Economic and Business Challenges for Biodiesel Production in Turkey

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Abstract

Driven by growing volatility in global crude oil markets, bioethanol and biodiesel have become targets of immense interest to investors and policy makers around the world. Turkey is no exception. We provide a brief assessment of the business case for biodiesel in Turkey, including the economics of its production and marketing. Based on the business fundamentals of our analysis, we then note key public policy and strategic challenges that need to be overcome to assure that Turkey can efficiently exploit the synergies that exist between its agricultural resources and its energy needs in the biodiesel area.

JEL Classificiation: I.52, M21, Q20, Q42

Key words: *Sustainable Energy, Renewable Energy, Biodiesel, Business Strategy*

1. Introduction

Currently, there is a strong interest in bioethanol and biodiesel, mainly driven by two key issues: (a) growing volatility in global crude oil markets and (b) concerns over climate change and the desire/pressure to address this global risk. The first issue derives primarily from on-going conflicts in many oil rich regions of the world, exacerbating historical price fluctuations of crude oil (see Figure 1, Appendix A). On climate change, CO2 emissions have risen from their pre-industrial average of 280ppm to 383ppm in 2006, and there is mounting scientific evidence that this will be associated with significant increases in average global temperature. As a result, a consensus has emerged within the international scientific community that we urgently need to stabilize CO2 levels at no more than 430ppm.[1] Since approximately 85% of current world energy supply comes from fossil sources, a major contributor to CO2 levels, the race is on to reduce the dependency on fossil sources through a more balanced energy mix. Biofuels are set to play an increasingly important role in this mix since they have a more favorable carbon balance than traditional fossil fuel sources. However, as will be noted in detail below, the extent of biofuels' involvement in the transition to a more balanced mix of renewable energy use[2] faces many challenges.[3]

Biofuel economics depend heavily on following main factors:

- Availability of land at the right climate
- Technology development
- Government policies

Biodiesel production amounted to 3.5bn liters in 2005 and was concentrated in the EU – accounting for 90% of all biodiesel production worldwide that year. This heavy concentration in the EU is primarily the result of public support for sustainable energy policies and associated regulatory initiatives that drive the development of biofuels. For example, the EU aims to increase the proportion of biofuels (whether bioethanol or biodiesel) to 5.75% of all petrol and diesel used in transport by 2010 and to 20% by 2020. (Similar growth incentives are seen as coming via regulation in the US and China.) Since the current share of biofuels in primary energy supply in the EU is approximately 3%, the European market needs to double in just 3 years in order to meet these targets.[4] Moreover, limited land availability in the EU27 will mean that in all likelihood biodiesel will need to be imported from outside the EU27. This will favor neighboring countries

[1] The most recent statement of this opinion was in early February 2007 with the release of the "next edition" of the Intergovernmental Panel on Climate Change (IPCC), which stated in much stronger language than previously their consensus conclusion that human activity is a primary driver of greenhouse gas concentrations that are very likely going to lead to the range of temperature increases noted in the discussion above. For details see http://www.ipcc.ch/.

[2] UNEP director Achim Steiner noted " there is significant potential and risk for competition between food production and production for a global biofuels market" Reuters, July 4, 2007

[3] See OECD Observer (December, 2006), www.oecdobserver.org, for a recent review of initiatives underway in the renewable energy arena and the challenges faced in OECD countries, including Turkey.

[4] Note that the EU has not met its 2006 biofuels target and there are similar concerns that it may not meet its 2010 goal. Currently the EU exports significant amounts of its rapeseed production and yet is a large net importer of vegetable oils used in the production of biofuels. The net balance makes up the current 3% mix in fuel grades. We return below to the role that Turkey might play as a partner for the EU in meeting these objectives.

such as Turkey and the Ukraine, in particular, although supplies from elsewhere (such as Africa and Brazil) could also be important.

In anticipation of these growing demands in the EU as well as its own entry into the EU, Turkey has modified its laws to permit the sale and use of biofuels. Today a blend of 2% biodiesel in regular diesel is permitted, compared to EU law which will soon permit up to 10%. Various companies in Turkey have begun active R&D programs to achieve compliance with the higher EU targets in mind. Development of the knowledge base and production capacity in Turkey for biodiesel production represents a huge opportunity, both for Turkish domestic consumption as well as for technology and product exports to the EU and elsewhere.

The key drivers ultimately promoting development of the biofuels market are the same for energy generally: concerns over security of supply (biofuels allow a more diversified mix, even if imported), climate change (carbon emissions are less than burning fossil fuels), and cost (although reliant on subsidies currently, the expectation is that with carbon taxes eventually factored in, biofuels will be cost competitive). The tax and subsidy regimes in different countries will in the meantime continue to play a pivotal role in the development of the biofuels industry.

The data and the research findings about biodiesel and its potential for development in Turkey varies somewhat across different organizations, academics and Government entities who have looked into this issue. The main reasons for these variations are (a) rapidly increasing interest in biodiesel; (b) largely unregistered and unreported biodiesel production, estimated indirectly from other data, such as oil imports; and (c) ongoing development of government policies and procedures to properly regulate this industry.

Vegetable oil, hence oil seed, is the main raw material used in producing biodiesel. Turkey is a net importer of both of these materials as shown in Table 1 and Table 2. According to the Turkish Ministry of Agriculture, in 2004 oil seed was planted in 7% of the total cultivated land. The government is aiming to double this percentage. Turkey's oil production as of the end of 2004 was ~500,000 tons while consumption was 1,300,000 tons, leaving a gap of 800,000 tons which was met by imports. By 2006, imports had increased to 954,000 (Oil World Annual 2006)[5].

[5] The Vegetable Oils and Fats Industrialists Association of Turkey estimates the Country's vegetable oil consumption as 19 kg./yr./person compared to 41kg./yr./person for an average European Union member country.

Year	Quantity (000 ton)	Cost ($ million)
2000	732	300
2001	763	284
2002	807	357
2003	869	442
2004	940	544

Table 1: Vegetable oil import figures (Turkish Agricultural Ministry)

Year	Quantity (000 ton)	Cost ($ million)
2000	1,135	225
2001	575	133
2002	865	223
2003	1,400	410
2004	1,274	441

Table 2: Oil seed import figures (Turkish Agricultural Ministry)

Prof. Adnan Akyarlı estimates Turkey's biodiesel production potential as 1,500,000 ton/yr, including the GAP (southeast) region's potential for lucrative farming (TÜBİTAK Meeting December, 2005). Mehmer Çağlar has estimated that there are 1,900,000 hectares of unused and suitable land in different parts of Turkey with a total annual potential of 1,250,000 tons of biodiesel production (TÜBİTAK Meeting December, 2005). He also states that in November 2005 total biodiesel production in Gebze, Adana, İzmir, Bursa, Polatlı, Urfa, Tarsus, Kırıkkale, Ankara ... regions exceeded 50,000 tons with the number of producers reaching 87**.** Mr. Çağlar points out that there are significant advantages for co-operatives to establish their own integrated biodiesel systems. Assuming a price of 0,55 YTL/Kg for canola seed and a 5 year pay-back period for an integrated biodiesel facility (oil production, biodiesel production, and purification of glycerine), the cost of biodiesel would be 1.27YTL/lt with additional by-product revenues of 0.08YTL/kg solids from oil production and 0.20YTL/lt revenues from purified glycerine. Cukobirlik, a co-operative of cotton growers in the southeastern Mediterranean region, shares this view and is in the process of building their own biodiesel facility to complement their oil production unit.

Doç. Dr. Mustafa Acaroğlu (TÜBİTAK Meeting December, 2005) points out that according to ALBIYO (an NGO of biodiesel producers), Turkey's total biodiesel production capacity had reached 450,000 ton/yr at the end of 2005, but the TOBB estimate is almost twice that figure, 878,000 ton/yr. Dr. Acaroğlu estimates that if you exclude the extremely large operations, biodiesel firms in Turkey employ about 700 people distributed in regions as shown in figure 1. According to Dr. Acaroğlu, 70% of the biodiesel is produced from imported palm oil or its derivatives, although the best oil seeds for biodiesel production in Turkey are safflower and canola.

