

Ethanol fuel for rural households

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India's economy is growing at 8% per annum and our national leaders are projecting that in another 10 years we will be the third largest economy in the world and thus an economic power. India also has a very ambitious space program and we are thinking of sending a man to the moon. However, 60% of our rural population still live in extremely primitive conditions and without any basic amenities of life. Thus they have practically no access to electricity and use 180 million tones of biomass every year for cooking via very primitive chulhas (cook stoves) which creates health hazard for the housewife. There are estimates by the World Health Organization (WHO) that about 1.5 million deaths per year take place world over because of pollution caused by smoke of chulhas. Unless and until we provide the rural population with basic amenities of life and try to bring them in the mainstream of national development, our talk of being an economic power will sound hollow.

The availability of clean cooking and lighting fuel, which is renewable and can be grown locally, will be the first and an important step in raising the quality of life of rural population. No modern society uses solid fuel like coal or wood for cooking. Liquid or gaseous fuels are far superior to solid fuels for cooking because of their clean combustion and existing supply chain convenience. Liquid fuels more so since they have much higher energy density than gaseous fuel like biogas or LPG.

Among all the liquid fuels, which can be produced locally and in a renewable manner, ethanol is one of the best. It is an excellent substitute for kerosene and burns better than it without any particulate output or unpleasant smell. In fact its combustion is almost as clean as that of LPG. Hence the use of ethanol fuel for cooking and lighting for rural areas needs to be encouraged.

Ethanol from Sweet Sorghum

Ethanol can be produced from any sugary or starchy material and is presently produced world over from sugarcane and corn. Both these crops are very energy and water intensive. Thus there is a need to produce it from a crop which uses much less water than sugarcane and produces

food from the same piece of land. This is essential because the increased industrial usage of ethanol will put severe pressures on land for food production.

Sweet-stalk sorghum (sweet-stalk jowar) is one such crop. Its earhead produces grain, which can be used for making bread, its sweet stem has nearly the same amount of sugar as in sugarcane and hence the juice can be fermented and used for ethanol production. The bagasse, left after juice extraction, together with leaves is an excellent fodder for animals. Thus from the same piece of land one can get food, fuel and fodder. No other crop gives all these three things together. Besides sweet sorghum uses nearly 50% less water than sugarcane to produce the same amount of sugar and is a 4-month crop so farmers can grow two crops/year from the same piece of land. Also the energy output/input ratio of producing ethanol from sweet sorghum is very positive. Thus about four times more energy is produced by burning ethanol from sweet sorghum than goes in its growing and production.

Our Institute Nimbkar Agricultural Research Institute (NARI), which introduced [sweet-stalk sorghum](#) in India in late 1960s, has pioneered its development. NARI has therefore developed the whole technology of its production and usage as a cooking and lighting fuel. Thus a very efficient [ethanol cook stove](#) running on 50% ethanol-water mixture has been developed. This mixture which can easily be distilled very efficiently in a rudimentary rural distillation unit is very safe and less flammable fuel than pure ethanol. The NARI stove works just like an LPG stove with high and low flame settings. Field testing of this stove has shown that the rural housewives like this stove and compare it very favorably with an LPG stove. The main thing is that the ethanol should be made available to rural households.

Similarly, NARI has developed a [lantern running on ethanol](#). It burns very cleanly without any smoke or smell. The ethanol lantern produces light equivalent to that from a 100 W bulb. Presently the Government of India is propagating solar lanterns running on PV cells. These lanterns which use compact fluorescent lamps (CFL) are costly {about Rs. 2000 (\$45/-) and above} and produce light equivalent to that from a 40 W incandescent bulb. This light is not sufficient for children's reading or doing fine work by a housewife. Besides the CFL lanterns are only twice as efficient as ethanol lanterns when we consider the power plant-to-light efficiency. Thus with little more R&D, it may be possible to make ethanol-based lanterns more efficient than electric lighting. In the absence of grid electricity to most of the rural areas, liquid fuel lanterns running on ethanol provide an attractive alternative.

