Biofuels Situation in India – Input to ICID TF Position Paper on Biofuels

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Abstract

Bio-energy production and use have both positive and negative environmental and socio-economic consequences, including those pertaining to water. Water, which is already a scarce resource in many parts of the world, will come under further stress providing competitive demand on water for food production. The expansion and intensification of bioenergy production could add to existing pressures on land and water management. Energy security is an essential building block for a developing country like India. In spite of several energy sector reforms, country is facing serious energy shortages and is forced to rely heavily on imports especially to meet the demand of transport sector. In such a scenario biofuel has emerged as a potential option which can not only reduce country's dependence on foreign oil but could also help in reducing greenhouse gas emissions. Biofuels apart from contributing towards energy security have various impacts on food and water resources. Although, the National Biofuel Policy of India has limited the production of bioethanol to molasses (a by-product of sugar industry) and biodiesel to non-edible seed oil such as jatropha, pongamia etc., the experts anticipate that biofuel program in country will disturb food market and result in depletion of water resources. In this paper India's bio-energy production and its impacts on food security has been addressed. In addition different biofuel production technologies by using different feedstocks, their impact on food, water, environment/climate change etc. have been analysed.

1. Context & Background

India is sixth in the world in energy demand accounting for 3.5% of world commercial energy consumption. A large part of the population has no access to commercial energy from hydrocarbons at all. India's import of crude oil was 147 million tons by 2007.

In India, a larger share than in other countries is needed for transport purposes, in particular for diesel. Consumption is expected to rise at an annual 6% rate by 2011-12. Presently domestic supply can satisfy only about 25% of demand. There is a growing demand gap between production and consumption of crude oil. Indian petrol reserves are expected to last for another 20 years max. Rising and volatile prices and respective

foreign exchange costs are one of the main risk factors of the Indian economic and social development prospects.

Bio-fuels provide a strategic advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, as well as in meeting the energy needs of India's vast rural population. Bio-fuels can increasingly satisfy these energy needs in an environmentally benign and cost-effective manner while reducing dependence on import of fossil fuels and thereby providing a higher degree of National Energy Security. The Indian approach to bio-fuels is based solely on non-food feedstock to be raised on degraded or wastelands that are not suited to agriculture, thus avoiding a possible conflict of fuel vs. food security

Recent shifts in biofuel policy have advocated cultivation on marginal lands as it is widely held such lands are unsuitable for food production and are insignificant carbon sinks. It is further believed such schemes can enhance rural welfare by creating new market opportunities for the rural poor. Coupling these themes, the government of India recently enacted a biodiesel policy mandating the use of non-edible oilseeds such as Jatropha curcas on wastelands, a government classification of marginal lands. However, biomass feedstock from India's wastelands currently supports an entire energy economy consisting of household fuelwood to electricity generation. Thus, India's biofuel and biomass policies are in direct competition for the same lands, which has the potential to spark territorial and class disputes. This paper tries to document different developments in Bio-fuel sector in India with a major focus on the present status, policies enacted o this behalf, impact assessment and its implications on the long term sustainability and food security.

2. Particularities of Water, Bio-energy and Food security Nexus

In the context of biofuel development, there has been very limited awareness and discussion of the water crisis. The current biofuel development strategy may aggravate the water crisis, and access to water could become a primary factor in the development of biofuel feedstock production. In regions already under water stress, biofuel production may further decrease the freshwater availability for other development options and may limit the "right to water" both for ecosystem sustenance and for meeting peoples' basic needs.

The availability of water in developing countries is a cause of concern for agricultural productivity and for health and sanitation. In underdeveloped rural areas, where there is very high demand for access to water for irrigation, cooking and drinking, bioenergy crop production would compete for scarce water supplies. An acceleration of biofuel expansion in areas requiring additional irrigation water from already depleted aquifers could cause much greater water scarcity problems and further push up cereal prices. Poorly managed use of inputs to cultivate energy crops could pollute drinking water, adversely affecting human and animal health.

According to one of the research papers by IWMI, irrigation water in India will be impacted and additional 30 km 3 of water will be required to produce the 100 million tonne of sugarcane to meet the demand. This will affect food crops, necessitating their import. Over 40 million ha was set apart to grow the oilseed plant jatropha in the country in 2005.