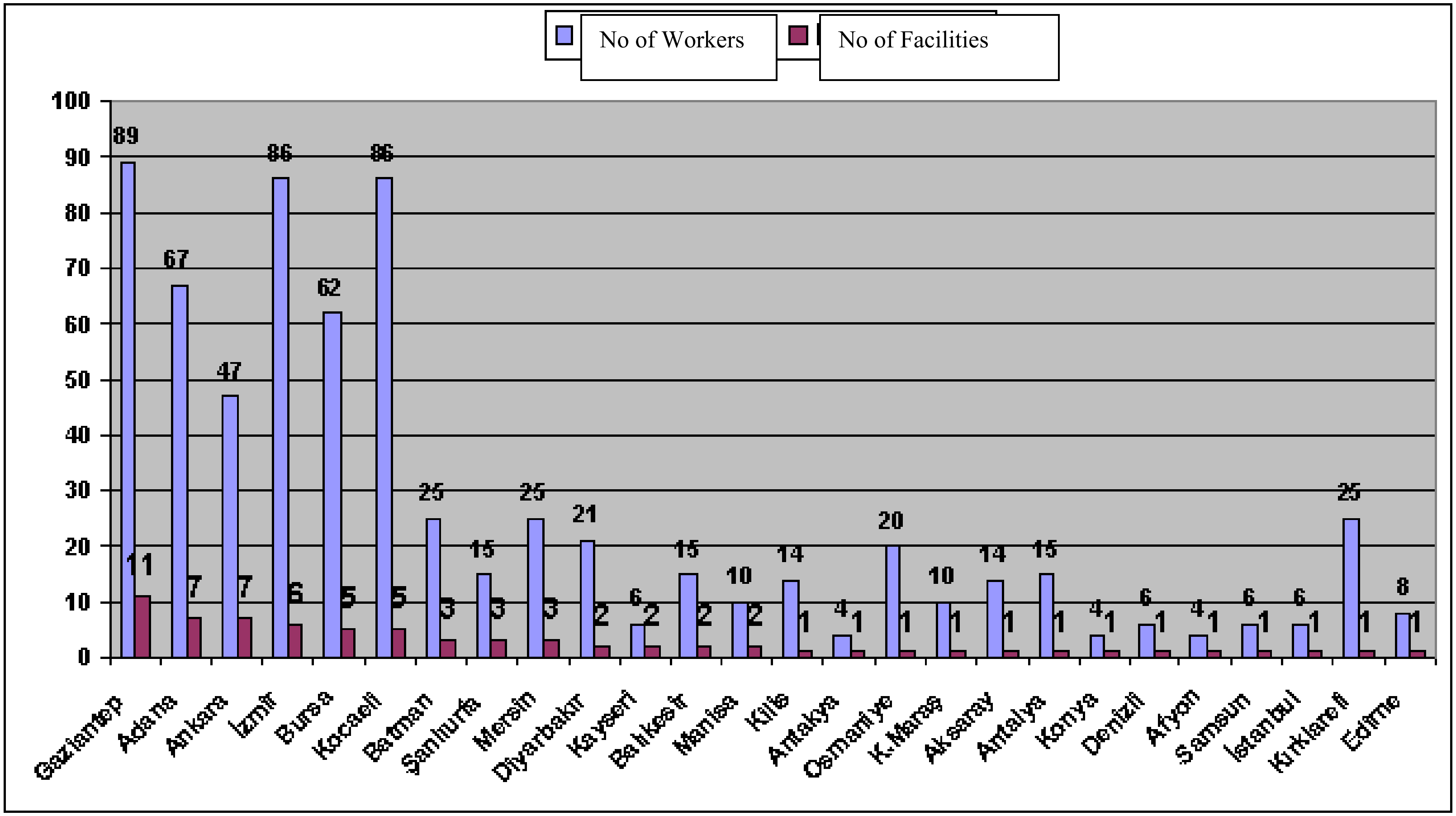

Figure 1: Number of biodiesel facilities and employment at various locations in Turkey
This figure is due to Dr. Mustafa Acaroğlu (TÜBİTAK Meeting December, 2005)

Per Dr. Acaroğlu, Turkey's total vetegable oil consumption is 1,500,000 tons and currently there is no large scale biodiesel production from used oils; almost all production facilities use new oil. His calculations indicate that if 0.3%-0.5%, which amounts to 5,000,000 lt of fresh oil, is collected every year after being used, it could yield 4,500,000 lt biodiesel which can add about 4,500,000 € to the Turkish economy. Currently, there are only a few companies that collect spent oil.[6]

According to Özden Öztürk, Fikret Akınerdem and Rahim Ada (TÜBİTAK meeting December 2005), canola and safflower oil will gain importance in biodiesel production since in Turkey their cultivation is much easier and cost of production is lower than wheat and sunflower oil. They estimate that 2,000,000 hectare irrigated agricultural area in the GAP region would be suitable for cultivating safflower and soy along with cotton. Their approximation is through triple rotation and use of 600,000 – 700,000 hectare land each year for oil seed production, in excess of 2,000,000 ton seed can be obtained yielding 700,000 ton oil or biodiesel. In addition, canola plant helps extend honey production period by flowering early in the spring. Its pulp is also valuable due to its high protein content[7].

Until 2003, oil importers have been producing biodiesel and marketing without being subjected to any fuel related taxes, such as OTV and KDV. This was made possible by presenting biodiesel as an extension of food process in the early days of its production through the efforts of an organization that biodiesel producers formed – ALBIYO (Alternatif Enerji ve Biyodizel Üreticileri Birliği). The result was a very cheap, extremely competitive, alternative to regular diesel. In 2003, through a joint public private partnership, the Government acted on biodiesel free ride issue through Enerji Piyasası Düzenleme Kurulu (EPDK) (Energy Market Organizing Committee – a group of independent, non-political individuals appointed for 5 years by the government) (www.epdk.gov.tr). They came up with a new set of regulations which still gives significant tax advantages to biodiesel produced from locally grown oil seeds, but eliminates all tax advantages of biodiesel made from imported oil. This will drastically reduce availability of untaxed biodiesel in the markets but its effectiveness to eliminate all biodiesel production from untaxed imported oil (imported with the "intention of food use") remains to be seen, especially in the case of small fleet owners who may also own biodiesel production facilities. The same set of regulations also put various licensing requirements for facilities that produce biodiesel either for their own use or for sale.

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[6] Quality and fuel value of used oil in Turkey, whether vegetable based or animal-fat based, needs to be carefully evaluated. For example, an entrepreneur who formed a business to collect used oil was on television in February 2007, showing a jar of black, overused oil which would not be suitable for biodiesel production and certainly should not have been used to that degree in food preparation. He claimed that such an extreme use of oil was a problem for spent oil collectors who plan to convert it into biodiesel.

[7] During his speech at a ceremony at Çukobirlik in May 2006, the head of ALBIYO, Tamer Afacan indicated that for every 1 YTL spent for biodiesel 0.84 YTL goes to the agricultural sector. He also claimed that although in 2004-2005 season there was only ~1200 hectares (3000 acres =.12,000 dönüm) land used for biodiesel related cultivation this number increased to ~ 50,000 hectares (125,000 acres = 500,000 dönüm) in the 2005-2006 season.

EPDK was given the authority to license biodiesel production activities and monitor mixing and distribution. This has significantly reduced the previous rather chaotic production and opportunistic use of biodiesel in Turkey[8]. On the other hand, the bureaucratic process required to obtain a license has discouraged the efforts of several companies that were planning to produce biodiesel legally. On February 28th of 2006, when the licensing process started, there were 200 companies that applied for the license. A year later, on February 2007, EPDK announced that 100 out of 200 companies that applied for the license decided not to pursue biodiesel production due in part to licensing difficulties with only 22 companies actually licensed by then. In February 2007 ALBIYO's president Tamer Afacan[9] estimated that ultimately about 50 companies will be able to qualify for biodiesel production.

