rs. 40 per liter; Cottonseed Oil Rs. 45 per liter; Soyoil Rs. 46 per liter; Rapeseed Oil Rs. 47.5 per liter; and Peanut Oil Rs. 55.5 per liter. Thus vegetable oil prices ranged between Rs. 40 to Rs. 55.5 per liter against the government's bio-diesel price of Rs. 26.5 per liter.
- [15] Sources report that 2-3 large export oriented bio-diesel units are being set up near ports, wherein they will use imported feedstock (like crude degummed edible oils or oil waste) at zero duty for exports of bio-diesel to the United States and European Union.
- [16] Source: Planning Commission (GOI) report on "Integrated Energy Policy", August 2006.
- [17] Biogas has 50 to 70 percent methane gas that is used for cooking and lighting purpose.
- [18] Bagasse – crop waste after crushing of the sugarcane.