Chapter XVI: Tweaking national biofuel policy for promotion of sweet sorghum as alternate feedstock

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I. Introduction

Energy is a critical input for economic growth and sustainable development in both developed and developing countries. Globally, the energy requirement for the transportation sector is met from fossil fuels that are non-renewable and contribute to atmospheric pollution. However, the sharp rise in crude oil prices from US$20 a barrel in 2002 to almost US$100 (even touching $140 before stabilizing at around $80) forced nations to seriously look for alternative energy sources that are renewable and non-polluting. This trend of rising oil prices is expected to continue in the face of their shrinking supplies and rising demand. Secondly, growing concerns over human-induced climate change, as evidenced by rising temperatures and environmental pollution is further driving the impetus for non-polluting energy sources. One such source is seed ethanol from plant biomass/grain and biodiesel from processing edible and non-edible vegetable oils.

The mandatory blending has triggered a rapid growth in the biofuel sector in the last decade. By 2007-08, world biofuel production had touched 62.2 billion tons (t), of which around 88% was in the form of ethanol. The two largest ethanol producers, Brazil and the United States, account for almost 87% of its total production. Biodiesel production that accounts for a smaller proportion of liquid biofuels increased from 0.01 million t in 1991 to 9.0 million t by 2008. The European Union (EU) produces over 60% of the global share with a significantly smaller contribution coming from USA (17%).

II. Energy demand in India

India's energy demand is primarily met through non-renewable energy sources such as coal, natural gas and oil that will continue to play a dominant role in the country's energy scenario in the next few decades. The highest

demand for energy comes from industry followed by transportation sector, which consumed about 16.9% (36.5 m of oil equivalent) of the total energy (217 million t) in 2005-06 (TERI 2007). Within the transportation sector, the consumption of motor spirit (gasoline) grew by 6.64%, from 7.01 million t in 2001-02 to 11.26 million t in 2008-09 and that of high speed diesel (HSD) by 4.1%, from 36.55 million t to 51.67 million t, respectively (GOI 2009). This growth will only escalate over the next several years since India's vehicular population is expected to grow by 10-12% per annum. Hence securing a long-term supply of energy sources and prioritizing development will ensure the country's future energy requirement. Currently, the country is looking for alternative energy options from biofuels to meet the energy demand for the transportation sector. To promote biofuels as an alternative energy source, Government of India stipulated mandatory blending requirements of gasoline with biofuels by 5-10% along with various other policy incentives. The policies are designed to facilitate and bring about optimal development and utilization of indigenous biomass feedstocks for biofuel production.

The policy chapter is organized as follows. Section III and IV present the biofuel policy in India since late 1940s and outline the salient features of the National Policy on Biofuels of India, 2009. Section V and VI describe the challenges and distortions affecting the biofuels development. Sections VII and VIII discuss sweet sorghum as a potential feedstock to augment ethanol production to meet blending targets and the possibilities of tweaking policies to support ethanol production from sweet sorghum. This is followed by Section IX which concludes with recommendations.

III. Biofuel policy in India

In 1948, the Power Alcohol Act heralded India's recognition of blending petrol with ethanol. The main objective was to utilize ethanol from molasses to blend with petrol with the aim of bringing down the price of sugar, trim wastage of molasses and reduce dependence on petrol imports. Subsequently, the Act was repealed in 2000, and in January 2003, the Government of India launched the Ethanol Blended Petrol Programme (EBPP) in nine States and four Union Territories promoting the use of ethanol for blending with gasoline and the use of biodiesel derived from non-edible oils for blending with diesel (5% blending). In April 2003, the National Mission on Biodiesel launched by the Government of India identified Jatropha curcas as the most suitable tree-borne oilseed for biodiesel production.

