# Impact of Commercialization of Biofuel on Prices of Related Commodities

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**ABSTRACT**

*This paper examines the use of vegetable oils and sugar for biofuel in selected countries, as a price stabilization mechanism in the EU, USA and Brazil. Two scenarios; one before and the other after the advent of the biofuel programme were analysed for soyabean, rapeseed, sugar and corn prices. Correlations between the price and production of biofuel for the selected vegetable oils were high and showed positive relationship after commercializing of the biofuel. This means that the biofuel programme had improved the prices for the selected vegetable oils. The index from the ARCH and GARCH models were much higher and the linear trend of selected vegetable oil prices showed a downward trend prior to commercialization. However, after their use as biofuel, the index became much lower and the linear trend of selected vegetable oil prices showed an upward trend. This means that, after commercializing the biofuel, prices stabilized and slowly increased. The findings indicate that the biofuel programme can remove excess production to new uses and improve prices. Hence, it can be deduced that removal of palm oil from the market and put to new uses (biofuel) could improve palm oil price. Therefore, it is strongly suggested that Malaysia should commercialize biofuel from palm oil.*

## INTRODUCTION

Vegetable oils and their derivatives, especially methyl esters (commonly referred to as biodiesel), are possible alternative diesel fuels. They have advanced from being purely experimental fuels to the initial stages of commercialization. They are technically competitive with or offer technical advantages over conventional diesel. Besides being a renewable resource, biodiesel produces less harmful emissions while the engine performance and fuel economy are nearly identical to those from conventional fuels.

In Europe, the production of biofuels started in the 1980s, before it developed more seriously in 1993. Present global production of biofuel is estimated at about 15 million tonnes per annum. Europe produces only a small share of this, just under 6% (890 600 t in 2000). Most of the global biofuel is ethanol which totalled 14.6 million tonnes in 2000. The main producers are the USA and Brazil, with Europe a rather small producer. However, Europe is the most important producer of biodiesel.

The European production of biodiesel has increased by almost 10 times from 80 000 t in 1993 to 780 000 t in 2001. In 2001, the total production of biofuel by France was about 312 000 t – 403 000 t biodiesel and 91 000 t ethanol. In

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Germany, production of biofuel is focused on biodiesel, which in 2001 was almost 360 000 t. This was a substantial increase from 2000 where production is 246 000 t, making Germany the fastest growing producer of biodiesel with an annual growth rate of almost 50%.

Currently, there is little international trade in biofuel, and it seems unlikely that the European countries would import biofuel from outside their Union, for example, from the USA and Brazil. Doing so would be subsidizing the exporting countries, as all biofuel production has to be subsidized. Presently, most of the biofuel produced in the European Union are consumed within the region. In October 2002, the European Parliament called on the EU Council to adopt a biofuel strategy in order to achieve a zero/low emission transportion sector.

## STRATEGY

In the US, its biodiesel industry faces serious economic, policy and technical challenges before it can produce a meaningful volume. To date, only a few small companies are producing biodiesel. This is because of the unfavourable economics and lack of government incentives to offset the cost of production. A recent report by the US government suggests that, biodiesel is a realistic approach to the sequestration of carbon dioxide and other greenhouse gases in the transportation sector.

The developed countries like the EU and USA have strategies for their biofuel industries with measures to ensure their (industry) success. These strategies are:

A. Strategies for Commercial Purpose
   i) Selling at a competitive price to conventional diesel by tax exemption on biofuel.
   ii) Creating a strong distribution channel to ensure the stability of supply and demand.
   iii) Offering incentives:
      a) Renewable power production incentive.
      b) Green municipal funds.
   iv) Building a relationship business - a long-term relationship, not single-transaction deals with customers:
      a) Becoming their fuel supply department, not just a vendor.
      b) Encouraging understanding about value for the whole society and economy.
   v) Focusing on fuel distributors and big consumers as key target markets:
      a) Truckers and long-distance bus companies.
      b) Maintain close relationship with transport companies and agriculture enterprises.
   vi) Promotion:
      a) Advertising in the local newspapers, radio and cable TV to launch the campaign.
      b) Pushing research and demonstration projects.
      c) Image campaigns for renewable fuel.
      d) Awards and prizes to customers utilizing biofuel.

B. Research and Development (R&D)
   a) Producing high quality fuel.
   b) Continuous improvement of the process through scientific and technical assistance from research.
   c) Continuous experimenting with the local public transport system.
   d) Monitoring and controlling.