The trade associations[10] formed by petroleum firms; PETDER, ADER, AKADER, PUIS, and TABGIS, jointly worked with EPDK on establishing a biodiesel norm. It is called TSEN 14214, based on the EU norm EN 14214. TSEN 14214 took only 7 parameters out of the 21 in EN 14214 as a "must" for the standard.

Also, as briefly indicated above, biodiesel was produced and sold locally, without any registration and without being subjected to the usual taxes that apply to diesel. Hence, the government was losing on taxes; 0.835YTL/lt OTV (Özel Tüketim Vergisi – Special Consumption Tax) plus the added 0.15YTL/lt KDV (Katma Deger Vergisi – Value Added Tax) total 0.985YTL/lt tax that it would otherwise collect from the use of biodiesel. As a result of this practice, in 2005 the diesel sales in Turkey went down consistently every month compared to 2004 sales. (EPDK presentation, TUBITAK meeting, December, 2005).

This situation also led to the following macroeconomic issue (EPDK presentation, TUBITAK meeting, December, 2005):

- Turkey has a major deficit in oil seed production to meet its current needs; only 35%-40% of oil seed needs are met by crops grown in Turkey.

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[8] EPDK estimates that by the end of 2005 there were about 90 significant biodiesel producers with ~1,000,000 ton/yr production.

[9] Hurriyet (News paper), February 21, 2007

[10] There are several NGO's interested in biodiesel, such as TEMA(Turkiye Erozyonla Mucadele, Agaclandirma ve Dogal Varliklari Koruma Vakfi), Tar-get (Tarimsal Arastirma, Gelistirme Tesebbusu) and petroleum trade associations which are:

- PETDER – Petrolcüler Dernegi – (90% of Petroleum marketing firms – all big players- are part of this organization)
- ADER – Formed by "second level", smaller, companies (e.g. OPET, Aytemiz, etc.)
- AKADER – Formed by yet smaller companies that do not belong to the top two trade associations. Unions –
- PUIS – Petrol Ofisi Bayileri (formed by Petrol Ofisi distributors)
- TABGIS – Formed by other petroleum related firms

- Biodiesel production in Turkey, until late 2005, was primarily based on imported oils, such as palm oil, soy oil, etc.
- The raw material cost of imported petroleum-based diesel that meets EU standards is 520$/ton. To this, in Turkey, $860/ton OTV tax (plus KDV of OTV) is added prior to the addition of about $155/ton KDV tax and profits of distributing firms which is around 10%.[11]
- Cost of biodiesel as raw product which was produced mostly from imported raw materials including methanol (used in large quantities during the production) is estimated as 720$/ton. Although this figure is $200/ton higher than petroleum based raw product cost, it is still considerably less than the fully taxed petroleum-based diesel, so that if no OTV tax is paid on it, it is a very desirable commodity for fuel.
- Hence, notwithstanding the available land and agricultural capacity and the cost differences between fully taxed regular diesel and untaxed biodiesel, Turkish farmers do not benefit from this potentially lucrative business, with Turkish biodiesel consumers relying instead primarily on imports.

In recognition of the above facts, in 2006 EPDK came up with two major rulings:

1. Biodiesel can only be mixed into diesel at two locations in the distribution system;
2. If biodiesel is produced from the seeds grown and harvested in Turkey, companies will not pay the usual OTV tax from sales 0.835YTL/lt (November 2005 values). That is, 2% of the biodiesel sold at the pump will not be subject to OTV, which accounts for over %60 of the price at the pump. However, companies who market 2% biodiesel will pay the 0.15YTL/lt KDV tax based on their total sales, including the biodiesel portion.

2006 was a transition period and about 5-6% of the existing biodiesel sales (~ 500,000 tons) consisted of palm oil based biodiesel which was mainly sourced from Africa through Malaysians who contracted most of the African Palm Oil production.[12]

2. Biodiesel Supply-chain Model

The biodiesel supply-chain consists of 3 major steps:

- Cultivating oil seed
- Producing vegetable oil
- Producing biodiesel

Each of these steps has several sub-activities. For the purpose of discussions in this paper we divided these activities into two categories: (a) agricultural processes, and (b)

[11] Calculations based on PETDER presentation at TUBITAK Meeting, December 2005 and information from Varol Dereli.
[12] Conversations with DB Tarimsal.

manufacturing processes. We identify the main issues relevant for the key stakeholders in each of these activities.

Agricultural Processes

Agricultural process encompasses all of supply-chain activities related to growing the oil seed crop for production of biodiesel. Although in this paper we are focusing on canola as the main biodiesel crop, the process as described in this section can easily be generalized for other oil seed types. The flow diagram of agricultural process is shown in Figure 2.

Canola agriculture is new to Turkish farmers. Therefore its growth rate will depend heavily on the information and training provided to the farmers as well as available government support. In Turkey, farming is a small family business which involves growing crops in smaller fields than in US or EU. In general, Turkish farmers do not research what to plant to get the best return from their fields. Usually they plant the same crop as their neighbor. The Government used to guarantee the purchase of farm products at a given price, but the IMF suggested eliminating this practice which was accomplished in 2001-2002 period when Kemal Dervish, who held various positions in the World Bank for many years, became the Minister of Economic Affairs[13]. The resulting change and "move to the market" left many farmers, especially tobacco growers, in a difficult situation. Of course, the earlier regime, when the government purchased agricultural products, such as tobacco, had the usual inefficiency problems or government intervention in the market, since some products did not meet buyers' expectations and wasted away in Government warehouses. With biofuels, as with any other product, a balance must be struck in providing government support between these incentives for inefficiency and the more rapid development of the industry.

Around the Black Sea, Mediterranean, and Aegean regions, farmers are more knowledgeable, and the ground and climate are more suitable for growing a large variety of crops of higher value than canola. Hence the opportunity to grow canola in these regions is limited due to competition from other higher value-added crops. So, even though it is more difficult to grow canola in Central and South Anatolia (including Diyarbakir, Urfa and Mardin), it is nevertheless economically more profitable.

One can grow canola in any kind of soil where it gets 30-60 cm precipitation per year. Normal or average 10-year yields for canola would be 800Kg – 1,200 Kg/Acre (200 – 300 Kg/decare). These numbers are based on no irrigation (but normal precipitation, as indicated above). These yields would be higher on the European side of the Bosphorus, as well as the Middle Black Sea, Aegean Sea, and Mediterranean Sea regions.

Currently it looks promising to grow canola in areas that are left empty for sugar beet rotation or are planting wheat which would be suitable for canola production as a

[13] Government still announces its purchase price. But, subsidies, as well as purchase prices have been reduced significantly. Hence, Turkish farmers' income suffered considerably, especially with the import of agricultural products (such as wheat) from other countries where farming is heavily subsidized by their government.

rotational crop or as replacement crop. Since canola roots stay in the ground during harvesting, they give back part of the nutrients they absorb and hence they are considered not as extractive of soil nutrients as some other crops.