Due to shortage in ethanol production[1] during 2004-05, the blending mandate was made optional in October 2004, and resumed in October 2006 in 20 States and 7 Union territories in the second phase of EBPP. These ad-hoc policy changes continued until 2009 when the Government of India came out with a comprehensive biofuel policy. This comprehensive National Policy on Biofuels was formulated by the Ministry of New and Renewable Energy (MNRE) and cleared by the Government of India in December 2009, calling for blending at least 20% biofuels with diesel and petrol by 2017.

1. Salient features

- An indicative target of 20% blending of biofuels both for biodiesel and bioethanol by 2017.
- Biodiesel production to be encouraged from non-edible oilseeds on waste, degraded and marginal lands.
- A Minimum Support Price (MSP) to be announced for farmers producing non-edible oilseeds used to produce biodiesel.
- Financial incentives for new and second generation biofuels, including a National Biofuel Fund.
- Biodiesel and bioethanol likely to be brought under the ambit of 'declared goods' by the Government to ensure the unrestricted movement of biofuels within and outside the states.
- Setting up a National Biofuel Coordination Committee under the Prime Minister for a broader policy perspective.
- Setting up a Biofuel Steering Committee under the Cabinet Secretary to oversee policy implementation.
- Several ministries are currently involved in the promotion, developing and policy making for the biofuel sector.
- The Ministry of New and Renewable Energy (MNRE) is the overall policymaker, promoting the development of biofuels and research and technology development for its production.
- The Ministry of Petroleum and Natural Gas has the responsibility of marketing biofuels, and developing and implementing a pricing and procurement policy.

[1] Shortage in ethanol production was mainly caused by a shortage in molasses production which was in turn driven by shortages in cane production.

- The Ministry of Agriculture's role is that of promoting research and development for the production of biofuel feedstock crops.
- The Ministry of Rural Development is specially tasked to do the promotion, especially of Jatropha plantations in wastelands.
- The Ministry of Science & Technology supports research in biofuel crops, specifically in the area of biotechnology.

In view of the multiple departments and agencies involved, a National Biofuel Coordination Committee (NBCC) headed by the Prime Minister has been set up to provide high-level co-ordination and policy guidance/review on different aspects of biofuel development, promotion and utilization.

IV. Policy challenges affecting biofuel development

Biofuel policies have important implications for the development of the energy sector. The profitability of biofuel production is significantly influenced by biofuel policies affecting multiple sectors which include agriculture, research, industry and trade.

For example, subsidies can affect the sector at different stages (Steenblik 2007). The various points in the biofuel supply chain where direct and indirect policy measures can support the sector are interrelated, and assigning policies to one category or another may be somewhat artificial in practice (FAO 2008).

The distortions of the biofuel policy of India at various stages of the biofuel supply chain in production, commercialization and sustenance in promotion of biofuel sector are discussed below.

1. Blending mandates

Imposing quantitative targets in the form of blending mandates is the key driver in the development and growth of the biofuel industry. The blending mandate of 5% ethanol with gasoline in 9 states of India in 2003 was enhanced to include 20 states in 2006. In 2010, the National Policy on Biofuels (NPB) approved a target 20% blending with biofuels (both biodiesel and bioethanol) by 2017.

In India, the main raw material for ethanol production is molasses, a by-product derived during sugar production. Supply of sugarcane and the production of molasses are dependent on sugar cycles. During 2006 and 2007, due to excess supply of cane and molasses, prices were depressed. The mandated blending targets were probably based on the surplus ethanol available during a good sugarcane production year. The price of molasses has been fluctuating considerably over the years from Rs 50 t^{-1} to Rs 6000 t^{-1} (US $1.1 to $133.3[2]) between 2003-2008. Additionally, there is competition from the potable and chemical industries for the alcohol from molasses. During a normal year, cane converted into sugar generates enough molasses to produce alcohol that can meet the needs of potable and chemical sectors (30-40% each) with another 20-30% surplus alcohol available for conversion into ethanol and related products. During 2009, the total supply of ethanol was 2.4 million tons that was sufficient to meet total demanded of 1.80 million tons from all three sectors (@5% blending target for ethanol). Despite this, the ethanol blending target could not be met due to inability of the OMCs to procure the required amount of fuel ethanol at prevailing market prices that are lower than alcohol prices for different uses. Another estimate by the Indian Chemical Council finds that even at 5% blending there would be a deficit of 1140 million liters in 2010-11 which would grow to 2400 million liters by 2014-15 assuming constant production of molasses and alcohol (Table 1). A study by Shijoj et al. (2011) finds that as per the 20% blending target set by the government by 2016–17, the fuel ethanol demand would be 1.93 million tons and total demand (ethanol + alcohol) would be as high as 3.52 million tons.