C. Legislation
   Energy Policy Act (*e.g.* according to a new law, all fuel sold in Poland must incorporate a bio-component portion).

## OBJECTIVES

In view of the above, the objectives of this paper are to examine the impact on prices in using soyabean oil, rapeseed oil, sugar and corn for biofuel and to highlight the measures adopted in selected countries to ensure the success of their biofuel industry.

## METHODOLOGY

This study starts with evaluating correlation between prices and production of biofuel for selected commodities, such as soyabean, rapeseed, sugar and corn, to observe the strength in the relationships. The ARCH and GARCH evaluations as well as linear trend analysis on prices of selected commodities will be analysed based on two scenarios. These scenarios are before and after the advent of the biofuel programme.

The autoregressive conditional heteroskedasticity (ARCH) and Generalized ARCH (GARCH) are used to determine the stability of prices before and after using vegetable oils as biofuel. The ARCH model introduced by Engle (1982) can account for the difference between the conditional and unconditional variances of a stochastic process. The most common ARCH ($q$) process used to examine price

volatility is the ARCH (1) model where:

$$\sigma^2_t = \phi + a\mu^2_{t-1} \quad (1)$$

This model (Equation 1) was used to examine the persistency of volatility in the prices of selected vegetable oil prices, sugar and corn. A more general process is the GARCH process developed by Bollerslev (1986) where GARCH ($p$,$q$) model is:

$$\sigma^2_t = \phi + \sum_{i=1}^{p} p_i \mu^2_{t-i} + \sum_{j=1}^{q} q_i \sigma^2_{t-i} \quad (2)$$

The sum ($p$+$q$) measures the volatility persistence. As it approaches unity, the persistence of shocks to volatility becomes greater, and at $p$+$q$ =1, the shock becomes permanent with the unconditional variance infinite. If $p$+$q$ > 1, the volatility is explosive. The model was developed based on monthly prices of selected vegetable oils from January 1982 to December 2004. The data were collected from various issues of *Oil World* and from the Internet, and comprised the soyabean oil, rapeseed oil, sugar, corn and RBD palm olein.

## EMPIRICAL RESULTS

The results comprised evaluations of the correlation analysis as well as the ARCH and GARCH analyses and is shown as below.

### Correlation Analysis

Biofuel was first produced commercially from rapeseed oil in 1999, then from soyabean oil and corn in 2001 and from sugar in 2002. Correlation analyses were carried out for two periods - before commercialization and after commercialization of biofuel. The correlation between price and production is the degree to which there is a linear relationship between them. The correlation coefficient, *r*, ranges from –1 to 1. A quick way of interpreting the *r*-value is that if it is < 0.4 numerically, then the correlation is poor or weak. From 0.4 to 0.7 is moderate correlation, and > 0.7 indicates a strong relationship.

*Table 1* shows the correlations between the price and production of the commodities before and after commercializing as biofuel. The coefficients for soyabean and corn before commercialization were negative at -0.6841 and -0.8682, respectively. However, after commercialization, the coefficients turned positive to 0.9863 and 0.9807, respectively. All the correlations were high. A positive sign means that the biofuel programme had improved the prices of both crops.

The correlations between prices and production of rapeseed and sugar before their commercialization as biofuel were positive with coefficient of 0.6054 and 0.4197, respectively. After their commercialization as biofuel, the coefficients increased to 0.7690 and 0.7061, respectively indicating that their prices had improved.

The movements of prices and production of methyl esters or ethanol from selected commodities are illustrated in (*Figures 1* to *4*). *Figure 1* shows that in early 2000, the production of methyl esters from soyabean oil increased significantly from the year before. The soyabean price trended upwards from early 2000 to 2004, in contrast to the previous years. There was therefore a positive correlation between price of soyabean oil and production of methyl esters from soyabean oil.