In developing countries like India, where there is intense pressure on farm land from current food security concerns, but expanded bio-fuel production could divert land away from foods crops thus exacerbating food security concerns.
For example:

- Diverting cereal from food and feed to fuel use has the potential to reduce food availability.
- In addition, there is a risk that food and feed production will be consigned to less productive land, which may result in lower yields, while the most fertile hectares support high-value fuel crops.

3. Bio-energy Production

Argument between Edible & Non-Edible Source of Bio-diesel:

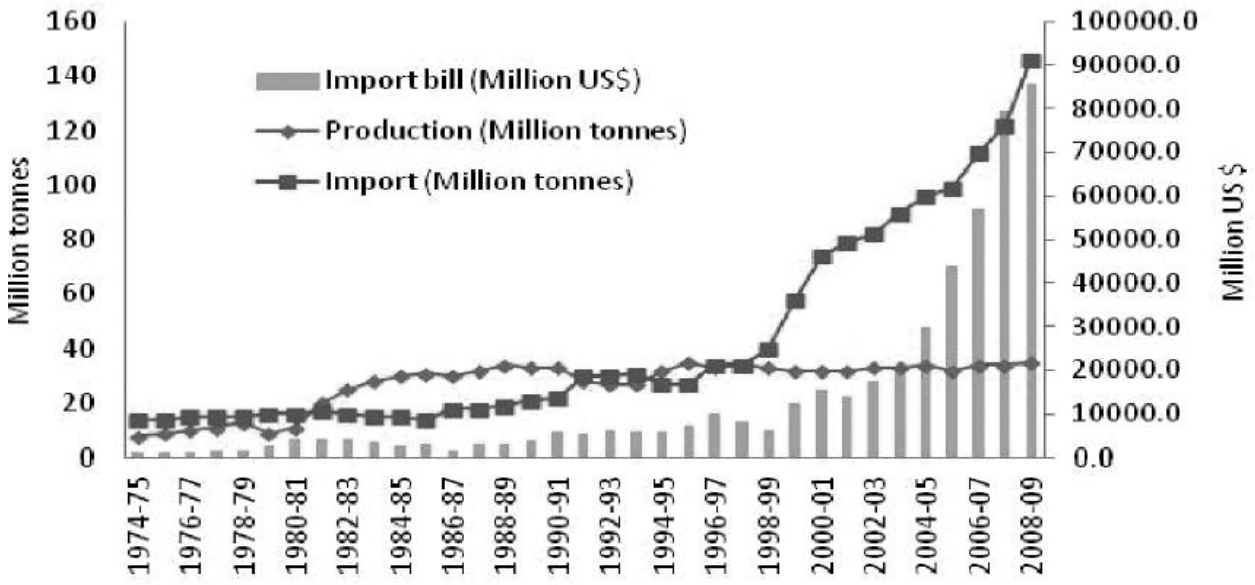
While the country is short of petroleum reserve, it has large arable land as well as good climatic conditions, potential to produce biomass to be processed into bio-fuels. Demand of edible oil is higher than production, so edible oils, as mainly used in Europe and the US for transport oil, are considered not eligible. As well, edible oils are much more expensive, sometimes by a factor 3-5, in India.

A clear comparison between the yields and economics of different edible and non-edible oils, and why production of non-edible oils for farmers is expected to be more viable than of edible oils.

Indian Scenario

The domestic production of crude oil from fossil fuels has been more or less stagnant over the years and meets only 30 per cent of the national requirement, while the balance is met through imports of nearly 146 million tonnes of crude petroleum products that cost the country close to US $ 90 billion in 2008-09.

Figure: Domestic Production & Import of Crude Oil in India 1974-75 to 2008-09



This growing dependence on fossil fuels for powering the transport sector is the key reason for the country to embrace biofuel production on its own. In addition to, various other socio-economic and environmental concerns have also encouraged the shift.

