FROM FIELD TO FACTORY TO DIESEL TANK

EMPOWERING LOUISIANA AGRICULTURE

BY PAUL A. OLIVIER PH.D.

A NEW CASH CROP

Louisiana farmers stand in need of a new cash crop, and the cultivation of the Chinese Tallow tree (*Triadica sebifera* syn *Sapium sebiferum*), an ideal oil-bearing plant for biodiesel production,[1] would fulfill this need in a timely manner. Within just a few years after planting, this perennial plant bears seed and continues to do so for decades.[2] Once established in Louisiana soils, as every farmer and rancher in the state can attest, this plant requires no irrigation, no herbicides, no fungicides, no insecticides, no tillage and very little fertilization.[3]

Its principle requirement would be an annual pruning and harvesting, and both could be accomplished in a one-pass operation using existing agricultural equipment modified for high clearance. This energy crop would create no soil erosion and runoff, and unlike conventional agriculture that heavily depends on inorganic fertilizers that deplete soil carbon, this new agricultural initiative would do just the opposite. A portion of the biomass left behind after pruning and harvesting would be sequestered as a soil

---

[1]"Initial extractions have yielded between 40% and 45% extractable material. Gas chromatography with flame ionization detection has revealed that the oil from Triadica sebifera contains over 50% palmitic fatty acid, along with some oleic, linoleic and linolenic fatty acids. These fatty acids can be transesterified and processed to form biodiesel." See: http://aiche.confex.com/aiche/2006/techprogram/P67546.HTM

[2] "S. sebiferum plants have tremendous reproductive potential. They may reach reproductive age in as little as three years, and in greenhouse experiments, seedlings flowered in their first year of growth… Trees can remain productive for 100 years." See: http://tncweeds.ucdavis.edu/esadocs/documnts/sapiseb.html

[3]"Cameron and Spencer (1989) examined the rate of Chinese tallow leaf decomposition and the quantity and rate of nutrient inputs from decomposing leaves in a tallow tree forest. They determined that approximately 24% of biomass in Chinese tallow leaves was lost within the first week; 50% of biomass was lost after four months, and total reduction occurred in approximately seven months. By comparison, some temperate deciduous trees take an average of 3.9 years to achieve total decay (Swift et al., 1979). Soil analysis revealed that concentrations of P, K, NO3-, Zn, Mn, and Fe were significantly higher in soils subtending tallow tree forests than from prairie plots, whereas concentrations of Na and Mg were significantly lower. Levels of Ca and S did not vary significantly between sites. These results suggest that established populations of Chinese tallow appear to significantly alter nutrient distribution in subtending soils, and may contribute to enhanced productivity of invaded habitats." http://www.fleppc.org/Manage_Plans/Tallow_Plan.pdf

constituent. Through allelopathic means, this amazing plant even produces its own herbicide.[4]

An Amazing Plant

Since the Tallow tree is highly resistant to drought, flooding, fire, cold, bacteria, virus, fungi, nematodes, mites, grasshoppers, beetles and all other insects that relish living biomass,[5] the farmer would entertain very little risk in growing it, and since mature seed remain on the Tallow tree during fall and winter for well over two months,[6] the farmer would entertain very little risk in harvesting it. With no growing or harvesting risk, the farmer would not need crop insurance, and since he would expend very little energy in cultivating this plant and transporting its seed to local biodiesel refineries, the entire supply chain, from field to factory to diesel tank, would be local, short and extremely efficient.

The Tallow tree is adaptable to a wide range of soil and light conditions. From highlands to lowlands, from inland areas to marshes, from fresh water soils to saline-sodic soils, from hills to flood plains, from open prairies to closed canopy forests, from pine forests to cypress swamps, from rural areas to densely populated urban areas, it can be found throughout most parishes in the state.[7] The Tallow tree quickly becomes the dominant plant in the area it invades, causing large-scale ecosystem modification by displacing not only native vegetation but also a lot of the wildlife that co-evolved alongside it. Once it is well established, it appears almost impossible to eradicate. Unless we find some way to work in harmony with this formidable enemy, it will surely defeat us.