*Figure 2* shows the correlation between price and production of methyl esters from rapeseed oil. It can be seen that, in early 2000 production of methyl esters from

**TABLE 1. CORRELATION BETWEEN PRICE AND PRODUCTION**

| Vegetable oils | Price *vs*. production before commercializing of biofuels | Price *vs*. production after commercializing of biofuels |
|---|---|---|
| Soyabean | -0.6841 | 0.9863 |
| Rapeseed | 0.6054 | 0.7061 |
| Sugar | 0.4197 | 0.7690 |
| Corn | -0.8682 | 0.9807 |

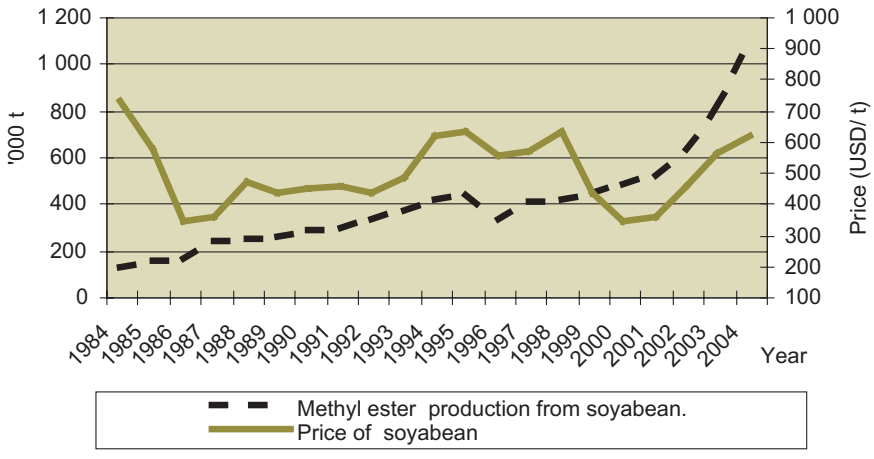


*Figure 1. Methyl ester production from soyabean oil and price of soyabean oil in US 1984-2004.*

rapeseed oil increased significantly from the previous year and that the price of rapeseed oil had also increased.

*Figure 3* shows that in early 2000 there was a marked increase in the production of ethanol from sugar. The sugar price was stable from early 2000 to 2004, as compared to the price in the previous years. This means that the price and production of ethanol from sugar had a positive relationship after the commercialization of ethanol as biofuel.

The price of corn and production of ethanol from it had a positive relationship after the commercialization of ethanol as biofuel. The production of ethanol from corn increased sharply in 2000 from previous year, while corn prices also rose from early 2000 to 2004, in contrast to the previous years (*Figure 4*). The high prices of corn oil during 1996 and 1997 was due to the decline in corn production. Production of corn in 1995 was 1.012 million tonnes while in 1996 it was 0.992 million tonnes. Production then increased again to 1.022 million tonnes in 1997.

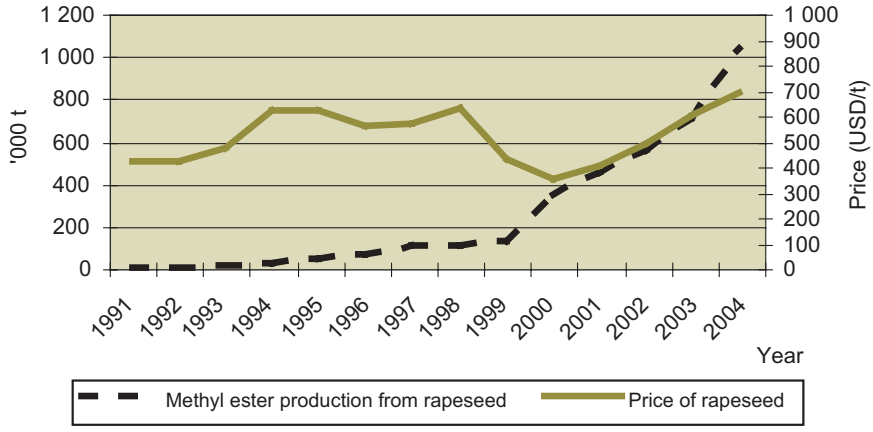


*Figure 2. Methyl ester production from rapeseed oil in Germany and the price of rapeseed oil, 1991-2004.*