Bioethanol & Biodiesel Production in India:

India is globally one of the largest producers of sugarcane and ethanol made from sugarcane molasses. For producing ethanol, India has about 330 distilleries with the annual production capacity of over 4.0 billion litres. In the year 2010, the country produced nearly 1.43 billion litres of ethanol, of which an estimated 50 million litres of ethanol were blended with petrol. Ethanol production is highly volatile in India due to the cyclical nature of sugarcane production and therefore, the blending of ethanol with petrol is also volatile. For instance, India produced around 2.15 billion litres of ethanol in 2008, of which 280 million litres were used for blended. In 2009, ethanol production went down to 1.07 billion litres and blending to 100 million litres. Blending was further down to 50 million litres in the subsequent year. Ethanol is primarily produced by the fermentation of molasses, and it is estimated that, from one tonne of sugarcane, 85-100

kg of sugar (8.5–10 %) and 40 kg (4%) of molasses can be obtained. The recovery of ethanol from molasses is 22-25 per cent as per Indian standards. Presently, only molasses produced during sugar production are available for ethanol production. Around one-fourth of it is being used for industrial purposes, while 30-35 per cent is being used for potable purposes, (beverages) and the rest 3-4 per cent for other uses. The surplus available alcohol is being diverted for blending with transportation fuel.

Unlike other countries, India is not using vegetable oils derived from rapeseed & mustard, soybean or oil palm for the production of biodiesel. It is because, India is not self-sufficient in edible oils production and depends upon imports of palm oil and other vegetable oils in large quantities to meet the domestic demand. Biodiesel is produced mostly from the non-edible oils extracted from the seeds of plants like jatropha and pongamia.

Demand for Bio-diesel Production

The demand for bio-diesel in India is increasing at the rate of 7.5 per cent per annum since 2004-05. Demand projections suggest that nearly 3.21 million tonnes (Mt) of biodiesel would be required for 5 per cent blending by the year 2011-12. To bring this into effect, and assuming that jatropha would be the major feedstock for biodiesel (i.e., 80 % of the requirement would be met from jatropha) with an average seed yield11 of 2.5 t/ha and 30 per cent biodiesel recovery rate, the area required under the crop would be 3.42 Mha. An estimated area of 26.25 M ha would be required under jatropha to meet 20 per cent blending target by the year 2020-21, if the yield and oil content of jatropha remain the same and if no new superior feedstocks are introduced. So far in the country, only around 0.5 M ha land has been put under jatropha cultivation and the government has not initiated purchasing of biodiesel through the designated purchase centres even though MPP of Rs 26.50 per litre was announced a few years ago. Presently, jatropha seeds are mainly crushed for oil at the village level or in small-scale plants for local use or for sale to the unorganized sector.

INDIAN BIODIESEL POLICY PROMOTION

Central Government's Jatropha promotion: Biodiesel program: 2003-2008

India established its biodiesel program in 2003 with the launch of the National Mission on Biodiesel (Government of India 2003). The Mission called for making mandatory a 20% biodiesel blending target by 2011-2012 using Jatropha as the primary feedstock. Although there are huge amount of (approximately 400) non-edible oilseeds can be

found in India, the Committee selected Jatropha for the biodiesel program because of its higher oil content (40% by weight) and lower gestation period (2-3 years) in comparison with other oilseeds (Government of India 2003). At the same time Biodiesel is understood as a crop that could be grown even in wastelands. The Committee recommended cultivating Jatropha on 17.4 million hectares of underutilized and degraded wasteland (approximately 5% of India's total land area), to reach the target of 20% blending.

India's National Policy on Biofuels: 2009- Present Status

On December 24, 2009, the government implemented the National Policy on Biofuels. The policy establishes indicative 20% blending targets by 2017 for both ethanol and biodiesel. The new policy unlike the previous was not feedstock specific. Instead, the policy calls for use of non-food feedstock grown exclusively on wastelands, both publicly and privately owned, in order to avoid conflicts with food security. According the government, this provision distinguishes India's policy from other countries' biofuel programs. The policy does not mention Jatropha specifically but instead states the government will assess the potential of over 400 tree born non-edible oilseeds currently growing in India.

A major highlight of the Indian Biodiesel Policy is that unlike in other developed countries, it gives due consideration to the aspect of food security of the country, and promotes only non-food feedstocks for biofuel production. The Policy also exercises sufficient caution to prevent conversion of fertile lands for biofuel production. Almost all the biofuel planting programmes in the country are being undertaken only on wastelands, degraded lands or forest areas. By limiting ethanol production to molasses-based feedstock, the Policy restricts excessive dependence on sugarcane which is a highly water-intensive crop. Wherever direct conversion of sugarcane juice to ethanol is permitted, it is subject to the ceiling on sugar production. Yet, there are several sticky points over which the policy is alleged to be faltering. One major contention is that there are wide variations in price and tax policies on biofuels across states and there is a need for harmonization and rationalization of these policies. In some states, the producers find the state announced prices highly non-remunerative. Also at the central level, the support prices are not revised regularly based on the changes in cost of cultivation and fluctuations in market forces.