Table 1. Projected demand and supply of alcohol in India (Million leters).

Alcohol requirement (million liters)	2010-11	2011-12	2012-13	2013-14	2014-15
Potable sector	1450	1550	1660	1780	1900
Industrial sector	1050	1100	1160	1210	1280
5 % blending	1040	1090	1150	1200	1260
Total alcohol required	3540	3740	3970	4190	4440
Highest expected alcohol availability (million liters)	2400	2400	2400	2400	2400
Deficit (million liters)	(1140)	(1340)	(1570)	(1790)	(2040)

Source: Indian Chemical Council, 2010

Note: On the basis of past trends, the growth rates are assumed to be 5% for the industrial sector, 7% for the potable sector and 5% for blending.

[2] One USD = Rs 45.

2. Input support (subsidies)

The justification for providing policy support to any new sector is based on its ability to overcome the initial costs of technological innovation and market development required to make the sector competitive. This is the 'infant industry' argument for providing subsidies.

Most inputs like fertilizer, pesticides and electricity to pump irrigation water for crop production are subsidized in India. The quantum of subsidy for a crop varies based on the inputs utilized for its production. Currently, molasses, a by-product of sugarcane is the chief raw material for ethanol production. The inputs utilized in cane production are highly subsidized through seed subsidy, purchase of implements and tools and electricity to pump irrigation water apart from fertilizer and pesticides subsidy. The subsidies provided for cane production indirectly accrue to molasses used in production of ethanol.

3. Output support

Besides production support, output support for the purchase of biofuels is also critical. The National Biofuels Policy proposes a Minimum Support Price (MSP) mechanism for Jatropha whose seed is used to produce biodiesel. For sugarcane, the existing statutory minimum price provides effective protection to growers. In the case of biodiesel, the policy proposes that the Minimum Purchase Price (MPP) be delinked to the prevailing retail price of diesel while for bioethanol it is based on the actual cost of production and import price of bioethanol.

4. Processing, distribution and marketing support

OMCs in twenty states and four Union Territories have been assigned the task of blending 5% ethanol with gasoline. The sugar industry has been permitted to produce and process ethanol from sugarcane juice to augment production to meet blending requirements. Other than molasses and sugarcane, the policy does not specify in concrete terms processing of alternative feedstocks for bioethanol. Alternative feedstocks like sweet sorghum and sugar beet are mentioned in the policy but there is no concrete road map suggested for their promotion.

OMCs have been responsible for the storage, distribution and marketing of biofuels in India. India's biofuel policy exempts the biofuel sector from central taxes and duties. While biodiesel is exempt from excise duty, bioethanol enjoys a concessional excise duty of 16%. Custom and excise duty concessions are also provided on plant and machinery for the production of biodiesel and bioethanol. While these policies do promote the biofuel sector, those promoting production of feedstock to fully realize the benefits provided on the processing front need to be looked at, since production and processing are interdependent. Though the policy mentions about exemption of central taxes and duties on biofuels, various forms of taxes like sales tax, license fee, permit fee and import taxes still exist hindering the growth and development of the biofuel industry. The policy provides no additional incentives for blenders and retailers of biofuel unlike in several other countries.