Terminator Technology

---

4 "Chinese tallow is known to possess a suite of toxic secondary metabolites in every part of the plant, so it is possible that this species does in fact gain a competitive advantage through chemical mediation, either by suppressing the growth and fitness of neighboring plants or facilitating its own growth." http://www.fleppc.org/Manage_Plans/Tallow_Plan.pdf

5 "Chinese tallow trees are remarkably free of insect pests and serious pathogenic organisms." See:

http://www.plants.usda.gov/plantguide/pdf/pg_trse6.pdf p. 5. Interesting field experiments reveal that certain native generalist herbivores such as grasshoppers are fully capable of feeding on the Tallow tree, that under confined and artificial conditions, they find it palatable and are not affected negatively in eating it, but since they do not recognize it as a suitable host plant under natural conditions, they do not feed upon it. See http://www.ruf.rice.edu/~ecology/Lankau_et_al2004.pdf

6 Seeds typically persist on the plants for periods of up to six months (McCormick, pers. observation). http://www.fleppc.org/Manage_Plans/Tallow_Plan.pdf

7 For it distribution within Louisiana, see: http://plants.usda.gov/java/county?state_name=Louisiana&statefips=22&symbol=TRSE6

To meet the objection of environmentalists rightfully concerned about the propagation of the highly invasive Tallow tree, some form of terminator technology could be used to produce infertile Tallow trees. [8] But terminator technology as described in US patent 5,732,765 is a fairly complicated process involving two generations of plants.

Genetically engineered DNA is inserted to produce a toxin that kills the embryo within the seed, a seed that looks normal in every respect but is infertile. But the production of this toxin cannot happen in the first generation. The first generation of plants must produce viable seed that a company such as Monsanto can sell to farmers. It is only second-generation that plants that are called upon to produce infertile seed, and consequently the farmer must come back to the seed company each year to buy seed.

This complicated two-generation process can be bypassed in the case of the Tallow tree. A Tallow tree can be rendered infertile by means of other techniques not described in the above patent, and this genetically modified tree, unlike cotton and other agronomic crops, does not have to be propagated from seed. It can be propagated by means of tissue culture techniques, or it can be propagated very cheaply from cuttings.

Some argue that Tallow trees cannot be propagated from cuttings, but this is clearly not the case. Horticulturists in Louisiana for many years have had no problem getting Tallow trees cuttings to root.

By clearing land of fertile Tallow trees and by cultivating infertile Tallow trees in their place, the farmer would play an important role in the eradication of this invasive plant. It could even happen that the pollen from infertile Tallow trees could render infertile the seed of wild Tallow trees growing nearby.[9] If the government currently does not have the resources and determination to control the proliferation of this invasive plant, Louisiana agriculture, driven by a strong profit incentive, could take the lead and do more in this regard than anyone could ever imagine.

Surplus or marginal lands would be cleared of invasive Tallow trees, and the biomass generated in this clearing would be used for the production of wood alcohol, as explained further in this paper. The planting and cultivation of infertile Tallow trees would follow. Within a few years the farmer could begin to harvest seed, and would do so year after year with very little additional investment or risk.

A Tallow Tree Hedge

The cultivation of the Tallow tree into a row-crop similar to tea cultivation where a hedge-like design is maintained by annual pruning to a specific height is far from being a complicated task. Growth regulators or growth inhibitors (auxins) that minimize vegetative growth and promote seed

[8] In 1998 the Delta and Pine Land Company, in collaboration with the USDA, was awarded US Patent Number 5,723,765: Control of Plant Gene Expression. This company was later bought by Monsanto.

[9] See: http://www.victoryseeds.com/news/terminator_gene.html

production should enhance mechanical pruning techniques and make this plant an even greater producer of oil.

Under controlled conditions, there are several native predator insects that find Tallow leaves quite palatable and nourishing, but in a natural setting, it appears that nature does not allow them to experiment with novel food sources.[10] Eventually, however, through the intensive cultivation of the Tallow tree by man, they might be stimulated to seek an alternative food source and take advantage of this rich bounty of biomass.

Since the biodiesel refinery might own and operate the harvester, the farmer might do nothing other than make a certain portion of his land available for fuel production. The farmer could always depend on a stable revenue stream from his Tallow trees, and this would help shield him from the risk associated with growing food crops. Instead of paying the farmer to take land out of cultivation and thereby allowing it to become uselessly infested with Tallow trees, the government could target this money toward the production of a strategic energy crop.

Tallow trees could be cultivated on a conventional 6x6-foot grid and initially trimmed to an appropriate height.[11] It would not take long for Tallow trees to fill out in multi-trunk fashion to a 4-foot height, supporting a seamless canopy of foliage effectively harnessing every square inch of available sunlight. Since the sides of any one Tallow tree would be fully occupied by other Tallow trees competing for sunlight, all leaves and seed-bearing stems would be restricted to a two-dimensional surface at the top of the plant, and since sunlight strikes the earth two-dimensionally, it makes little sense, as some have suggested, to prune Tallow trees in complex three-dimensional patterns.

Each Tallow tree produces thousands of six- to eight-inch stems, and at the end of each stem lays a cluster of seeds containing a coating of wax on the outside, commonly referred to as Chinese Vegetable Tallow, as well as a sweet-smelling oil on the inside, called Stillingia Oil. Both wax and oil can be converted into biodiesel. The meal that remains behind after the oil is extracted is high in protein and can be used as an animal feed or fertilizer.[12] As a fertilizer, this meal could be returned to the field from which it came to help restore and stabilize soil nutrient levels.