Another unique way in which ethanol can be used for lighting in rural areas is via electricity generation through two wheelers. All two wheelers world over run on petrol powered internal combustion engine, which can be easily converted to run on ethanol. Electricity generation can take place when the two wheeler is converted into a hybrid vehicle. In a hybrid

vehicle the small internal combustion engine running efficiently on ethanol or petrol charges the battery to run the electric motor system. Thus in the stop/start conditions of city driving the vehicle mostly runs on the efficient electric motor. Such hybrid systems are being used extensively all over the world in cars. These hybrid cars make the internal combustion engine run very efficiently thereby giving higher mileage with reduced air pollution. When the vehicle is not running the system can act like a power plant producing electric power. Every two wheeler can therefore potentially become a mobile power plant. However extensive R&D is needed to make this happen.

There is a rapid penetration of these two wheelers in rural India - roughly 12 million of these vehicles exist in these areas. Each two wheeler can easily power 5-10 households. A rough estimate shows that rural-based two wheelers can produce ~ 24,000 MW power, enough to light up the whole rural India. On an average these two wheelers run only 10% of time. Thus 90% of time they are standing idle and during this time they can power the rural India via ethanol fuel. Running these hybrid two wheelers on ethanol fuel will therefore improve the environment and at the same time light up the lives of rural India.

Besides sweet sorghum another technology which will be very useful in producing ethanol on large scale and without effecting food production will be the use of agricultural residues. Major efforts therefore world over are being put in converting these residues (consisting of cellulose and hemicellulose) into ethanol. Once the technology becomes economically attractive then this will help in producing food and fuel from the same piece of land since after food harvest the residues left could be used for ethanol.

Another liquid fuel that is being recently promoted by Government of India (GOI) is biodiesel from *Jatropha* or *Karanja* (*Pongamia pinnata*). These fuels are excellent for diesel-based combustion engines of automobiles or gensets but are unsuitable for two wheelers. Besides they cannot be used in existing kerosene cooking stoves or lanterns since they produce high amount of carbon during combustion which chokes up the fine nozzles used in these devices. Consequently R&D is needed to make new stoves and lanterns to run on biodiesel. Besides the yield output of biodiesel from the existing crops is very low and there is a need to improve them so that farmers can get good remuneration from their produce. Ethanol does not suffer from these shortcomings and can be used immediately for rural area applications if made available.

Policy decisions

However for ethanol to be used routinely in rural areas, Government of India (GOI) should take a policy decision of allowing its use as a household fuel. Presently its production and sale is controlled by a very rigid excise regime primarily because of issues regarding the drinking

of this ethanol. However there is enough chemistry known to mankind so as to make any ethanol non-potable and unpalatable. Use of such chemicals will completely hinder drinking.

To further facilitate the use of ethanol for rural households it is necessary that GOI together with state governments should completely remove the excise duty on ethanol used for this purpose. This will make the fuel very affordable and it will be similar to providing subsidy to poor for kerosene and LPG. The cost of ethanol from sweet sorghum after excise duty removal can be as low as Rs. 10-14/liter.

It can be contended that with the removal of excise duty on ethanol for rural applications, the government of India will lose substantial revenue. However with the increasing ethanol consumption for automobile purposes, there will be many opportunities for GOI to recover the lost revenue. Besides the GOI will save money in less importation of kerosene. With the introduction of flexi-fuel vehicles (vehicles which can run either on petrol or ethanol) in the country, there will be a boom in the economy resulting in more revenues for GOI. These flexi-fuel cars are already running in large numbers in Brazil and Europe.

The use of ethanol for rural applications will also create a great wealth in rural areas in terms of growing the crops and producing ethanol from them. It is estimated that the industry to produce ethanol for such purposes for rural areas can be of the order of Rs. 2,00,000 crores/year (\$ 45 billion) and can make the ethanol economy 100 times bigger than the present one based on automobile consumption only. Interestingly if all the existing sorghum growing area (~ 10 million ha) in India can be brought under sweet-stalk sorghum then 15% of all the required ethanol could be produced from this area. Besides farmers do not need to change their agricultural practices.

In order that large scale ethanol production and its use takes place in rural India the GOI needs to clearly enunciate a National Alcohol Policy and set up a National Technology Mission on its use for rural applications.

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