5. Financial and fiscal incentives

Apex financial institutions like the National Bank for Agriculture and Rural Development (NABARD), Indian Renewable Energy Development Agency (IREDA), and Small Scale Industries Development of India (SIDBI) have refinancing provisions to set up biodiesel plantations, oil expelling/extraction units, and infrastructure for storage and distribution. The lending towards these sectors would be classified as priority sector lending. The policy states consideration of subsidies and grants upon merit for new and second generation feedstocks; advanced technologies and conversion processes; and production units based on new and second generation feedstocks. Similar emphasis is not explicitly mentioned for bioethanol.

6. Consumption support

The biofuel policy's thrust is primarily on the supply side even though demand side factors also play a major role in promoting biofuels. For example, many countries actively promote flex-fuel vehicles designed to use a higher percentage blend of ethanol with petrol than ordinary vehicles through reduced registration fees and road tax exemptions. Similarly, support is provided for the purchase of biofuels, co-products and flex-fuel vehicles.

Under Section 52 of the Motor Vehicles Act in India, an existing vehicle engine can be converted to use biofuels and accordingly, engine manufacturers need

to suitably modify the engines to ensure compatibility with biofuels. Demand for such vehicles and consequently biofuels can be stimulated by providing exemption of road tax and reduced registration fee for vehicles running on blended fuels. Incentives similar to the ones approved by MNRE for the dissemination and promotion of battery operated vehicles (BOV) will also help in augmenting the biofuel industry.

7. Research & development

The policy's major thrust is innovation, research and development (R&D) and demonstration. It focuses on R&D efforts in processing and production technologies and maximizing efficiencies and utilization of by-products along the biofuel value chain. Demonstration projects are to be set up for biodiesel and bioethanol production, focusing on conversion technologies through Public–Private Partnerships (PPP). Grants are to be provided to academic institutions, research organizations, specialized centers and industry for promising R&D and demonstration projects.

8. Institutional mechanisms

Among the institutional policies that promote the biofuel industry are international cooperation through technical cooperation in production, conversion and utilization; trade in biofuels; state participation in planning and implementing biofuel programs, and capacity building for dissemination and creating awareness.

Though a policy on biofuels is in place to promote biofuels at various stages of the supply chain, the government's initiatives on their production and commercialization have not taken off as anticipated to meet the energy demand both for ethanol and biodiesel.

V. Sustaining bioethanol production to meet blending mandates

The NPB states that a level playing field is necessary for accelerated development and utilization of biofuels vis-a-vis direct and indirect subsidies to fossil fuels and distortions in energy pricing. To augment availability of ethanol and reduce the oversupply of sugar, the NPB permits sugar industry to produce

ethanol directly from sugarcane juice. The policy implies further concessions to sugarcane growers and processors who are already benefitting from the input subsidy. Sugarcane has the advantage of having massive infrastructure already established for it, and favorable government policy support since earlier years. This has led to policymakers tailoring policies favoring ethanol production from sugarcane and molasses. However this is counter intuitive to the policy recommendation of using degraded and less fertile land for biofuel production. This lopsided policy that implies concessions for ethanol production through sugarcane could have a detrimental effect on resource allocation in the agriculture sector.

However, considering the demand for sugar in India, it is highly unlikely that sugarcane juice will be used for ethanol production in India. The analysis conducted by Shinoj et al (2011) has shown that it is highly unsustainable to extend the sugarcane area beyond a limit, given the fact that sugarcane is a crop that is highly water intensive with a water requirement of 20,000–30,000 m^3 per ha per crop.

Due to the lopsided policy along with non-availability, economic viability and sustainability of ethanol from molasses the viability of blending mandates the EBPP has not been successfully implemented. This necessitates options to augment bioethanol production to meet the blending mandates through policy support for alternative feedstocks. One such alternative feedstock that has been pilot tested in recent years is sweet sorghum. Though the policy document mentions feedstocks like sweet sorghum, sugarbeet etc, for ethanol production, neither have these crops been given due prominence in the policy nor has a clear roadmap been specified for their commercialization and utilization. Policy support mechanism to promote alternative feedstocks will benefit all the stakeholders of the bioethanol supply chain in the long run while meeting the mandated requirements.