Mechanical and chemical pruning techniques would force the plants to throw

10 "Dietary experimentation is generally selected against, as the risks of selecting a toxic plant exceed the benefits of gaining an additional food source (Feeny, 1975; Abrahamson & Weis, 1997)." See http://www.ruf.rice.edu/~ecology/Lankau_et_al2004.pdf p.73.

11 See drawing at the end of this paper.

12 "According to one report, seed contains about 20% oil, 24% tallow, 11% extracted meat, 8% fibrous coat and 37% shell…. Stillingia oil is considered superior to linseed oil in its drying and polymerizing properties, probably due to the presence of 2,4-decadienoic acid. Seed meal, left after the extraction of oil, possesses a high content of protein, and is a valuable feed and fertilizer." See: http://www.hort.purdue.edu/newcrop/duke_energy/Sapium_sebiferum.html

up a sea of stems all vertically aligned to the same four-foot height to meet the horizontal cut of the harvester blade.[13] Each front tire of the harvester would have its own set of blades to clear a path through this maze of branches. Each year the harvester would tread the same path so as to minimize damage to itself and to the trees it services.

THE RICHEST OIL-BEARING PLANT

But just how productive is the Tallow tree?

The Tallow tree has been cultivated in China for over 14 centuries, and it appears that the Chinese knew what they were doing. Per acre it produces 39 times more oil than cotton seed, 19 times more oil than flax, 15 times more oil than soybeans, 10 times more oil than sunflower or safflower, 9 times more oil than *Jatropha curcas* or corn, 7 times more oil than peanuts and 5 times more oil than rape seed. Its annual production situates at about 645 gallons or 15.4 barrels of oil per acre.[14] Some experts, however, cite figures as high as 970 gallons or 23.1 barrels of oil per acre.[15] Dr. Gary Breitenbeck of LSU, based on his work with Tallow tree cultivars that he has recently observed, believes that this figure could be as high as 1,200 gallons of oil per acre.

The Tallow tree not only produces more seed per acre than any of the above plants, but its seed has the highest percentage of extractable oil for biodiesel production (from 40.5% to 50.7%).[16] Nature, with a little help from the Chinese, has engineered the perfect oil-bearing plant, each a virtual oil well that never runs dry.

THE HIGHEST ENERGY YIELD

If we compare the amount of energy stored in Tallow biodiesel to the amount energy

---

13 "In their effusive praise of the utility of Chinese tallow as a cash crop, Scheld et al. (1980) suggest that the tallow tree is readily adaptable to, and even appears to facilitate, machine harvesting of seeds, as evidenced by the fact that the majority of harvestable crop is 'borne largely in the periphery of

the crown, where it is readily accessible by hand or mechanical means.'" http://www.fleppc.org/Manage_Plans/Tallow_Plan.pdf

14 See Klass, Donald, *Biomass for Renewable Energy*, Fuels and Chemicals, Academic Press, 1998.

"The main benefit of choosing Triadica sebifera as a biodiesel feedstock is its high oil yield for a given plot of land. One hectare of Chinese Tallow trees can produce approximately 12,500 kg of seed, which could potentially yield 5,500 kg of oil. This amount of oil per hectare is almost 15 times that of soy oil, which is the most commonly used oil for making biodiesel in the United States."

http://aiche.confex.com/aiche/2006/techprogram/P67546.HTM

15 See http://www.engg.ksu.edu/chsr/events/che650/200601/docs/10Schrock.pdf Slide 55.

16 "The seed kernel is rich in lipids, consisting of approximately 40.5 - 50.7% fat by weight,

and also contains between 8.1-9.2% protein (Duke and Aysensu, 1985)." http://www.fleppc.org/Manage_Plans/Tallow_Plan.pdf required to grow, process and distribute this fuel, only then do we appreciate what this unique plant has to offer. Not only does biodiesel have the highest energy yield of any liquid fuel (more than twice that of bioethanol), but Tallow tree biodiesel has the highest energy yield of any other biodiesel. Since the cultivation of this plant demands so little input from the farmer, no plant grown on Louisiana soils could possibly produce a fuel of a higher net energy balance.

