Summary of a paper written in Norwegian. Professor Herman L Qvam

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Biofuel, Cold Pressed Pure Plant Oil as Fuel for Developing Agriculture

The purpose of this summary note is to see the possibilities of biofuel from the small scale farmers point of view. We omit questions about pollution, finance and social conditions and restrict the overview to technical basic conditions. Some comparisons might be drawn to the situation the small scale farmer had in our own agriculture some 50 to 60 years back when the mechanization of agriculture started here.

Area for agriculture.

Statistically it is shown that agriculture based on animals as pulling power, it was necessary to set aside 20 to 25 % of area for fodder for the animals. (USA, Denmark, Norway etc). If the animals are replaced by mechanized pulling power, these areas can be freed for growing other crops. It is fair to assume that the situation is similar in developing agriculture.

From the FAO report “The State of Food and Agriculture” 2008 it is shown that there are available agricultural areas around the world. In Latin America and Sub-Sahara Africa only 20 % of land suited for rainfed crop production are in use. For industrial countries and transition countries only 50 % are in use. For South Asia , Near East and North Africa there are not much free areas.

Potential agricultural areas and reassigned areas should be ample for producing biofuel for own agricultural use.

Fuel types and need

Average figures for mechanized agriculture shows that a tractor needs about 100 l of diesel fuel to cultivate one hectare land per crop. 100 liters of diesel equals $3,6 \times 10^3$ MJ (Mega Joule)

This fuel can be obtained in several ways.

-Ordinary fossil based diesel can be bought from the world market. The primary energy for making diesel has to be fossil crude oil.

-Biodiesel or bioethanol can be produced from various crops to be used in ordinary or slightly modified standard engines. The transesterification to biodiesel is done in centralized processing plants. This requires extra processing energy.

-Pure Plant Oil (PPO) or Straight Vegetable Oil (SVO) can be pressed directly from the oil fruit and by filtration and proper handling and storage (all at a low technical level) this can be used as ordinary fuel in modified diesel engines (preheating oil when starting, extra filters and in some cases modified injectors). This production of fuel can be done locally with small costs for logistics and equipment. The process energy is low.

The PPO is the raw material for further processing by transesterification into Biodiesel.

Engines and Engine Conversions

Various types of engines and engine conversions can be applied for biofuels.

Bioethanol can be used in most petrol engines in various blends with petrol.

Biodiesel can be used in most ordinary diesel engines without modifying the engines.

Pure Plant Oil (PPO) can be used in modified diesel engines. The most commonly used system is to use a two tank system with ordinary diesel for starting a cold engine.

The conversion is technically simple. However, some care has to be shown when in use.

Particularly Germany has led the use of PPO and the conversion of engines. Both the tractor manufacturer Fendt and Deutz Fahr has tractors for two tank system diesel and PPO. Mercedes Benz and Catepillar are some other engine makes that are working with PPO. In Germany alone there are more than 15 firms with conversion sets for PPO. Germany has issued a Standard V DIN 51605 for the components of PPO for fuel.

Energy

The energy need for producing PPO and biodiesel is shown below. The energy need for transesterification (making biodiesel from PPO) is about the same as for

producing PPO (alt b). As all energy use has to be paid for, the best is to produce to the lowest possible energy level.