VI. Sweet sorghum as an alternate source of bioethanol production

Sweet sorghum stalk has been found to be a potential source of raw material for commercial ethanol production. Sweet sorghum does not compromise on food, feed or fodder production when used for energy production, thereby meeting the biofuel program's vision without compromising on food security[3].

Cultivation of sweet sorghum involves the judicious use of scarce resources like irrigation water and other inputs (sweet sorghum uses less than a third of the inputs used by sugarcane, such as water, electricity and fertilizers) making it a promising alternative feedstock (Reddy et al. 2008; Srinivasa Rao et al. 2009; Table 2). Sweet sorghum scores favorably on all the parameters compared to alternative feedstocks. Additionally, the pollution levels in sweet sorghum-based ethanol production has 25% of the biological oxygen dissolved (BOD), ie, 19500 mg liter^{-1} and lower chemical oxygen dissolved (COD), ie, 38640 mg liter^{-1} compared to molasses-based ethanol production (as per a pilot study conducted by Vasantdada Sugar Institute, Pune, India). Hence, besides molasses there is a need for clear guidelines to promote alternative feedstocks like sweet sorghum for bioethanol production.

Field surveys conducted by ICRISAT in Ibrahimbad, Medak district, Andhra Pradesh, in 2008 under the National Agricultural Innovation Project (NAIP) revealed that the cost of inputs (fertilizer and imputed cost of irrigation) in the cultivation of sugarcane was Rs 6691 ha^{-1} compared to Rs 1948 ha^{-1} for sweet sorghum. The cultivation of sugarcane requires higher amounts of scarce resources such as irrigation water and fertilizers which are highly subsidized. Sugarcane requires nearly 160-180 ha cm of irrigation water while sweet sorghum is cultivated under rainfed conditions. Additionally, crop-wise estimates of input subsidies during 2001-2002 (Table 3) show that sugarcane had the highest input subsidy of Rs 6099 ha^{-1} while sorghum had the lowest. The difference in irrigation subsidy alone provided to sugarcane was Rs 1444 ha^{-1} relative to sorghum.

[3] The grain can be harvested for food, and bagasse left after extraction of juice from the stalk is an excellent feed for livestock.

Table 3. Crop-wise distribution of input subsidies per hectare in India (2000-2001).

Crop	% Fertilizer subsidy to total subsidy	% Electricity & canal subsidy to total subsidy	Subsidy/ha of crop area (Rs)
Paddy	31.43	31.01	3587
Sugarcane	5.51	4.95	6099
Sorghum	3.55	1.01	839
Maize	2.64	1.87	1634
Total (billion rupees)	138.0	366.40	

Source: *Acharya* and Jogi 2004.

VII. Tweaking policies to support alternate feedstocks

1. Economics of sweet sorghum cultivation and processing

As mentioned earlier, the justification for providing policy support to any new sector is based on its ability to overcome the initial costs of technological innovation and market development required to make the sector competitive.

Data on cost of cultivation for sweet sorghum collected over a period of three years by ICRISAT across various locations under the project on value chain model for bioethanol production in India, funded by NAIP, ICAR, Government of India, shows that sweet sorghum stalk yields have varied between 14 to 18 t ha^{-1}. With the buy-back price of sweet sorghum stalk at Rs 700-1000 t^{-1} sweet sorghum cultivation is competitive with other dryland crops in Medak district of Andhra Pradesh (Table 4). Across clusters in western Maharashtra also, sweet sorghum was found to be profitable with competing crops like sorghum intercropped with pigeonpea and sole sorghum. However, it becomes less competitive when compared to commercial crops like cotton and soybean in Maharashtra clusters. The high opportunity cost of land for cultivation forces the distillery to pay higher prices for sweet sorghum cultivation (if fertile lands used for cultivation of cotton and soybean has to be replaced to cultivate sweet sorghum).

Table 4. Benefit cost ratio of sweet sorghum cultivation with competing crops in Ibrahimbad, Medak, Andhra Pradesh.