4. Issues and Concerns

Food Security

India is particularly vulnerable to food security issues. As of 2008, the United Nations Development Programme estimated that over 27% of Indians live below the poverty line and lack access to enough calories per day to sustain a healthy lifestyle. As recently as 2006, India imported 2.2 million tons of wheat in order to ensure food availability. If more food is siphoned off from the food markets into the energy market to grow the biofuel industry, it is likely that the food-versus-fuel conflict will come into play.

Water scarcity

Ambitious plans in India to boost domestic production of biofuels raise serious concerns for future water supplies if traditional food crops are used. In rainfed areas, biofuel crops use 'green water' (water stored in the soil). But, if they use this green water more intensively than traditional land uses, biofuel crops may reduce the amount of water that ends up as 'blue water' in groundwater aquifers and rivers in the long run. River and groundwater systems would therefore be affected; although there is still a lot of uncertainty as to just how the production of energy crops might affect river flow downstream.

For example, In the Krishna Basin in India, irrigated sugarcane could help to meet the growing demand for fuel through ethanol production. But major conflicts are already emerging between water for irrigation and environmental needs. For instance, the environmental flow requirements of the Krishna Basin are rarely met, especially during droughts, because more and more water is being withdrawn. At the moment, most sugarcane is irrigated by water pumped from underground. If sugarcane for biofuel expands and more water is drawn from rivers, this will have serious implications for the environment.

Land & Ecological Degradation: In India, biodiesel is mainly produced mainly from non-edible oilseed crops like jatropha and pongamia, edible oil waste and animal fats. Currently, jatropha, the major feedstock for biodiesel, occupies around 0.5 million hectares of wastelands across the country, of which 65-70 per cent are new plantations of under three years. Majority of the focus in India has been concentrated on Jatropha for production of biofuels. The issue of land degradation due to cultivation of Biofuel crops is limited in India because majority of the feedstock for Biodiesel comes from Jatropha which can grow over wastelands. In fact according to a study by ICRISAT (International Crop Research Institute for the Semi-Arid Tropics),large-scale cultivation

of Jatropha – known as a potential source of biofuel – can improve the soil quality of degraded lands and address climate change. scientists at the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, have found that Jatropha plantations can also sequester carbon in abundant quantities. Jatropha plantations older than four years added as much as 1,450 kilograms of organic carbon per hectare per year through leaf fall, pruned twigs and residue after removal of oil, the study said. Also, by increasing organic carbon in soils and live root activity Jatropha plants encouraged growth of the soil's microbe population – a key indicator of soil health. Nutrient availability also improved through recycling of the biomass back into the soil. Nitrogen increased by 85 kilograms per hectare, potassium by 44 kilograms, and phosphorus by eight kilograms. Therefore currently Jatropha is seen as an alternative to rehabilitate degraded lands in India.

Inequity in Development: Although biofuel production promises to benefit India's rural poor, there is also the possibility of causing harm. If land is transferred from its current use for biofuel production, the poor will benefit from employment but may risk losing fodder for their livestock or materials for their houses and other structures. The Indian government cited that there were over 30 million hectares of wasteland available for jatropha production around the nation. However, a lot of this wasteland is also considered Common Property Resources (CPR), land that is collectively owned by rural villages and communities. This land is generally a source of food, fuel, fodder, timber, and thatching for the poorest in India. One study reports that 12-25% of poor household incomes depend on CPR. This is going to further aggravate the inequity in development in India and increase the problems of the rural poor

5. Impact Assessment

Impact of Jatropha Cultivation

According to survey study of NCAP on sample households at different farms at Chhattisgarh, Rajasthan & Uttarakhand, on an average, around 40-50 man days were expected to be created per hectare per year as the plants start yielding, and it would further increase as the plants reach maturity. The average plot size was of less than one quarter of a hectare in Rajasthan and a little more than half a hectare in Chhattisgarh. The yields were more or less similar across the states and farm-categories and were between 2-3 tonnes per hectare at third year. In all sample households, more than 80 per cent of the employment created in jatropha cultivation activities was catered from within the family. In all the three states, farmers were found to apply fertilizers and manures only in the first year. The farmers applied both manures and fertilizers in

Rajasthan, while in the other two states they applied only manures. None of the farms in any of the locations was found to follow any crop protection measures.