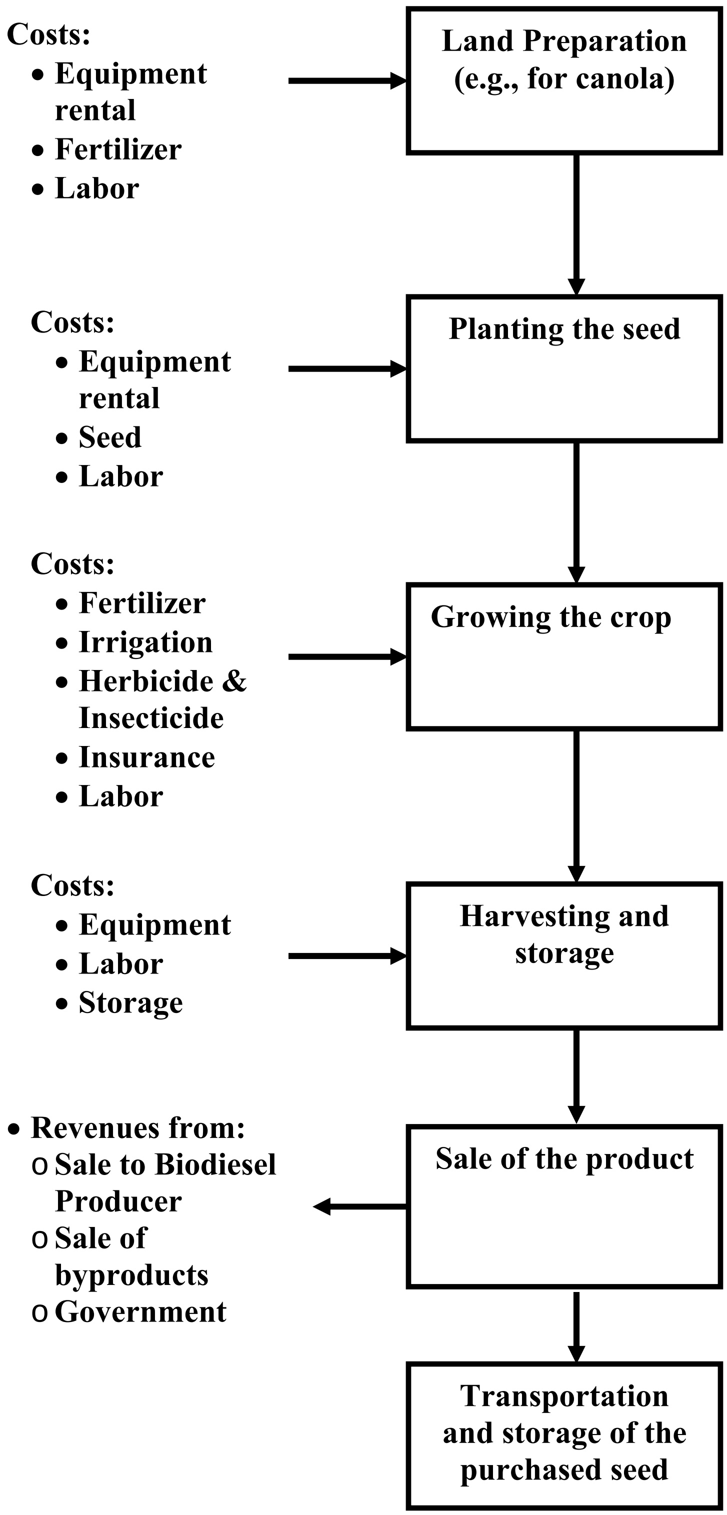

Figure 2: Flow Diagram of Agricultural Process

Turkey has total of 55,000,000 Acres of land suitable for agriculture. Some of these areas are arid, not very fertile land, such as parts of the Central Anatolia and South East Anatolia. These can be suitable for Canola agriculture provided the right type of seed is selected. Turkey's population engaged in agriculture decreased from 70% to 40% within the last 25 years. A lot of land is left fallow during rotation periods, therefore presenting an opportunity for canola growth. For example, PANKO Birlik (Pancar Kooperatifi – cooperative of sugar beat producers) members have 2,000,000 decare (500,000 acres) of fertile area that could be utilized for canola production as a part of rotation patterns for sugar beets. Currently PANKO Birlik is experimenting with growing various oilseeds in different parts of Turkey. According to some informal estimates, this area has the potential to produce 600,000 tons of Canola seed, yielding 240,000 tons of Canola oil on a yearly basis.

In the arid regions of Turkey (mainly in Central and South Eastern Anatolia) canola would be competing against growing of wheat and barley. It should not be compared to growing sugar beet in these regions since sugar beets require irrigation. Moreover, if a farmer has the capability of doing irrigation, higher margin crops such as potatoes, onions, vegetables, corn, sunflower, and animal food (like clover, etc.) may be more attractive to grow than canola. One of the biggest irrigation problems in Central Anatolia is the lack of water due to too many wells that have been drilled and poor irrigation practices, leading to a lack of underground water within reasonable depths.

Canola seed for planting is currently being imported. In the first year of sizable canola planting there were only a couple of companies: Tat Tohumculuk and Kingsan. This year additional companies are selling seeds as well, such as Monsanto, Pioneer, and Agromar.

In Turkey the smallest feasible canola field is 50 Acres. This corresponding number is 600 Acres in Canada and 100 Acres in the US. Here feasibility is in terms of making a reasonable profit in light of equipment rental fees and the costs of labor.

Cost of oil seed production is somewhere between 55 - 120 YTL/decare which yields 120-500 Kg/decare product. These numbers vary significantly based on location, irrigation, etc, (See Table 3). Last year near the Aydin region, farmers achieved 400 Kg/decare yield (with irrigation). This number can go up to 700 Kg/decare for farms on Trakya (European side). Breakdown of the oil seed production cost factors is as follows:

- Initial turning over of the land (surgu)
- Smoothing and fertilizing (tirmik ve gubre)
- Sowing equipment rental
- Seed (GMO can be used, hybrid is more expensive but yields more)
- Fertilizer (cost of fertilizer varies depending on the quality of the ground)
- Harvesting

The above costs do not include any agricultural chemical applications for disease and pests. Since canola production is very new in Turkey, such diseases have not developed yet but should be anticipated for the future. For our economic model, base-line oil-seed (product) cost is assumed to be 0.55 YTL/Kg (but alternative scenarios are also considered). Last year the purchase price of canola was 0.45 YTL/Kg; for 2007 the price is expected to go up to 0.50 or 0.55 YTL/Kg (so that, with Government incentives of 0.22YTL/Kg, the final revenue to the farmer for canola seed will be 0.77YTL/Kg).

Another cost important for agriculture is the cost of fertilizer. Fertilizer manufactured in Turkey is very costly compared to world market prices. This is due to two main factors (a) high cost of fuel used in fertilizer production – mainly imported natural gas from Russia sold to the industry with no subsidy–, and (b) high cost of raw materials - 80% of raw materials being imported from outside of Turkey. Therefore fertilizer imports, especially from Russia and Ukraine, where both fuel and raw materials are much cheaper (some are subsidized by local governments), have been increasing. In 2004 fertilizer production was 3,200,000 tons while imports were 2,700,000 tons (www.evrensel.net). The average market price in Turkey for fertilizer ranges between 360-800 YTL/ton. The price changes based on the nitrogen, phosphorous, potassium and sulfur content.

Not all farmers in the Aegean region were successful in cultivating canola in non-irrigated soils. It grew very well in irrigated soils. For plants grown in very fertile soils (such as the region around Aydin) some farmers had difficulty in harvesting. Plants had seeds all the way down to 10 cm from the ground and also had thick stems, hence available machinery could not get sufficiently low to the ground and could not cut the stem quickly. Moreover, shaking the plant during harvesting seeds leads to spillage onto the ground, reducing yield.

In terms of regional and seasonal growth patterns, the following are key issues affecting Turkey's canola agriculture:

- In fertile regions which have irrigation capabilities canola cannot compete with the higher value added crops, such as: cotton, corn, vegetables, etc., except as an alternative rotational crop – for example for sugar beets.
- Canola can be a good alternative to growing wheat in arid regions.
- Where wheat agriculture is limited to the summer wheat, canola can be grown in the winter.
- Depending on climate and irrigation conditions, canola can be planted twice in a calendar year: winter canola and summer canola.

Currently Turkish farmers are experimenting and learning how to grow canola efficiently. For example, proper seed selection, crop and planting patterns, harvest times to avoid losses from frost, and many other determinants of yield and profitability.

In all of Turkey, the cost of the land is an important factor. The land is divided into small, varying size fields due to inheritance, making industrial scale production with machinery rather inefficient cost wise. Partly for these reasons, much of the land in middle to south-east Anatolia is utilized poorly. Canola can be farmed relatively efficiently even on smaller fields, assuming that the results of several such fields are aggregated properly, e.g. through a district cooperative. Moreover, in arid regions, such as in many parts of Anatolia, Canola is more suitable for production than competing crops.