Free-range chickens and other foul could be raised under the shaded canopy of the Tallow tree. They would thrive on insects and other invertebrates that flourish within this dense bonsai-like forest, and they would also feast upon any seed that might fall to the ground after harvesting.[17]

Their waste, rich in nitrogen and phosphorus, would help breakdown the leaves that fall in autumn as well as the twigs and pods left behind by harvesters a few months later. All of this activity would create a rich layer of mulch, leading to a thorough aeration of the topsoil. Since cattle, horses and donkeys do not eat Tallow leaves, they could graze freely along the turn rows of these cultivated grids, and the donkey could be enlisted to protect the resident poultry from fox, coyotes and wild dogs. Bee-keepers would benefit from the abundance of nectar made available in these intensively cultivated zones.[18]

Coastal Areas

In coastal areas flooded with salt water as a consequence of hurricanes Katrina and Rita, we find farmland that remains to this day unfit for conventional agriculture. Surprisingly most of these contaminated soils have been able to support Tallow trees, even those that were flooded, for example, with 8 to 10 feet of salt water where virtually everything else had died.[19]

Hurricanes will inevitably return to coastal Louisiana, but with the Tallow tree, all is not hopeless. By growing Tallow trees instead of rice, cane and other food crops, Louisiana farmers will continue to earn a living in these marginal, low-lying coastal areas. The Tallow tree could even be cultivated as a means of preventing coastal erosion and as a first line of defense against storm surges generated by hurricanes.

In our addiction to fossil fuels, we pollute our environment, we contribute to global warming, we drain money from our economy and as Thomas Friedman so correctly argues, we often provide terrorists with the funds they need to bomb us. By growing our own oil, a green oil, we put an end to this absurd and short-sighted

17 "Birds, including domestic fowl readily eat its fruits. It has been considered a desirable plant for bird-food (Duke 1983)." See: http://www.plants.usda.gov/plantguide/pdf/pg_trse6.pdf p. 2.

18 "The flowers of Chinese tallow are favored by honeybees, which produce a desirable, light-colored honey from it." See: http://www.plants.usda.gov/plantguide/pdf/pg_trse6.pdf p. 2.

19 As reported to me by Dr. Gary Breitenbeck of Louisiana State University.

behavior. But could we ever grow oil to such an extent that we would no longer be obliged to import it, at least the oil needed to meet the US demand for diesel fuel?

THE US DEMAND FOR FUEL

In 2003 the US consumed 39.9 billion gallons of diesel fuel,[20] while one acre of Tallow trees produces, as you may recall, about 645 gallons of oil per year. Therefore 62 million acres of Tallow trees would be needed to meet the 2003 demand for diesel. This acreage appears to be quite large, but the United States has a huge land mass, and size here is quite relative.

In 2002 US farmers placed more than 941 million acres under cultivation. Therefore less than 7% of the 2002 farmland would have to be set aside for Tallow tree cultivation.

But back in 1953 US farmers put 1.21 billion acres of farmland into production. The difference between 1953 and 2002 cultivation figures is some 265 million acres, four times more acreage than what would have been needed to satisfy the US demand for diesel fuel in 2003. This, of course, does not include what could be cultivated on marginal lands unfit for agriculture yet already infested by Tallow trees.

The US government subsidizes farmers to grow in an unsustainable manner large quantities of food that its citizens cannot consume. As a result, commodity prices plummet, calling for more subsidy and protection. From 1995 through 2004 American taxpayers spent an unbelievable $143.8 billion on direct farm subsidy payments. "Of that amount, more than $104 billion—72%—went to just 10% of recipients, including large farming operations, cooperatives, partnerships and corporations such as Archer Daniels Midland and Tyson Foods."[21] Never in the history of mankind has so much food been produced by so few people for such a large number of people who cannot consume it.

THE FOOD OR FUEL DEBATE

But why do we extract oil from an edible, annual food commodity like soy or peanuts, when we could extract it from a largely inedible, perennial commodity that, unlike soy and peanuts, consumes very little fertilizer and fuel, and at the same time produces far more oil? In our frantic search for fuel, why do we conflate food with fuel when the two are quite distinct? Just as we do not drink gasoline or diesel, why should we burn food?

Along similar lines, why make ethanol from sugar, when sugar itself is a far more valuable commodity than the fuel it produces? Would it not make more sense to make ethanol from the waste food, paper

[20] See Biodiesel: The Sustainability Dimensions by Al Kurki, Amanda Hill and Mike Morris, p. 2.

[21] See *U.S. Farm Subsidies: Billions and Billions Served* by James Pethokoukis http://www.policytoday.com/index.php?option=com_content&task=view&id=66&Itemid=40

and cardboard that we so casually dump in landfills? In addition to biodegradable municipal solid waste, the US also produces a huge tonnage of sewage sludge, industrial bio-sludge, recycled paper fines, agricultural and forestry residues as well as manure.

In total the US produces over a billion tons of biodegradable waste each year. This waste, according to Dr. Mark Holtzapple of Texas A&M University, could generate 135 billion gallons of mixed alcohols per year,[22] almost enough fuel to meet the entire US demand for gasoline that currently stands at 130 billion gallons per year.[23] But unfortunately Dr. Holtzapple's mixed alcohol fermentation process is still experimental with respect to woody biomass, and these one billion tons of waste lie distributed throughout the whole of the United States. Not all of it is economically accessible, transportable and available for alcohol production. However, this shortfall in biomass could be easily remedied.