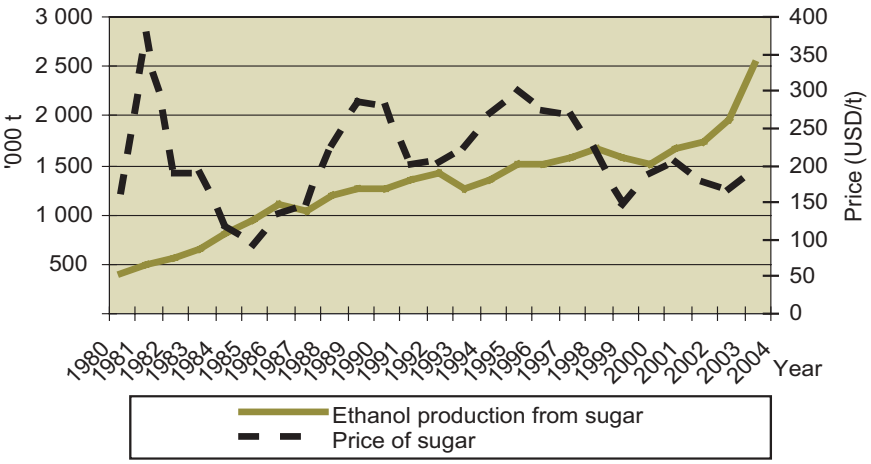


*Figure 3. Ethanol production from sugar in the US and price of sugar, 1980-2004.*

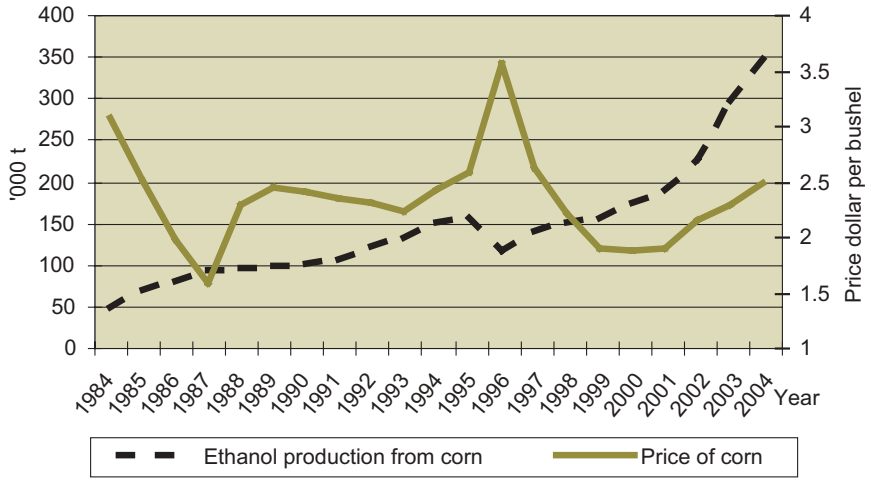


*Figure 4: Ethanol production from corn and the price of corn, 1984-2004.*

## Results of the ARCH And GARCH Analyses

The ARCH and GARCH output analyses were used to determine the price volatility of the selected commodities. *Table 2* shows the price volatility index for soyabean oil, rapeseed oil, sugar and corn before and after commercializing as biofuel. Before the advent of biofuel, the price volatility index for soyabean oil, rapeseed oil, sugar and corn were 0.6523, 0.8339, 1.1250 and 1.1250 respectively. But, after the production of biofuel, the index declined to 0.5652, 0.1049, 0.9052 and 0.7660 respectively. These indicate that, the soyabean oil, rapeseed oil, sugar and corn prices had become more stable compared to the period before using as biofuel (*Figure 5* until *Figure 8*).

Though palm olein can be used as biofuel, it has not yet been commercialized. It is useful to estimate its price volatility to compare with that of rapeseed oil. The same period (before and after the use of rapeseed oil for biofuel) were therefore assumed. If the price volatility of palm olein was similar to that of rapeseed oil, then it can be de-

duced that the pattern in price volatility was due to time. However, if the pattern in price volatility differed, then it can be deduced that only rapeseed oil had benefited from its use as biofuel.

The price volatility of palm olein based on the index from ARCH and GARCH was 0.9689 for 1982 to 1998 (*Table 3*). In 1999 to 2004, it increased to 1.1715. Thus, the price volatility of RBD olein was less in 1982 -1998 than in 1999-2004. This indicates that, RBD palm olein did not benefit from the use of rapeseed and soyabean oil for biofuel (*Figure 9*). Therefore, Malaysia should implement a biofuel programme for its palm oil industry to improve palm oil prices in the future.

## CONCLUSION

The analyses indicate that biofuel programme can remove excess production to new uses and hence, improve the prices of those commodities (soyabean oil, rapeseed oil, sugar and corn). Shifting the excess production to new uses is analogous to shifting the demand curve for the product, so that higher prices are paid for the lower quantity supplied to the market. The major implication of this study is that, removal of palm oil from the market to be put to new uses (biofuel) would lead to improving palm oil prices. Therefore, Malaysia should implement a biofuel commercialization programme to ensure the benefits of price improvements are reaped by the Malaysian palm oil industry.