Before making a recommendation concerning whether canola would be an efficient crop, either as a primary crop or as a rotational crop, one needs to consider the economics of alternative crops in a given environment. For example, as one can see from the comparison of canola with corn given in Table 3 below that, under the current circumstances, a farmer who can grow corn would not find it profitable to switch to canola. This is true even though the cost of planting and harvesting canola seed is considerably less than for corn.

Table 3: Illustrative Profitability of Canola vs. Corn
(At Estimated 2006 Prices and Yields)

	Corn Seed (requires irrigation)	Canola Seed (with irrigation)	Canola Seed (without irrigation)
Yield: Kg/decare	1000	300 to 500	120 to 200
Total Area (decare) to be planted to obtain 1 ton canola or corn (seed)	1	2 to 3	5 to 8
Cost of growing canola or corn including the price of seed, soil preparation, agricultural chemicals, etc: YTL/decare	300	70 to 120	55 to 95
Revenues from selling Canola (seed) or (corn) seed: YTL/ton P = Market Price: YTL/ton S = Govm't Subsidy: YTL/ton	620 = 550 (P) + 70 (S)	770 = 550 (P) + 220 (S)	770 = 550 (P) + 220 (S)
Profit: YTL/ton of canola (seed) or corn (seed)	320 320 = 620 – 1*300	410 to 630 410 = 770 – 3*120 630 = 770 – 2*70	10 to 545 10 = 770 – 8*95 545 = 770 – 5*55
Profit: YTL/decare	320	137 to 315 315 = 630/2 137 = 410/3	0 to 109 0 ≈ 10/8 109 = 545/5

In terms of the above Table, the bottom line is that when corn competes head-to-head with canola, as it does when irrigation is possible, then the more established crop of corn has both relatively higher profits, even in the best case for canola seed, and far less uncertainty, given current knowledge. Of course, corn needs good irrigation and the cost of agricultural chemicals is high. Moreover, due to water shortages, the available area for corn growing is shrinking. On the other side, canola oil is less well known, markets are less well developed, and government policies over the medium run may also be more uncertain for canola than for corn. Nonetheless, one sees directly from Table 3 that for areas where irrigation is unavailable or limited, canola could be a profitable alternative. However, even here there are significant uncertainties that need to be resolved to ensure that profitability per decare rises significantly above zero, and uncertainty about profitability is reduced. We will have more to say about some of the drivers of this profitability below, including research on all aspects of the planting and harvesting process, but it should be clear that this uncertainty will remain a critical hurdle in convincing farmers that canola and other dedicated biofuel crops are worthwhile.

When compared to wheat, the incentives for a farmer to plant canola are more favorable than for corn (and required soil and climatic conditions for wheat and canola are comparable). The costs per decare for planting and harvesting canola are slightly less than for wheat (primarily because of seed costs). Moreover, there is a ready market for locally grown canola whereas wheat faces tough competition, in part because of the availability of imports from countries like the US where wheat is subsidized by the government. Turkish farmers' expectations in Central Anatolia and its surroundings are to obtain a profit of 80-90 YTL/decare (based on conversations with farmers in Aegean region). They are unable to achieve this profit by planting wheat because of the noted competition with subsidized imports, but they may be able to achieve this profit by planting canola.

These examples suggest that there are several challenges in introducing canola agriculture in Turkey. To cope with the agricultural and cost elements noted above, advertising and good technical advice is needed. In the initial years, seed companies should oversee the process of planting and growth to ensure that this is done properly and, possibly, also to learn themselves more about seed varieties required in various parts of Turkey.

Another crop that can potentially compete with canola is safflower (aspir) which is more drought resistant. Last year aspir grew in some experimental locations where canola failed (plotted in adjacent fields and no irrigation is used)[14]. In Turkey, aspir farming is even less known than canola farming but looks like a worthy product to pursue.

A further major concern in Turkey is that there is no insurance for canola agriculture, where as in Canada and US governments subsidize part of the insurance cost. In Turkey government pays 50% of the insurance premium for other crops but not for canola (no policy on canola yet). Also, the Turkish government is selective in the perils it covers in its insurance subsidies; for example, it does not insure wheat against fire. Generally, a reexamination of crop insurance incentives needs to be undertaken to avoid disincentives for planting otherwise efficient crops, including canola. Eligibility for such insurance in the case of canola and other biofuel crops could be coupled with participation in information programs that make available to farmers the latest information on seed types and other important issues for the successful growing of these crops.

[14] Communications with Ahmet Türkmen.

We summarize the issues for major stakeholders for each process step in oil seed farming and harvesting for dedicated biofuel crops in the Appendix B below.

Manufacturing Processes

This model encompasses major steps of supply-chain for producing biodiesel from oil seed. The process of manufacturing biodiesel from oil is made up of two completely separate manufacturing systems which are usually located separately from each other: (a) producing oil from the seed, and (b) producing biodiesel from oil. Where available, glycerin purification can also be considered an integral part of this operation that can be built and operated in a separate location.

Oil Production

Each canola seed contains about 40% oil. The remainder of the seed is processed into canola meal, which is used as a high protein livestock feed. Research indicates the fatty acid composition of canola oil is most favorable in terms of health benefits and as a part of a nutritionally balanced diet. (Canola council of Canada)[15] Hence, canola is used in many food products and for cooking, and its competing use for biodiesel could therefore have a strong impact on vegetable oil markets in the food industry. This will create added complexity in managing a biodiesel business because of competing oil-for-food and oil-for-biodiesel prices. For example, if price in vegetable oil markets exceed the price of canola oil for biodiesel, producers can sell the raw material (vegetable oil) as is rather than converting. This may cause problems for distributors of biodiesel products who may not want to get into long-term contracts. Such a scenario would also upset biodiesel manufacturers' plans dramatically; reducing profits and extending the capital cost recovery period.

Let us briefly summarize the canola oil production process from canola seed to purified canola oil. These steps are very similar for most vegetable oil production processes:

- First stage is rolling or flaking the seed. This will crack the cells and facilitate oil extraction.
- Next stage involves cooking the rolled or flaked seeds and subjecting them to a mild pressure which squeezes out some of the oil and compresses the seeds into large chunks of cake fragments.
- Cake fragments are further processed to extract most of the remaining oil.
- Once the solvent used for extraction is removed and recovered the oil undergoes purification processes.

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[15] The Canola Council of Canada is a national trade association representing producers, input suppliers, processors and marketers of canola and its products. The organization's mission is to foster a regulatory, policy and business climate based upon innovation, resilience, and creation of superior value for a healthier world; allowing the industry to grow 15 million tonnes of market demand and production by 2015. http://www.canola-council.org

- Degumming consists of removal of gums (phosphatides) and free moisture, and cooling/storage of dry oil.
- The next refining steps are: neutralization of fatty acids, drying (removing of traces of water), bleaching by adsorption of the color producing substances, and deodorization through vacuum steam distillation.

While vegetable oil itself can be used as biofuel, such an application presents several challenges, especially in start-up and shut-down of the engine. Also, using straight vegetable oil can clog fuel injectors by forming gum around the nozzle. Thus, additional purification steps are appropriate in producing vegetable oils to meet standards for use in combustion engines, and further innovations in engine technology are also needed.

Biodiesel Production (see Figure 4)

Currently almost all biodiesel is produced using base catalyzed transesterification of the oil. This process requires low temperatures and pressures and has about 98% conversion yield. The main processing steps are as follows:

- Reaction:
    - Mixing of alcohol (usually methanol) and catalyst (typically anhydrous sodium hydroxide).
    - Adding oil and (sometimes) heating the mix.
- Separation of biodiesel and glycerin phases
- Alcohol removal from each phase
- Glycerin neutralization by using an acid to neutralize unused catalyst and soaps. Preliminary removal of water and alcohol yields 65% (low purity) glycerin (appropriate for mixing with animal feed) which can be further purified by distillation to 99+% purity and sold to the cosmetic industry.
- Biodiesel purification (sometimes) by washing, with warm water, to remove residual catalyst or soaps. Sending to storage after drying.