METHANOL PRODUCTION

One acre of Tallow trees produces approximately 5.6 tons of seed/year, and over half of this weight in seed is not extractable oil and could serve as biomass for alcohol production. But in addition to this seed biomass, there would be a huge biomass made available each year by the pruning of the Tallow tree.[24]

We can conservatively project that the dry weight in Tallow tree biomass should be at least 2.5 times its weight in seed, and instead of attempting the direct fermentation of this woody biomass as Dr. Holtzapple suggests, we could gasify this biomass and convert the resulting synthesis gas into methanol.

On methanol (wood alcohol) the National Renewable Energy Laboratory writes: "The long time interest in methanol is due to its potential fuel and chemical uses. In particular, methanol can be used directly or blended with other petroleum products as a clean burning transportation fuel. Methanol is also an important chemical intermediate used to produce: formaldehyde, dimethyl ether (DME), methyl tert-butyl ether (MTBE), acetic acid, olefins, methyl amines, and methyl halides, to name a few."[25] Methanol can even be used to

[22] See http://en.wikipedia.org/wiki/Bioconversion_of_biomass_to_mixed_alcohol_fuels

[23] The energy density of mixed alcohols is less than that of gasoline.

[24] "More recently, the (Tallow) tree has been regarded as a promising biomass candidate in the Gulf coast region of the United States, because of its ability to re-sprout, its rapid growth rate, and its drought and salt tolerance (Scheld & Cowels 1981). Field trials demonstrate that the species can produce six times as much woody biomass as Populus selections grown in Wisconsin (Scheld & Cowles 1981). Chinese tallow can be grown over large areas by conventional agricultural methods and can provide woody biomass for direct burning or conversion to charcoal, ethanol, and methanol (Scheld & Cowles 1981)." See: http://www.plants.usda.gov/plantguide/pdf/pg_trse6.pdf p. 3. Also see: http://www.srs.fs.usda.gov/pubs/ja/ja_eberhardt003.pdf p. 320.

[25] See http://www.nrel.gov/docs/fy04osti/34929.pdf

produce polyethylene (PE) and polypropylene (PP).[26]

Methanol is less toxic than gasoline, and unlike gasoline it is not carcinogenic. "When used in spark engines, the higher the concentration of methanol in a methanol/gasoline blend the lower the amount of CO, HC, and NOx in the exhaust emissions. In fact, the addition of tertiary butyl alcohol (TBA) and methanol may reduce the CO emissions up to 40 % and the hydrocarbon emissions up to 20 % in comparison with conventional gasoline."[27]

Not only is methanol one of the safest fuels available,[28] but if accidentally spilled into the environment it is easily degraded by a diverse range of micro-organisms. Methanol can be converted into a gasoline with a high octane number, and surprisingly it can also be converted into diesel. It can even be used in direct methanol fuel cells without having to extract hydrogen from methanol.[29]

Without doubt Tallow tree biomass could serve as a feedstock for methanol production, and with a methanol production rate of 157 gallons/ton of biomass[30] and with over 17 tons of Tallow tree biomass per acre per year, we can safely project that one acre of Tallow trees, in addition to 645 gallons of oil, could produce annually over 2,690 gallons of methanol. This means that with 62 million acres of Tallow trees under cultivation, the United States could produce over 166 billion gallons of methanol. Even though the energy density of methanol is approximately half of that of gasoline, this quantity of methanol would fulfill approximately two thirds of the US demand for gasoline.[31]

---

26 See: http://www.chalmers.se/ee/SV/forskning/forskargrupper/miljosystemanalys/publikationer/pdf-filer/2006_2/downloadFile/attachedFile_1_f0/2006-17.pdf?nocache=1178190483.71

27 See ibid, p. 64.

28 "In the United States, there are over 180,000 vehicle fires each year in which gasoline is the first material to ignite. According to the Environmental Protection Agency (EPA), a switch to methanol could reduce the incidence of these fires by 90 percent, saving 720 lives, preventing nearly 3,900 serious injuries, and reducing property losses by millions of dollars." http://www.methanol.org/fuelcell/special/promise.cfm

29 Also see: http://www.methanol.org/fuelcell/special/promise1.cfm

30 "Today, technological developments in the conversion of biomass to other products have occurred because of the need to mitigate climate change. These technologies allow us to convert biomass efficiently and economically into methanol. For example, one ton of dry biomass can be converted to produce about 157 gallons of methanol because conversion efficiencies approach 50% today. This efficiency of conversion means that small diameter stems of trees and wood waste materials, that would normally go to a landfill or were combusted to produce steam to generate electricity, can now be collected in a sustainable manner to substitute for natural gas production of methanol." http://www.iforest.com/docs/BiomassBiodiesel.pdf

31 To close the gap on the remaining third, we can always turn to a portion of the one billion

Dr. Kristiina Vogt of Interforest LLC is developing a mobile methanol production unit to be operated on forest waste and other waste carbon sources.[32] ESR Ltd has worked on the development of a gasifier whose gaseous input is pure oxygen (hence no NOx is created) and consequently would produce an even larger amount of synthesis gas and methanol. Under no conditions should we turn to natural gas as a feedstock for the production of methanol. Since methanol is typically used in the production of biodiesel,[33] Tallow tree biodiesel should remain a fundamentally green fuel.