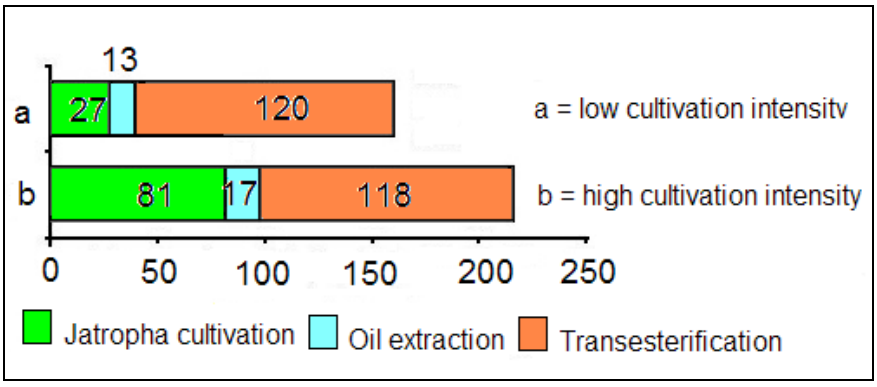
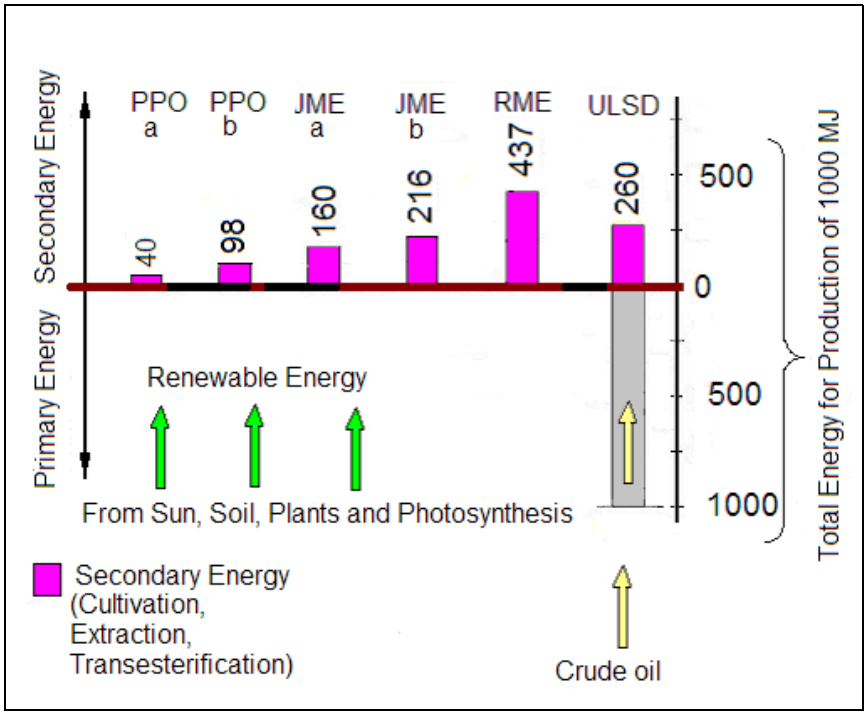


Fig 1 Energy measured in MJ (Mega Joule) needed for producing 1000 MJ Jatropha PPO and Biodiesel.



PPO = Pure Plant Oil from Jatropha, JME= Biodiesel from Jatropha, RME = biodiesel from rape seed

ULSD = Ultra low sulphur diesel from fossil crude

Fig 2 Primary and Secondary (Process) energy for producing various fuels.

From figure 2 it is clear that the Primary Energy for production of biofuel and fossil fuel vary enormously. The Primary Energy for fossil fuel is the amount of crude oil needed to produce diesel with energy content of 1000 MJ (Mega Joule) . In addition there is a need for 260 MJ in Secondary Energy (Process Energy).

This can be compared to the energy needed to produce 1000 MJ of Jatropha PPO. The Primary Energy for this is the radiation from the sun, the plants and the photosynthesis during the growing season. All this is for free. The Secondary Energy (Process Energy) is the running of the press, some fertilizer and handling , all much less energy consuming than the process of making fossil diesel.

Energy balance is defined as **Energy stored / Energy for production**

From the example above the Energy balance for fossil diesel is : 1000 / 1260 = 0.8

Similarly the Energy balance for Jatropha PPO is : 1000 / 98 = 10.2

10 times more Process energy is consumed to make one unit of fossil energy than energy in the form of PPO. The Primary Energy for fossil fuel is consumed. It is renewable for PPO.

Energy balance for Biodiesel made from Jatropha is : 1000 / 216 = 4.6

The Energy balance for biofuels varies greatly dependant on type of plant used. E.g for biodiesel made from Soybean the FAO report gives an Energy balance of 1.2 to 3.2. however by use of high technology.

The production of fossil fuel is very specialized and involves high technology levels and complicated distribution systems. The market prices vary a lot and makes it difficult for a farmer to adjust . The remote farmer have no influence on the price structure. During the last period with high prices it was reported that the price of camels had tripled as the farmers could not afford to by tractor fuel.

Fig 3 Price variation for crude oil last 12 months

Jatropha

Jatropha Curcas is a bush like plant that can grow on near barren soil with a yearly rainfall down to 300 mm. The fruits with the seeds is of the size of plums and can be handpicked. The plants can became some 50 years old. Yield is reported to vary much.