In Turkey there are many small biodiesel manufacturing facilities that can probably meet the needs of the local population. Large biodiesel facilities to serve the needs of major oil companies are very few, but this appears to be a promising business with the EU decision to encourage the use of biodiesel. With favorable economics and increasing demand, both to lower Turkey's petroleum dependency and to market to the EU, it seems that Turkey should invest in developing this technology. Similar to Brazil, but on a smaller scale, Turkey can become not only a significant oil producer but also a technology developer and implementer targeting other developing countries in the process. Investing in the next generation production process (which would use solid catalysts and hence reduce the production cost significantly while enhancing the purity of the products) presents additional opportunities (Institut Français du Petrole).[16]

[16] "Biodiesel, Second Generation Technology", Presentation by Colin Baudouin of Institut Français du Petrole at WRA 2005 - 6th European Fuels Conference.

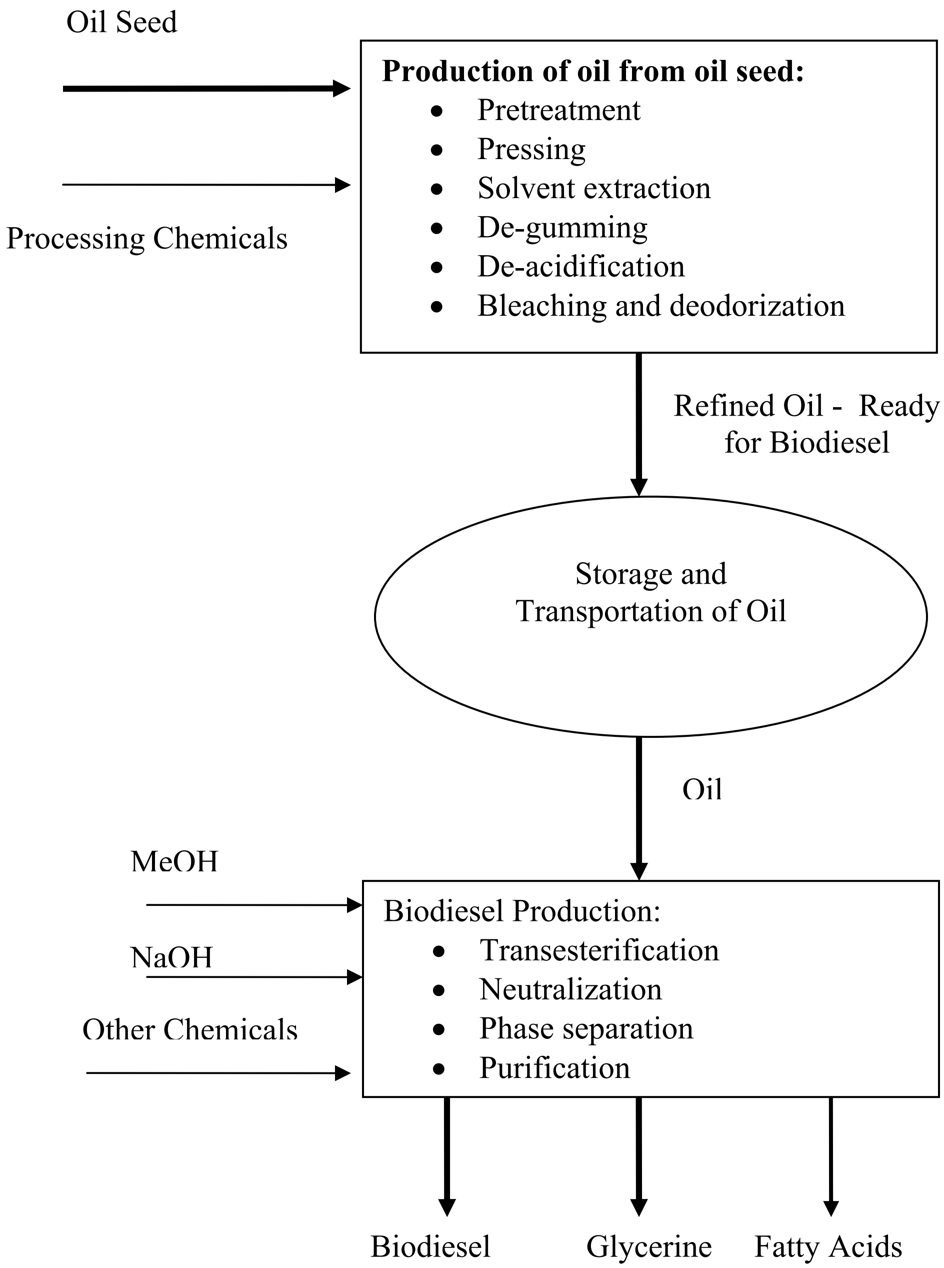


Figure 4: Flow Diagram for Biodiesel Production

We have developed an economic model of a small scale production facility in Turkey. The model tracks the process flows of existing seed-to-oil production technologies (per Figure 4). Our calculations indicate that the net present value (NPV) of such an investment is solidly positive. As intuitively might be expected, the magnitude of this NPV depends on the seed (or vegetable oil) price, biodiesel price and exchange rates between technology markets and final product markets (e.g., on the \$/€ and €/YTL rates).

We summarize the issues for major stakeholders for each process step in seed-to-oil production biodiesel production crops in Appendix B below.

3. Strategic Considerations for Turkey

Turkey can significantly benefit from biodiesel policy of EU while reducing its own crude oil dependency. To be able to accomplish this objective a comprehensive and integrated analysis of biodiesel potential in Turkey should be conducted. Key strategies for agriculture and manufacturing should be determined along with policies to maximize the benefit of biodiesel move on Turkish economy. Consider the key issues.

Agricultural Strategies

Although Turkey has a large area suitable for dedicated biofuel crops, farming has not developed to fully utilize this potential. The following initiatives could improve the current situation.

<u>Seed selection and production</u>: Identify the best oil-seeds to grow in each region based on its climate, irrigation capabilities, and the selection of alternatives. Canola seems to be a good oil seed to grow in most regions (with safflower as a potential alternative), but this needs to be tested. Seed selection, availability, and making the best choice for a given location are important topics to consider. Developing high yielding seeds for each region and growing these seed plants in Turkey is of strategic importance.

<u>Education and training</u>: Educating farmers on oil-seed farming, especially on growing canola, since it can be quite profitable. Farmers in Turkey are not familiar with canola agriculture. Unless they receive credible information on which they can act, they will continue to plant what their neighbor does.

<u>Crop insurance</u>: Canola is susceptible to freeze damage if it has not reached a minimum size of a 5-leaf plant before freezing temperatures hit. Especially with climate change causing unpredictable weather conditions, it would be desirable for the government to work with private insurers to develop appropriate crop insurance programs against freezing conditions.

<u>Appropriate equipment</u>: Farm equipment is another challenge for Turkish farmers. Current equipment used for wheat, barley and/or other crops is not the best for canola which has large plants with many very small seeds.

Most of the above initiatives can be achieved without government assistance, as pure business opportunities. However, many of these activities could benefit significantly from targeted public-private partnerships by having biodiesel companies and/or farming organizations work with universities and research organizations to assure that good science and engineering are coupled with existing knowledge and practices.

Manufacturing Strategies

The increasing importance of biodiesel, both for the Turkish economy and in Global energy markets, presents several opportunities to address challenges faced locally and globally. In the manufacturing area, some of these opportunities and possible strategies for Turkey are suggested below.

Technology development for the near term: Given its long history in agricultural products, Turkey manufactures some of the best presses for oil production and exports such equipment on a limited basis. R & D for oil refining, respecting local conditions and knowledge, needs to be fostered. Although there are many biodiesel production units being advertised for sale, there are very few facilities that are currently suitable for production of biodiesel that meets EU's and Turkey's standards. This may change in the near future with implementation of EPDK licensing requirements which would emphasize more rapid technology development in Turkey.