Any one doubting the viability of methanol production from woody biomass should visit the new website of the Biomass Energy Foundation.[34] Its chairman and chief scientist, Dr. Tom Reed, published back in 1973 an article called *Methanol: A Clean Fuel for the Future*. In 1989 Dr. Reed told his friend, Bill Ayres, of the possibility of making biodiesel from cooking oil, and Bill became the first commercial producer of biodiesel in the USA.

As part of the Rapid Energy Group, Bill Ayres is currently developing a process to produce methanol from any type of natural or synthetic gas. Using this type of methanol converter, Bill Ayres cites figures as high 250 gallons of methanol per dry ton of biomass. At 20 dry tons of biomass per acre of Tallow trees per year, this gives 5,000 gallons of methanol per acre per year. Never in the history of modern agriculture has a farmer had the possibility of making so much money per acre of land.

The production of biodiesel and the production of methanol work hand-in-hand and could take place on the one integrated processing site that may also include the production of ammonia.[35] Since Tallow tree biomass could be harvested, transported and even processed in parallel to Tallow tree seed, the energy yield of Tallow tree wood alcohol should exceed that of any other alcohol.

In addition to his MixAlco fermentation process,[36] Dr. Holtzapple has developed a Brayton cycle engine that operates according to the same thermodynamic principle as a jet engine. This engine (consisting of a compressor, combustor, heat exchanger and expander) can burn fuel with an efficiency rating from 45% to 60%, enabling a typical compact automobile to travel anywhere from 120 to 180 mpg.[37] His engine can burn almost any type of fuel (alcohols as well as diesel), and with a four-fold increase in fuel efficiency, the amount

---

tons of waste biomass generated each year in the USA.

32 See http://www.iforest.com/biomass.htm

33 "Simply put, biodiesel is the product of mixing vegetable oil or animal fat with alcohol (usually methanol or ethanol) and a catalyst, usually lye. Glycerin is the main by-product." See p. 2 of http://attra.ncat.org/new_pubs/attra-pub/biodiesel_sustainable.html?id=Louisiana

34 http://www.biomassenergyfoundation.org/ABOUTUS/team.htm

35 On many sites where methanol (CH_3OH) is produced, we also find the production of ammonia (NH_3).

36 See http://epa.gov/earth1r6///6pd/pd-u-sw/wte_ftworth/cafo/holtzapple.pdf

37 See http://www.starrotor.com/Engine.htm

of land that must be set aside for Tallow tree cultivation drops from 62 million acres to 15.5 million acres, or an area of only 156 x 156 miles.

Benefits

If we were to take a relatively small portion of US farmland out of food production and devote it to the cultivation of the Tallow tree, our energy crisis would disappear, and eventually US farmers might realize that it is in the best interest of every American taxpayer if they were to compete in global food markets without government subsidies.

But if our politicians and lobbyists insist on subsidizing farmers, why not shift these subsidies from food to fuel and reduce our dependency upon foreign oil? After all we are no longer living in the depths of the Great Depression when food was scare and farmers needed the stabilizing hand of big government. Our vulnerability as a nation does not lie in the procurement of food commodities such as corn, wheat and sugar, but in the procurement of something far more vital to our national security – oil.

Every farmer and every American taxpayer would benefit from this modest shift from food to fuel. As more farm land would be set aside for oil and alcohol production from the Tallow tree, food commodity prices would rise, our nation would import no oil to meet its transportation needs, our trade deficit would decrease, our dollar would increase in value, inflationary pressures driven by rising oil prices would decrease, and the United States would be less prone to engage in war in the midst of oil-producing countries that sponsor terrorism. These same oil-producing countries would have to learn how to do what is right by their people, rather than appease and placate them with a part of the money they earn from selling us oil.

Oil money represents false wealth that in many cases does not reflect the human capital that makes an economy function in a healthy manner. Oil money is the curse of any developing country that is trying to find a secure place in a global economy. Oil money easily generates dictators and potentates, it sustains them in power, and it gives them an authority and prominence on the world stage that they should never possess.