	Benefit-Cost ratio		
Crop name	2008	2009*	2010**
Sweet sorghum	1.55	0.96	0.81
Maize–Pigeonpea	1.30	NA	0.97
Sorghum–Pigeonpea	1.37	0.97	0.59

Note: *, ** Low returns from crops during 2009 and 2010 was due to adverse climatic conditions.

Sweet sorghum is economically the next best alternative for ethanol production after molasses (Table 5) when the feedstock is priced at Rs 800 per ton of stalk. However, feedstock and ethanol pricing have a bearing on the viability of ethanol production from all available feedstocks.

Table 5. Relative economics of ethanol production from different feedstocks in India.

Parameter	Sweet sorghum	Sugarcane molasses	Sugarcane juice	Grains (pearl millet & broken rice)
Cost of raw material (Rs t^{-1})	700*	3000-5000**	1200+	8000+
Cost of processing (Rs t^{-1})	384	1890	490	2800
Total cost of ethanol production (Rs t^{-1})	1084	4890-6890	1690	10800
Output of ethanol (l)	45	270	70	400
Value of ethanol (Rs t^{-1})	1215	7290	1890	10800
Net Returns (Rs t^{-1})	131	2400 to 400	200	0
Cost of feedstock (Rs l^{-1})	15.56	11.11-18.51	17.14	20.0
Cost of ethanol (Rs l^{-1})	24.08	18.11-25.51	24.14	27
Profit from ethanol (Rs l^{-1})	2.91	8.88-1.48	2.85	0

Note: The information on the parameters is collected from Rusni distilleries for sweet sorghum, Nizam Deccan Sugars Pvt. Ltd. for molasses and AGRO Bio-tech, Ajitgarh, Rajasthan, for grains.

* The value of by-products is not considered in the analysis. Even when the feedstock is priced at Rs 800, it becomes profitable to produce ethanol from sweet sorghum without accounting for capital costs. However, the cost of feedstock has varied between Rs 700 and 1200 t^{-1}.

** The molasses prices have ranged between Rs 3000 and 5000 t^{-1} during the last few years and hence the profitability of molasses ethanol production is highly sensitive to fluctuating molasses prices.

+ The data on all the other feedstocks cost is for the year 2009. The prices of feedstock (sugarcane and grains) have increased in the recent years.

On the processing side, economic viability assessment was carried out by the authors using the data from a distillery crushing sweet sorghum for ethanol production. The distillery which had a buy-back arrangement with farmers for cultivation of sweet sorghum was paying Rs 1200-1300 t^{-1} of stalk to farmers since they had to be compensated for loss in returns for cultivation of crops like cotton and soybean. With feedstock price fixed at Rs 1200-1300 t^{-1} of stalk and subsequent processing costs incurred by the distillery, ethanol has to be priced at Rs 36 per liter from the existing administered Rs 27 per liter to make the distillery viable.

Several scenarios were developed by varying feedstock price, ethanol price and ethanol recovery rate by performing sensitivity analysis. The sensitivity analysis performed helped to estimate the break-even points and ethanol pricing scenarios for sweet sorghum value chain.

2. Policy support for sweet sorghum

The area under cultivation of alternative feedstocks for ethanol production is low due the reasons mentioned (higher feedstock prices, assured buy-back arrangement for farmers and low ethanol prices).

In the current market context, policy support for the production of a biofuel crop primarily depends on mutual/simultaneous co-existence of producers and processors to promote alternate feedstocks. For growers it's the relative profitability of bioethanol crops vis-a–vis competing crops and assured buyback at pre-determined prices are important factors determining allocation of land for these crops. While for industry, the raw material's conversion efficiency, its continuous supply for at least 5-6 months in a year, the economics of establishing multi-feedstock production units and the purchase price of ethanol by oil companies are critical factors. For industries producing ethanol from alternative feedstock, policy support should be in the form of a minimum purchase price to ensure at least a break-even price of ethanol production.