Impact of Biofuels on Farmers, Industry and Overall Population

The biofuel industry could have significant positive impacts on the health, education, and productivity of the rural poor population in India. Some anticipate that the biofuel industry will create new jobs for the poorest communities in India because biofuel production requires mostly unskilled labor, which is widely available in rural areas. Although many people worry that biofuels decrease food security, others counter that the opposite is true. Their argument is that food security is determined by one's ability to purchase food at the market price rather than by the abundance or shortage of food. If higher incomes result from increased employment, the rural poor will have more access to food even if prices rise. Furthermore, biofuel production has the potential to increase access of rural communities to cleaner, more reliable energy.

Although biofuel production has the potential to benefit India's rural poor, there is also the possibility of causing harm. If land is transferred from its current use for biofuel production, the poor will benefit from employment but may risk losing fodder for their livestock or materials for their houses and other structures.

The wellbeing of the urban poor could be particularly endangered by the biofuels, in contrast with the rural poor who may have some opportunities to benefit. Although the urban poor do not risk losing their land to biofuel production, they don't gain employment opportunities or income increases from an expanded biofuel industry either. If India produces biofuels from food commodities on a large-scale or if other countries around the world decide to do so, global food prices will likely rise. The rural poor may be less affected by increased food prices as a result of their ability to produce their own food and live outside the global food market or due to their increased income as a result of biofuel production in rural areas. The urban poor have more at stake because their food security is more tightly linked to fluctuations in the global food market and because they are unlikely to reap any benefits or additional income from the biofuels industry.

There are also numerous questions concerning exactly who will benefit from the biofuel industry — small farmers or large corporations? As a result of the fact that so little is known about jatropha, small farmers are unlikely to risk planting jatropha, which will not reap any profits for 2 to 3 years, if at all. They are more likely to plant more

conventional crops such as sugarcane, which can better ensure benefits but potentially endanger the food security of the entire poor population. For these reasons, larger companies might become the larger stakeholders in the biofuel industry, which could lead to greater losses but also greater gains. The question seems to be, whether biofuels widen or narrow the inequality gap?

6. Identified Risks

Food security concerns: Sugarcane and edible vegetable oils such as palm oil are two of the most common feedstocks for biofuel production around the world. However, there are concerns that India must steer clear of these two feedstock sources in order to avoid serious problems of food insecurity. India is already the largest consumer of the sugar in the world. If sugar were then additionally diverted to the biofuel industry, the food industry would be less able to meet its demand. UN researchers suggest that sorghum and tropical sugar beets would be better suited to drive India's bioethanol production. Similarly, India's demand for vegetable oil already outstrips its supply. However, non-edible oils could be used instead to produce biodiesel.

Water quality concerns: Currently, it takes 3,500 liters of irrigation water to produce one liter of ethanol from sugarcane. Many experts say that as a result, India must look to drought resistant crops such as jatropha to avoid enormous water shortages as a result of biofuels. However, it is unclear how much water jatropha needs to produce its maximum yield. If jatropha requires a significant amount of irrigation to reach its potential, it is almost assured that water shortages will increase in frequency. It is also possible that the biofuel industry's demand for water would take water away from food production, which could further exacerbate food insecurity in India.

Lack of public policies & logistic framework: From a logistical standpoint, India is not ready to invest heavily in fuels because the political and physical infrastructure necessary to support the industry currently does not exist. Although the Indian government proposed the National Mission on Biofuels in 2003, the government still lacks the political backing to realistically implement a program of that magnitude. The Mission provides governmental suggestion on developing the biofuel industry. However, there is little policy to make sure these guidelines are followed. Moreover the physical infrastructure to support a proposed biofuel industry of that size is lacking. While there are a significant number of industrial plants that can process bioethanol, there are very few capable of producing biodiesel. In India the demand for diesel is over five times higher than the demand for petrol. Thus if India is serious about biodiesel

from jatropha or other oil seed plants, it must invest significantly in acquiring additional and advanced technologies in oil extraction, transesterification, and storage for biodiesel oil. For example, prior to 2006, there were no transesterification plants capable of producing commercial biodiesel. Now there are only a handful of transesterification plants in operation and they do not operate at full capacity. India needs to scale up its efforts drastically if it hopes to produces fuels with 20% biofuel by 2017