Longer-run technology development: Development of new technologies is also an important area that needs to be explored immediately. Using solid catalysts instead of the current homogeneous catalysts (NaOH or NaOMe) can change biodiesel production economics significantly, also eliminating the glycerin purification step. Hence, Government support in R&D for next generation biodiesel production should be considered a priority. If a technology base is established in Turkey both for processing and manufacturing facility development, it can be valuable not only for local production but also for positioning Turkey as a biodiesel powerhouse in the EU and beyond.

Glycerin purification and improving value add of other by-products: Glycerin availability will increase dramatically with increases in biodiesel production as it is the main by-product of the process (approximately for every 3 moles of biodiesel one mole of glycerin is produced –on a weight basis, glycerin production is equal to 10%-14% of biodiesel production). This introduces two big challenges and well as opportunities: (1) The glycerin that comes out of the current process is in "crude" form with purity around 65%. By increasing this purity to over 99%, its value increases significantly, since at that point it becomes pharmaceutical grade, making the manufacturing of cost effective glycerin purification units a good business opportunity; (2) An additional glycerin related opportunity is to find new uses for this chemical that will become very abundant in a short time.[17] As this is closer to basic engineering research, Government support of research and technology in this area could be valuable. Generally, by-products, other than glycerin, are also produced during oil and biodiesel manufacturing. R & D activity to improve the value add of such products could be important for biodiesel production in Turkey and elsewhere.

[17] One consequence of the increasing abundance of glycerin is that its price has fallen from 1800 Euros/ton in the summer of 2000 to roughly 450 Euros/ton by July 2007 (for the refined product). See Biofuels, Bioprod. Bioref. 1:6-7 (2007)

Policy Issues and Initiatives

Perhaps the most central issue emerging in the present move to renewable energy sources is the implied greater interaction between agriculture and energy. These sectors have traditionally interacted only through the impact of energy as an input to agriculture. Now energy and agriculture have become substitutes in their respective product markets. The implications for these markets and for national policies are immense.

To begin with, it is important for a country like Turkey with great agricultural potential to not move from oil/fossil fuel energy dependency to food dependency through a myopic and sudden shift of agricultural lands to dedicated biofuel crops. The US and the EU have shown the undesirable effects of subsidy policy on crop and crop rotation choices, and on global trade flows. While arguably the move to more sustainable energy practices, including the use of biofuels, is potentially desirable, it must be done with great care to avoid long-term mistakes and the syndrome of subsidy dependency that, once instilled, is very difficult to eradicate.

On the other hand, it is important to understand that in the early days of experimentation in considering new energy sources, some stimulation (read subsidies) may be desirable to indicate public support for sustainable energy practices and to attract attention of farmers to the always risky prospects of changing crop rotation and planting patterns. The idea that biodiesel products could become an important element of Turkey's future energy portfolio is important in itself as an element of Turkey's energy security, providing some buffering from the increasing volatility of world energy markets. But doing so will require a careful analysis, and discipline, to ensure that all elements of the value chain for biofuel products are sustainable financially and environmentally.

On the financial side of sustainability, subsidies (if any) must be temporary and targeted to well-defined purposes. Also, the global marketplace, with its intricate network of subsidies and constraints, must be followed closely to assure a level playing field for Turkish industry. We would assume that any subsidies provided would be either for agriculture or for R&D, e.g., investment incentives, for Turkish research institutions and domestic companies. Moreover, in the real economy such subsidies and incentives cannot be paid for effort alone. They must be paid for results (tons of seed or biofuel actually produced). Of course, such arguments do not apply to scientific developments, such as discovery efforts for new technologies.

On the environmental side, the ruthless exploitation of global rainforests for palm oil, supposedly to support sustainable energy policies in developed countries, is now well documented. Less well documented is the fact that 1st generation biofuels leave most of the energy from dedicated biofuel crops unharvested in the stalks and remaining biomass. Thus, careful carbon accounting and careful caloric balances must be a part of any responsible plan, private or public, to promote biofuels. Unless a technology or a product is environmentally sustainable, whatever its "bio" metaphors might evoke, it cannot be an object of policy support. This means that Turkish and international research establishments, and NGOs, have a continuing valuable role to play in assessing policy initiatives and in bringing the voice of the planet and future generations to the table in discussions of biofuel policy.

4. Conclusions and Future Plans

It should be clear from the above that the potential for exploitation of biodiesel in Turkey is significant. However, there are a number of important factors that could influence the payoff from biodiesel and the speed of its development in Turkey.

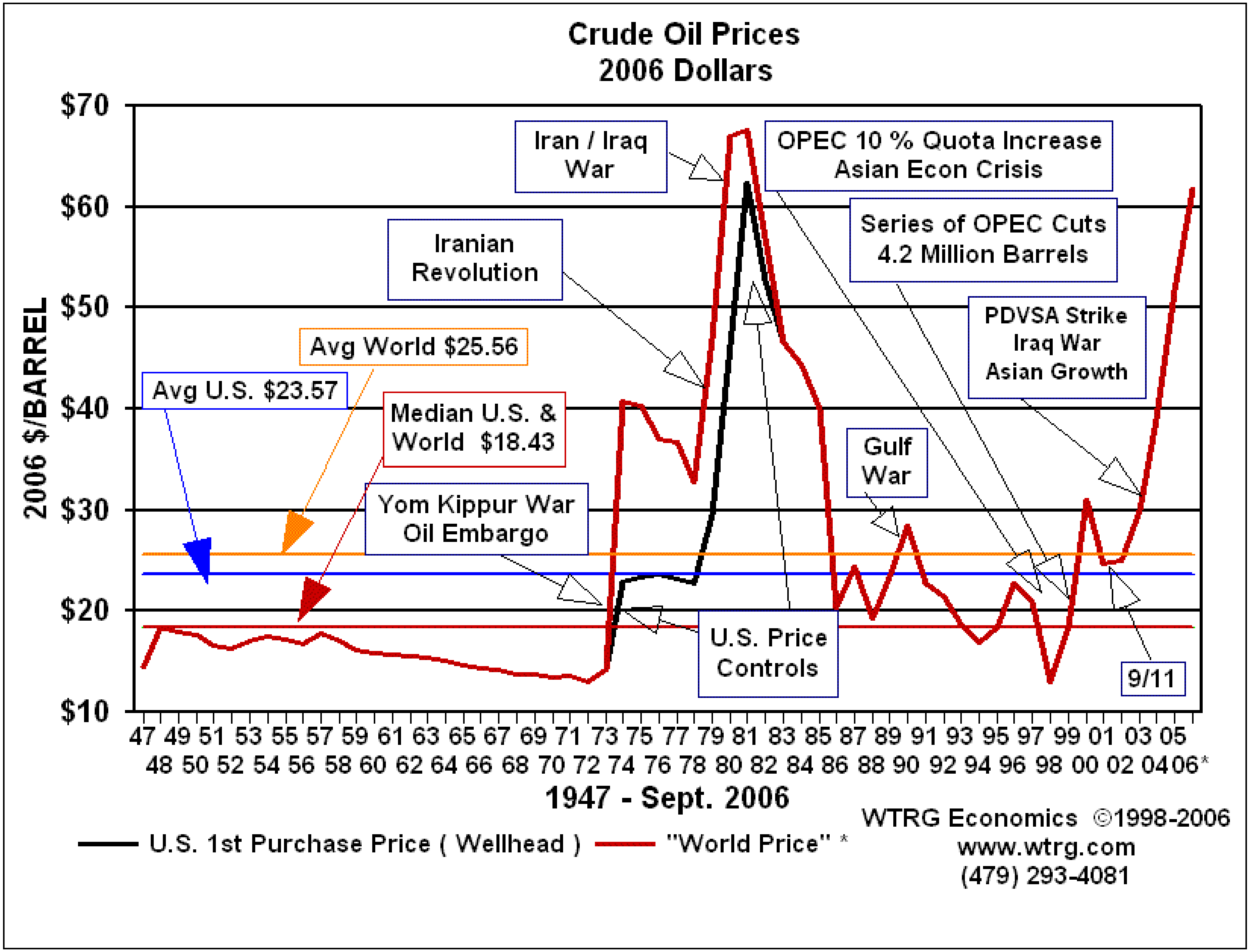
On the agricultural side, the primary factors are likely to be the synergies in crop rotation with other crops such as wheat, as well as the assessment and evaluation of available land and water supplies for such crops. Preliminary estimates suggest a strong potential for displacement of much of the imported oils and fats currently used for both cooking and biofuels in Turkey. However, a more rigorous assessment and discussion will be important before conclusions on the appropriate targets for Turkish production over the next two decades can be drawn. It will also be critical to work with farmers, and their associations, both to communicate essential elements of what works and what doesn't in terms of planting, growing and harvesting dedicated biofuel crops, but also to ensure that policies in this area are informed by the real constraints faced by farmers. Other key issues on the agricultural side include Development and availability of best seeds for different climatic conditions around Turkey; availability of fertilizer at a reasonable price; availability of farming equipment (preferably manufactured in Turkey and suitable/economic for smaller farms); and insurance for biofuel crops.