Policies favoring ethanol production from feedstock such as sweet sorghum by capping a third of the 5-10% requirements in the initial years will serve as an incentive to tap alternative sources.

Additionally, conversion of any form of sugars to alcohol requires special permissions and licensing (opinions based on the visits to industries by ICRISAT scientists). Barriers to licensing and permissions for conversion of multiple feedstocks to ethanol deters industry from processing as the industry cannot sustain on single feedstock to run on optimal capacity and profitability. Licensing has to be made easy for establishment and operationalization of multi-feedstock units that can operate for longer periods in a year to augment the ethanol production using different feedstock.

Options can be explored with sugar industry to integrate crushing of sweet sorghum during lean periods of sugarcane crushing.

Viability gap funding as undertaken for infrastructure projects in PPP mode can also be explored for financial assistance for private sector for production of ethanol from alternate feedstocks like sweet sorghum.

Policy support for the industries established to crush alternate feedstocks in the form of 'infant industry sops' during the initial years has to be provided by the Government until the industry achieves technological and efficiency breakthrough.

Sweet sorghum is a newly introduced promising crop for the production of bioethanol. Research is on to develop promising cultivars for higher stalk and support yield and juice content. So are pilot projects linking farmers to the bioethanol industry. Hence, funding support for ongoing research on sweet sorghum and its promotion are critical. Identifying institutional mechanisms through PPP and funding support by national and international funding agencies to promote such biofuel crops will go a long way in promoting alternative feedstocks.

3. Economic viability and cost of subsidy from policy perspective

Various studies across countries have calculated the point at which ethanol from various feedstocks would be competitive with fossil fuels and policy incentives and interventions to be provided for promotion of bioethanol. In the Indian context, there are arguments in favor of bioethanol that it would become economical in a scenario of higher crude oil prices, high to the tune

of USD 147/barrel (July 2008). The analysis conducted by Shinoj et al. 2011 on the sustainability of sugarcane based ethanol has shown that even in such a scenario, it would be difficult to meet the mandated ethanol blending requirement.

To determine the break-even points of production of ethanol from sweet sorghum in the Indian context, the Tyner and Taheripour (2007) framework of determining break-even points of ethanol production from maize as feedstock relative to crude oil is replicated by the authors. The analysis is done taking into account current prices and conversion technology of the feedstock that could form the basis for price and policy incentives to promote biofuels from alternative feedstocks.

The break-even price analysis shows that with a conversion rate at 4.5% of ethanol from sweet sorghum, the feedstock price should be Rs 1200 t^{-1} of stalk when the price of crude is at $85 per barrel.

A) Cost of subsidy

An estimate is made by the authors on the magnitude of support required if alternate feedstocks like sweet sorghum are prioritized and promoted with enabling environment in India and taking into consideration the land required for its cultivation and ethanol production for blending mandates. Based on projections by the Planning Commission, 1.97 billion liters of bioethanol at the rate of 10% blending would be required by 2017. Currently, the entire blending requirement by OMCs has to come from sugarcane molasses. Given the unsustainable scenario of ethanol production from molasses (shortage of molasses due to cyclical nature of sugarcane production, fluctuating prices of molasses, inability of OMCs to procure ethanol at the prevailing market rate and better price and assured demand for potable and industrial uses) ethanol could be produced from alternate feedstocks like sweet sorghum.

Since, in the short run it would not be possible to bring a larger area under its cultivation and also because of the research and extension efforts required to make it a viable option for blending, it is assumed that only 5% of the total ethanol required for blending would come from sweet sorghum during 2012 and this would go up to 20% by 2020. Based on these assumptions, annual requirement of bioethanol from sweet sorghum, and land requirement for sweet sorghum during 2012-2014, 2015-2019 and 2020 have been projected at 5, 10 and 20% of the total ethanol requirement respectively.