Lack of good scientific and analytical Assessment of the risks and the opportunities of different kinds of technologies and development choices: Pro-biofuels experts claim that the impacts of biofuels can be mitigated through two major types of technological innovation. First, nations can focus on cellulosic biofuel technologies that use byproducts or waste products of food and other crops to create biofuels. Technologies necessary for this option to be feasible are just starting to become available but are relatively expensive. Similarly, investments in existing technologies that increase agricultural productivity could soften the impact of biofuels especially when coupled with technologies for cellulosic biofuel production. The choice does not necessarily need to be between food and fuel. However, the elimination of this conflict is highly dependent on India's willingness to invest in new technologies.

Lack of Research: Much research is undoubtedly necessary to better understand the capabilities and downfalls of biofuels. A huge number of questions remain and more are still surfacing. For example, whether jatropha will be economically viable compared to oil, whether indirect and environmental costs of biofuels will outweigh the direct benefits, or whether impoverished farmers will significantly benefit, all are still unanswered. Some believe that research needs to come before the Indian government invests major sums into biofuel development policy particularly those policies based around jatropha. Others have indicated that India must work to improve its agricultural practices before it moves forward with the rest of its biofuel agenda.

Unfortunately, however, there still is not enough information/research done about jatropha to prove to the Ministry that the Government would get a substantial return on its investment.

7. Mitigation of Risks

Extensive programmes on biofuels based on agricultural feedstocks can have considerable implications for the food and livelihood security of the people in a country. The recent debates
over the rising food prices and the associated fallouts as a result of large-scale shift of area from food crops to biofuel feedstock crops have created concerns among the policymakers, scientists
and common man in both developed and developing countries. It is mainly because, the market response of a shift against food crops at the global level may affect not only the agricultural sector but other sectors of economy also, irrespective of the level of participation of a country in biofuel production. Moreover, huge sums of outlays for subsidies on biofuels essentially means a shift of money away from the poor and vulnerable who end up spending more on food due to increased food prices, with little left for energy, even though cheaper.

Alternative Feedstock for Ethanol Production

The concerns regarding the feedstock availability, economic viability and sustainability of molasses-based ethanol have necessitated the search for alternative feedstocks to produce ethanol. Sweet sorghum has been found to be one such potential source of raw material for commercial ethanol production due to various advantages. Sweet sorghum is similar to grain sorghum, has rapid growth, wider adaptability and high biomass producing ability with sugar-rich stalks, and is suitable for seed propagation and mechanized crop production.

The growing period (four months) and water requirement (8000 m3/ha over two crops) of sweet sorghum is only one-fourth of that of sugarcane. Moreover, the ethanol yield from two crops of sweet sorghum per year10 is higher than that obtained from molasses in a year. At the present rates of feedstock, the per litre cost of production of sweet sorghum-based ethanol (Rs 17–19) is considerably lower than that of molasses-based ethanol (Rs 24–32). Adequate extension efforts, coupled with repeated field trials and industrial trials all over the country are required to sensitize the farmers and distillers to enable large-scale adoption of sorghum. Tropical sugar beet is another potential feedstock for ethanol production, even though the scope of its commercial exploitation has not so far been widely tested in India.

However, the field trials conducted by Tamil Nadu Agricultural University (TNAU) have shown that tropical sugarbeet can be successfully cultivated in India on large-scale. Sugarbeet is a crop of 5–6 months duration and grows well in sandy loam soil. The ability of this crop to thrive well in saline and alkaline soils is of special

significance. Ethanol can be directly produced from the sugarbeet juice at an average recovery rate of 80–90 litres of ethanol/tonne of sugarbeet. The ethanol yield from sugarbeet (6000–6400 litre/ha) is far higher than from sugarcane molasses and sweet sorghum, and can be realized at a very low cost of production (Rs 12–14/litre). Sugarbeet can also be explored as a source of sugar in addition to ethanol