On the business side, the primary factors include use of appropriate technology, achieving efficient scale, and optimizing production and distribution methods. For major Turkish players in the petrochemical industry, these are well known challenges, and do not present significant barriers to investment in biofuels. What is required for business to flourish is a clear statement of public policy goals, a stable implementation of these and the establishment of a level playing field that does not subsidize inefficient or illegal activities. These objectives are at least as important as the tax policies or investment incentives that might be implemented in support of transportation or energy infrastructure or to stimulate investments.

On the government policy side, the primary factors are tax policies (and their enforcement) related to both imported vegetable oils and biofuels themselves. Government support will also be needed for basic R&D to inform their policies and to assure through open debate that Turkey's energy and fiscal policies assure financial integrity of the system and environmental sustainability. Failing on any of these accounts will lead to both inefficient outcomes as well as undermining public trust in the entire biofuels and sustainable energy enterprise.

Perhaps the most pressing need in Turkey is a national assessment of alternative strategies that integrate technology, R&D and the realities of agricultural resources to determine what the real potential is for biofuels in the next two decades. This assessment should include interdependencies of biofuel policies with a sustainable food strategy for Turkey. Such an assessment must enlist the assistance and input of public research institutions, agricultural trade associations and private companies to assure that a proper balance is struck between technological and environmental feasibility and the financial interests of those who will have to grow, refine and distribute biodiesel products.

Appendix A
Figure 1: Crude Oil Prices and Geo-Political Events



Appendix B: Key Issues of Major Stakeholders

Table B1: Key Issues for Major Stakeholders in Oil Seed Production

Process Step	Key issues for Major Stakeholders in Oil Seed Production		
	Farmer	**Biodiesel Producer**	**Government**
Selection of land to grow the crop	o Maximizing his profit by selecting the right crop. o Needs education and training (currently plants what the neighbor plants)	o Having an agreement and relationship with the farmer to secure much needed oil seed at competitive prices	o Meeting the needs of its population. o Maximizing national wealth, and securing strategic food and fuel supply. o Providing incentives via subsidies, education & seed for planting
Land Preparation for canola	o Needs education and training on what to do, when, and how o Renting equipment o Buying and putting down fertilizer o Small land sizes increase cost of equipment rental per unit area. Collaborate with neighboring land owners to minimize overhead.		o Land reform to prevent further reduction of farm land.
Planting the seed	o Selecting the seed type o Investing options for the seed purchase o Time of planting to achieve right growth stage before cold to avoid frost damage o Finding the right planting equipment	o Can provide seed to the farmer	o Identify best seeds for each growing region. o Provide guidance to the farmer on seed selection. o Subsidize seed cost? o Support research for production of seed in Turkey

Growing the crop	o Decision to fertilize o Decision to use agricultural chemicals to fight disease – currently, since canola growing is very new in Turkey, there are no diseases developed yet for canola.	o Monitor crop growth to anticipate the supply potential	Decision to promote or subsidize insurance for the crop against frost damage (currently Government does not provide any insurance support and crop insurance for canola is not available)
Harvesting and storage	o Harvesting with minimum yield loss o Finding and using the right equipment	o Monitoring for better estimate of crop yield from farmers under agreement or others.	o Monitoring the yields and availability to make price adjustments
Sale of the product	o Selling price may be fixed by an earlier agreement with the biodiesel producer. o Excess yield may be sold in short-term markets.	o Keeping good and trustworthy relationship with the farmer--guaranteed seed for planting for the following year.	o Gather statistics on sales and (in the early years) monitor actual sales to pay subsidies.
Storage of the Purchased Seed	o Major producers or cooperatives could negotiate contracts with seed suppliers.	Seed storage logistics depends on the location of oil producer, its capacity, and the availability of storage facilities for these type of seeds.	o Government policy for seed purchase and storage needs to be developed for canola. .

Table B2: Key issues for Stakeholders in Oil and Biodiesel Production and Sales

Process Step	Key issues for Major Stakeholders in Oil and Biodiesel Production and Sales		
	Biodiesel Producer	**Biodiesel Seller at the Pump**	**Government**
Oil Production	o Selecting the oil producer(s) and having agreement well before seed is available. o Having distributed oil production vs. centralized oil production must be decided: Centralized production may enjoy volume discount and better control, distributed production reduces production risk dues to potential problems. o Depending on the dynamics of vegetable oil and biodiesel prices one may consider selling the oil without converting into biodiesel.	o Oil supply scenarios are of great concern to biodiesel sellers since limited supply may cause difficulties in securing contracts. o	o Oil production from seeds grown in Turkey vs. from imported seeds is a debate that needs to be revisited and carefully reconsidered to maximize Turkey's benefit from this newly developing "biodiesel" market.
Transportation and Storage of Oil	o Most likely will be stored at a location very close to the biodiesel production site. o Oil supply may become a critical issue in		o If government gives the same or similar tax incentives for imported oil, providing storage facilities at duty-free regions may be

	the coming years if only oil from domestically grown seeds is allowed to enjoy tax break.		feasible.
Biodiesel Production	o Process design, plant design, equipment purchase and installation can be done partially or totally by Turkish companies. o Building a flexible facility that can handle multiple types of oils, including used oil, would be advantageous o Companies should consider be part of the next generation technology development. o EU standard currently specifies 21 analytical quality variables. Turkish standard took 7 of these as mandatory properties. Producer may need to test and meet more if plans to sell out of Turkey.	o Securing biodiesel supply from local sources may become challenging if the biodiesel demand in Turkey grows fast, along with EU. o Internal use of biodiesel by some of the producers (e.g. by the members of a co-operative that produces the seed - Cukobirlik) may cause shortages in the initial years. o Supply demand dynamics will determine how, if any, of the tax profits will be shared between the producers and the seller at the pump.	o Government needs to have an in-depth study of biodiesel supply/demand and its impact on Turkey's economy to determine if the current regulations are serving for the best interest of the farmer, biodiesel producer, and Turkey's energy needs. o Analytical standards for biodiesel may need to be aligned closely with EU if a significant export is to be emphasized. o Promote and support research on biodiesel technology

Mixing of Biodiesel and Diesel+	o Currently the regulations require this mixing to take place at the refineries or at petroleum companies' pre-distribution storage vessels. So, either the producer or the seller can make this arrangement	o	o
Marketing and Sales	o Current regulations may lead to development of partnerships with oil producers and biodiesel manufacturers and sellers. Hence, petroleum companies may get involved in oil supply business as well.	o Currently all major petroleum companies are interested in providing biodiesel at the pump. If the supply is less than the demand actually seller can pay more just to be able to offer biodiesel at their stations.	o Monitoring the biodiesel supply - demand closely and making necessary policy adjustments is essential to ensure a healthy market development and value add to Turkish economy.