Based on these annual projections, the cumulative area that would need to be brought under sweet sorghum cultivation by 2020 would be 0.5 million ha, a small proportion of the total area presently under cultivation in kharif (rainy season) sorghum alone (around 3.5 million ha). The area under kharif sorghum in the state of Maharashtra is close to 1.2 million ha. Here we assume that initially sweet sorghum would replace kharif sorghum since both crops grow under similar conditions and the grain from sweet sorghum crop would compensate for the loss in sorghum grain.

It is expected that the on-farm sweet sorghum stalk productivity of 20 t ha^{-1} increase to 30 t ha^{-1} between now and 2020 with improved cultivars, better management practices and increased awareness of farmers on sweet sorghum cultivation. With increased productivity, a larger area could be brought under sweet sorghum cultivation, and hence ethanol available for blending from sweet sorghum stalk as raw material would also increase.

The estimated break-even price of sweet sorghum for ethanol production is Rs 1200 t^{-1} (including the cost of processing) at 4.5% recovery when crude is priced at $85 a barrel. Based on the estimated break-even, if a support of Rs1200 ha^{-1} (one third of what is provided for crops like paddy and sugarcane) is provided for processors, the total economic cost of subsidies for sweet sorghum production would amount to Rs 105 million to Rs 605 million ($2.33 to 13.35 million) by 2020 based on area required for sweet sorghum cultivation. Comparing the amount of subsidies provided to water-intensive crops like sugarcane and paddy in India which account for an average of Rs 3000-4000 ha^{-1} and the subsidies provided in the United States and EU for biofuel production the estimated quantum of support for sweet sorghum is modest.

VIII. Conclusion

While the policy framework to promote the biofuel sector in India is very encouraging, experience has shown that the Government's initiatives have not translated into results on the production and commercialization fronts to meet the country's energy demand, calling for a re-examination of the policy from various stages of the biofuel supply chain. This chapter highlighted the key features of the biofuel program in India, and critically examined them to meet the mandated ethanol blending program stipulated by the Government of India.

The focus of the policy is on ethanol production from molasses that is plagued by price volatility combined with demand for molasses-based alcohol from the potable and chemical industries. Its production is dependent on sugar production and hence volatility in sugar production also affects molasses availability. This is already evident as the viability of blending mandates is at stake as the EBPP has not been successfully implemented across the country owing to non-availability of ethanol for blending on a continuous basis.

The policy is thus sugarcane-centric which is counter to the policy recommendation of using degraded and less fertile land for biofuel production. Sugarcane is a big beneficiary of subsidies on fertilizer, pesticides and electricity for pumping irrigation water for crop production in India. The policy document not only favors production of ethanol from sugarcane through molasses but also recommends sugarcane juice as another option. While mention is made of other feedstocks like sweet sorghum, sugar beet etc. in the policy document for ethanol production, due prominence and a clear road map are not given. In view of the above, prioritization of alternative feedstocks to fulfill targeted blending mandates is called for. Policies favoring alternative feedstock such as sweet sorghum by capping a third of the 5-10% requirement will serve as an incentive to promote alternative feedstocks. A small subsidy in the initial years will go a long way in promoting alternative feedstocks which can supplement ethanol production for blending requirements.

The major thrust of the biofuel policy is primarily on supply side. However, the demand side factors like provisions for consumption support also play a significant role in promotion of biofuels. Promotion of flex-fuel vehicles designed to use higher percentage blends of ethanol as in case of Brazil is a classic example. Similarly, reduction in registration fees and road tax exemptions for vehicles running on biofuels are provided by many countries. Policy sops of such kind and incentives similar to the ones announced and approved by the MNRE for dissemination and promotion of battery operated vehicles (BOV) will also help in promoting and sustaining the biofuel industry. Such sops should be provided only in the initial years (5-10) until the industry is able to sustain on its own.

It is hoped that modifications in the existing NBP favoring bioethanol production from alternate feedstocks like sweet sorghum besides molasses will benefit all the stakeholders in the biofuels supply chain and will quicken the pace of biofuel production in the country to meet the blending mandates.

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