Concurrently, India has to look for improved technology and management practices to maximize the efficiency from the existing feedstocks. Therefore, in order to realize this goal, a shift in the focus of research towards developing lower-cost second generation biofuels is needed along with sufficient (and sustained) political resolve to make adequate investments. The government should also take efforts to reflect the changing priorities in its policies

8. ICID Recommendation

Policies for Responding to Rising Bioenergy Demand

- Biofuel development should be carefully designed, so as not to crowd out investments in roads, more general agricultural development, health, nutrition and other efforts aimed at climate change mitigation and adaptation.
- Policy should ensure that smallholders, including women farmers, have access to resources, infrastructure, services and organizations so that they can participate in biofuel production on a fair basis. Policies need to examine the environmental consequences of biofuel development and avoid unsustainable practices.
- Increased investment in overall agricultural productivity will help them both to increase their own food production and be able to engage in the biofuel market. It may even be possible for farmers to leap-frog to second generation cellulosic biofuel technologies, creating energy and emission efficiency gains.
- Global cooperation is needed on R&D to bring technologies on line that will allow production of biofuels from non-food crops, thereby avoiding tradeoffs among food, feed, fiber and fuel uses of staple crops.
- Participatory decision-making and cross-sectoral policy coordination should be institutionalized in the area of bioenergy. The clear allocation of the roles of duty-bearers and rights-holders may also increase government responsiveness, as well as accountability and transparency.

Mitigation of Negative Impacts of Biofuels

Appropriate policies can make bioenergy development more pro-poor and environmentally sustainable. Poor farmers might be able to grow energy crops on degraded or marginal land not suitable for food production, but appropriate soil and fertilizer management practices will have to be tailored to soil type and climatic conditions, otherwise bioenergy production may aggravate land degradation, generate GHG emissions and cause environmental problems through soil erosion and degradation of water quality. Also, further investment is needed in developing technologies to convert cellulose to energy. This could provide developing country farmers, including smallholders, with a use for crop residues like stalks and leaves, which would be converted into ethanol for electricity, thereby benefiting both poor farmers with additional income and also poor consumers with cheaper energy. Smaller-scale and rural-based production will open up opportunities for biofuel to be pro-poor. Organizing groups of smallholders through contract farming schemes to grow and market biomass to processing plants may be most effective for this

In nutshell, even though India's biofuel programme sufficiently addresses the larger concerns of food security, rural livelihood security, gender empowerment, etc., there are several aspects which need further attention and concerted involvement. This paper tries to elucidate issues as economic viability and long-term sustainability of sugarcane-based ethanol programme, commercial feasibility of jatropha-based biodiesel, technological challenges constraining the development of second generation biofuels industry etc. Therefore, the immediate challenge before India or for those sake different nations is to bridge the existing gaps in the biofuel sector and to usher in a more consumer-friendly and market-oriented bio-energy revolution in the country which should be not only pro-poor but also environmentally sustainable.

To protect the poor and food- insecure people from adverse effects of the rapid growth of the biofuel sector there is a need to develop policies for food and fuel to be linked to safeguard food security, to assist those negatively impacted by climate change and the expansion of biofuels production and to raise awareness among policymakers to provide for integration of local, regional or international policies that affect the agricultural sector and the rural economy.

9. References

- FAO (Food and Agriculture Organization) (2008) Biofuels: Prospects, risks and opportunities, The State of Food and Agriculture, Rome.
- FAPRI (Food and Agricultural Policy Research Institute) (2010) World Biofuels: Agricultural Outlook, Iowa.
- Licht, F. O. (2009) World Ethanol and Biofuels Report
- GAIN Report (2011) Biofuels Policy Overview, Report No. IN 1159, USDA Foreign Agriculture Service.
- GoI (Government of India) (2003) Report of the Committee on Development of Biofuels, Planning Commission, New Delhi.
- GoI (Government of India) (2008) Agricultural Statistics at Glance. Ministry of Agriculture, New Delhi.
- GoI (Government of India)(2009) National Policy on Biofuels. Ministry of New and Renewable Energy, New Delhi.
- NATIONAL CENTRE FOR AGRICULTURAL ECONOMICS AND POLICY RESEARCH (NCAER) - Biofuels in India: Potential, Policy and Emerging Paradigms (Policy Paper 27)
- INSTITUTE FOR AGRICULTURE AND TRADE POLICY – "Biofuels and Global Water Challenges"