Extensive testing of the plant is reported to be going on in India and China. For unknown reason the plant is not considered in the FAO report The State of Food and Agriculture 2008.

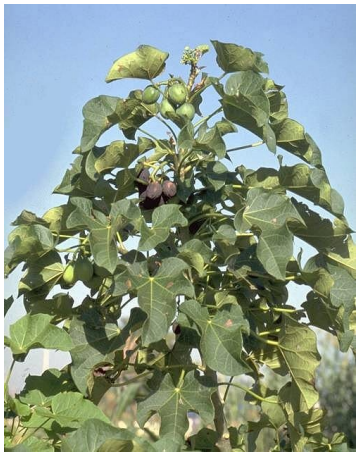


Fig 4 Jatropha plant and a Chinese press for cold pressing of PPO.

Vehicle for Developing Agriculture

The GT (Getting There) is a vehicle concept that takes the above factors into consideration. The vehicle is of simple design, but with two rigid axles and a patented internal drive train it has 4x4 drive and a very high stability in the terrain.(45 degrees sideways tilting angle empty)

The engine is converted to run on PPO by a two tank system.

The vehicle concept won the World Bank competition Development Marketplace 2006 first of 2500 entries.

The vehicle is intended to give the remote farmer or village access to market without building roads. The design make use of paths and dirt roads because of low ground pressure and light weight.

In addition to be a transporter of freight the vehicle should also be a light tractor for light agricultural work.

The vehicle has an electric generator and can work as a Multifunctional Platform according to UNDPs requirements.

The vehicle can use single tires, twins or individual belts.

It is easy to make the vehicle as a knock down version . This will facilitate 16 complete vehicles into two 20 foot containers and make a good transport preparedness for emergencies.

The fuel consumption in terrain is dependent on total vehicle weight.

Vehicle	Vehicle weight	Payload ton	Total weight
M621 Military truck	**6,1**	**2,5**	**8,6**
Mercedes Unimog	**5,0**	**2,5**	**7,5**
70hk Tractor/trailer	**6,0**	**2,5**	**8,5**
GT (Getting There)	**2,1**	**2,5**	***4,6***

The vehicle is described at www.greentrac.org

Fig 5 The GT (Getting There) with individual belts. Two tanks can be seen for diesel and PPO. The vehicle use the payload toget equal weight on both axles for best traction.

Referanses

1. The State of Food and Agriculture" FAO 2008
2. Bugge, Jacob. NOTAT: RAPSOLJE TIL TRANSPORT 2: Landbruk og energi (www.folkesenter.dk/plant-oil), 9/11 2000.
3. Von Damme, Patrick. Baert, Arne. Bioenergi from plants. Ghent University, Blgium.
4. Bugge, Jacob. NOTAT: RAPSOLJE TIL TRANSPORT 1: ENERGIBALANSE OG CO2-BALANSE. Dansk Vidensenter for Planteoljeteknologi (www.folkesenter.dk/plant-oil), 2000.
5. ELSBETT Umrüsttechnologie-Grundsätzliches (www.elsbett.com/de/elsbett-umruesttechnologie/grundsaetzliches.html).
6. DEUTZ Technical Circular 0199-99-1174 EN (www.deutz.com).
7. Utenriksdepartementet. ECON-rapport 2007. Prosjekt 53870.
8. GreenTrac www.greentrac.org
9. Muench-Kiefer: www.jatropha.de/documents/Muench-Kiefer-Jatropha-Diplomarbeit1986-de.pdf
10. Technologi- und Förderzentrum (TFZ) 10/07. Einfluss der Rapssaatreife auf Kraftstoffqualität und deren Auswirkungen in Verbrennungsmotor, www.tfz.bayern.de
11. RANENERGI BIODRIVSTOFF-POTENSIAL FOR NY NÆRINGSVIRKSOMHET
12. www.malifolkecenter.org
13. Nature vol 449/11 Oktober 2007
14. profi 11/2007. Deutz-Fahr Agrotron NaturalPower: Rapsöl fahren mit Herstellergarantie (www.profi.com).
15. Advanced Combustion Research for Energy from Vegetable Oils (www.nf-2000.org/secure/Fair/S484.htm).
16. www.worldagroforestrycentre.org/news/default.asp
17. www.journeytoforever.org
18. www.ufop.de/downloads/03_schuemann.pdf
19. Biofuels for transportation Worldwatch Institute 2006