In growing our own fuel, do we not have a cheaper and more effective means of dethroning dictators and spreading democracy than engaging in war? Do we not have a marvelous way to constrain countries such as Iran and Syria in their ability to sponsor terrorism? Terrorists need money to bomb us, and at this time it appears that they get it primarily, either directly or indirectly, from the sale of two things: illicit drugs and oil.

When will we begin to understand that trading in the latter is essentially no different from trading in the former? The former harms our bodies in roughly the same way that the latter harms our planet. Both fuel our addictions and leave us vulnerable and unsafe.[38]

[38] Perhaps no one describes better our addiction to foreign oil than Thomas Friedman: “We need to end our dependence on this part of the world for energy, because it is debilitating for us and for them. It is terrible for us, because addicts never tell the truth to their pushers. We are the oil addicts and they are the oil pushers. The only way we can be brutally honest with them is if we

COMBATING GLOBAL WARMING

This strategic shift in agriculture and fuel production would make a big difference not only in how we conduct foreign policy, but it would also signal to the rest of the world that the United States is serious about combating global warming. Only the morally blind or utterly naïve can now claim that not enough data is in to substantiate that our polar ice is melting, that our seas are rising, and that everything around us is heating up.[39] Louisiana has an excellent opportunity to play a leading role in combating global warming, and the US, unlike many countries that have limited land mass, has sufficient acreage to grow all of the oil and biomass needed to fuel its vehicles.

As oil prices have risen dramatically in recent years, countries such as Indonesia have been converting vast tracts of forests and peat bogs into palm-oil plantations to meet the growing demand of the biodiesel industry. But is this a legitimate way to combat global warming?

Tropical rainforests remove millions of tons of carbon dioxide from the atmosphere each year, and by clear-cutting and burning them, not only do countries such as Indonesia eliminate one of our planet's vital air filtration systems, but they also pump huge amounts carbon dioxide, smoke and decomposition gases into the atmosphere.

With deforestation accounting for 20% of the world's emissions of greenhouse gases, it makes no sense to produce biodiesel from the clear-cutting of rainforests and the planting of palm-oil trees. This is a totally misguided way to combat global warming, and since palm oil is a basic food commodity, it makes no sense, as we have argued previously, to burn food to fuel our vehicles.

It is true that in the production of biodiesel from non-invasive Tallow trees, we would have to remove and clear a significant acreage of invasive Tallow trees. Obviously no environmentalist would object to this. But every ton of this biomass could be used in the production of methanol, and within a few short years, this replanted acreage would fully resume its function of capturing carbon dioxide from the atmosphere.

A MAJOR SHIFT IN THINKING

Following the logic of growing fuel from Tallow trees, we see that all that is big in oil production becomes so small. It begins with a seed about the size of a pea, a seed that is transported a short distance to a refinery that does not demand a huge economy of scale to operate profitably. The oil that this refinery produces is once again transported a short distance to a diesel pump that fuels a truck that travels La Hwy 182. The same logic applies to the production of methanol from Tallow tree biomass. In both cases, the entire supply chain of fuel, with all the jobs,

---

undertake the necessary conservation measures, investments in renewable fuels and a gasoline tax hike that could make us energy independent." See http://select.nytimes.com/2006/12/01/opinion/01friedman.html?th&emc=th

[39] See New York Times, January 29, 2007, "World Scientists Near Consensus on Warming"

http://www.nytimes.com/2007/01/30/world/30climate.html?th&emc=th

money and consumption associated with it, remains completely within our state.

A new biodiesel micro-reactor, developed in association with the Oregon Nanoscience and Microtechnologies Institute (ONAMI), would allow biodiesel to be produced 10 to 100 times faster than traditional methods and on a scale even smaller than before. A device the size of a suitcase could produce "hundreds of thousand of gallons per year," claims its inventor, Goran Jovanovic.[40]

As we place large quantities of green oil on the biodiesel marketplace, many new technologies will emerge to exploit this abundant resource, and this trend toward small, decentralized biodiesel and methanol processing facilities will become the predominant paradigm.

The development of a non-invasive Tallow tree (modified terminator technology or the genetic modification), innovations in the growing and harvesting of Tallow trees (the hedge-row design along with harvesters modified for high clearance), followed by innovations that lower the cost and improve the efficiency of processing of oil into biodiesel (the micro-reactor designed by Jovanovic), followed by gasification to convert pruning biomass into methanol (Interforest LLC as well as the exciting work of Bill Ayres of the Rapid Energy Group), followed by an entirely new generation of engines to burn these fuels (the StarRotor engine of Dr. Mark Holtzapple), all set the stage for dramatic change.

A NIGHTMARE FOR BIG OIL

For Big Oil this represents a nightmare. This coalition of enormous wealth will do everything within its power to convince us that global warming is a myth, that devoting so much land to fuel production is unrealistic and impractical, that the technology is not there to make it happen, and that we should remain dependent on foreign oil and the unstable politics that surround its production.

In the meantime our hills, prairies, forests, swamps and marshes become further infested by the ubiquitous Tallow tree. All long the I-10 corridor, from Lafayette to Houston, one is particularly struck by the abundance of Tallow trees. This stretch of interstate is one of the best examples of how bad things have become. We could view this as a curse, or we could seize the opportunity and proactively view it as a blessing. For everywhere we look within our state, we are surrounded by green oil.

We are surrounded by green oil, and yet Big Oil tells that we have no other choice than to turn to countries such as Iran and Venezuela to procure it. We are surrounded by green oil, and yet Big Oil points to a remote discovery lying 30,000 feet below the waters of the Gulf of Mexico, some 175 miles off our coast.

We should not forget that this is the same gulf whose waters are rising in temperature, fueling and empowering hurricanes such as Rita and Katrina, hurricanes that call into question the wisdom of extracting oil so far out at sea and so deep below its surface.

[40] See http://oregonstate.edu/dept/ncs/newsarch/2006/Feb06/microreactors.htm

We are surrounded by green oil, yet Big Oil has invested so much in fossil fuels that, contrary to the image it portrays in its barrage of green advertising, it has no flexibility to change.

In the production of green oil, where will we find the huge oil spills that devastate our oceans, coastlines and rivers? Where will we find the sulfur and other compounds that pollute our air and poison our soil and water? In the production of green oil, where is the Big Hand that orchestrates an increase in the price of fuel at the first hint of a disruption in supply? Where are the mega-refineries, endless pipelines, huge storage facilities and vast shipping lanes that are a prime target for terrorist attack? And finally, in the production of green oil, would we still be obliged to maintain a strong military presence in some of the most volatile regions on earth?

If Big Oil were called upon to clean up every square foot of land and every gallon of water it has polluted within our state; if it were called upon to restore all that it has damaged with respect to the wetlands and marshes that once served as a buffer against hurricanes and tropical storms; if it were held accountable for its share of the damage that hurricanes do in the case of a vanishing coastline; if it were called upon to pay its share of the cost of diverting the Mississippi into eroded coastal areas while still enabling oil tankers and barges to work their way up the Mississippi; if it were called upon to pay all of the royalties, leases and taxes owed to the state of Louisiana that it somehow managed over the years to avoid paying; if it were called upon to cover its share of the medical costs associated with living in a cancer zone that a large portion of south Louisiana has become; if it were called upon to pay the cost of the military presence it needs to operate freely around the world; if it were called upon to pay its share in the battle against global warming as outlined in the Kyoto Protocol; in other words, if it were called upon to behave in a responsible manner; how much would a gallon of diesel or gasoline cost in the state of Louisiana?

Big Oil, in spite of all the wealth it represents, is a highly subsidized industry that gobbles up each year hundreds of billions of taxpayer dollars. If a small portion of this money were devoted to enabling and facilitating the production of oil and alcohol from the Tallow tree, what a vibrant and thriving industry this new activity would become. Recent scandals in the Department of the Interior show us just how cozy, if not illegal, the relationship between Big Oil and government has become.[41]

Of course, if dinosaur fuel were our only option, Big Oil would have a point, and we should all lie low and simply accept our fate of living in a polluted environment that terrorists stand an excellent chance of polluting even further with a dirty bomb. The true horror of 9/11 lies not in the past in terms of lives lost and buildings destroyed, but in a fate far worst that will surely befall

---

[41] "In what has now become a major scandal, the Interior Department inadvertently signed 1,100 drilling leases in the late 1990's that offered lucrative incentives to deepwater drillers, regardless of how high energy prices might climb. Officials then covered up the mistake for nearly six years. In that time, the prices for oil and gas soared and the magnitude of the potential loss to taxpayers escalated to more than $10 billion." See New York Times, September 15, 2006.

our nation if it does not seek out fresh alternatives to the political, military, energy and environmental policies espoused by the Bush administration over the last seven years.

CONCLUSION

This proposal contradicts everything that Big Oil stands for, and it boldly predicts that the state of Louisiana, in less than 15 years from now, will be a world leader in the production of green energy. To do this it will have to make friends with a plant that it has always considered to be its enemy. But making friends with this wild and unruly pest should prove to be far easier than making friends with many of the countries who currently ship us oil.

Many people think that by going green, we must limit economic growth, eliminate all unnecessary travel, and make drastic changes to our way of life. They are convinced that by going green, we must submit to a dramatic decline in our standard of living.

But if we make use of thoroughly abundant and sustainable resources, such as the Chinese Tallow tree, nothing could be further from the truth.

paul.olivier@esrint.com

US telephone: 1-337-447-4124

Chinese Tallow Test Plot