**TABLE 2. PRICE VOLATILITY OF SELECTED COMMODITIES**

| Commodities | Model | Before impl. biofuel (1982-2000) | After impl. biofuel (2001-2004) |
|---|---|---|---|
| Soyabean oil | ARCH (p)<br>GARCH (q)<br>**Sum (p + q)** | 0.3536<br>0.2987<br>**0.6523** | 0.5652<br>*- NR -*<br>**0.5652** |
| | | Before impl. biofuel (1982-1998) | After impl. biofuel (1999-2004) |
| Rapeseed oil | ARCH (p)<br>GARCH (q)<br>**Sum (p + q)** | 0.8339<br>*- NR -*<br>**0.8339** | 0.1049<br>*- NR -*<br>**0.1049** |
| | | Before impl. biofuel (1960-2001) | After impl. biofuel (2002-2004) |
| Sugar | ARCH (p)<br>GARCH (q)<br>**Sum (p + q)** | 0.4609<br>0.6641<br>**1.1250** | 0.1617<br>0.7435<br>**0.9052** |
| | | Before impl. biofuel (1977-2000) | After impl. biofuel (2001-2004) |
| Corn | ARCH (p)<br>GARCH (q)<br>**Sum (p + q)** | 0.5707<br>1.0097<br>**1.1250** | 0.1464<br>0.6196<br>**0.7660** |

Note: NR - not relevant.

**TABLE 3. PRICE VOLATILITY MODEL FOR RBD PALM OLEIN**

| Model | In year (1982-1998) | After assuming impl. biofuel (1999-2004) |
|---|---|---|
| ARCH (p)<br>GARCH (q) | 0.4812<br>0.4877 | 0.1649<br>1.0066 |
| Sum (p + q) | 0.9689 | 1.1715 |

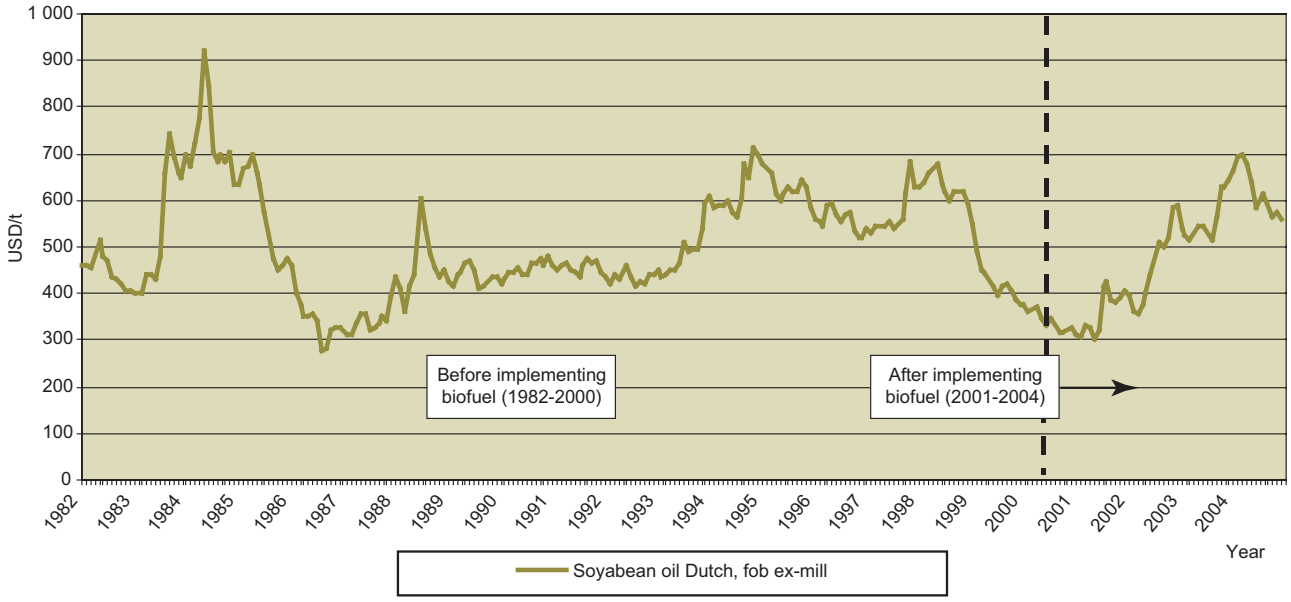


*Figure 5. Price of SBO (1982:1-2004:12).*

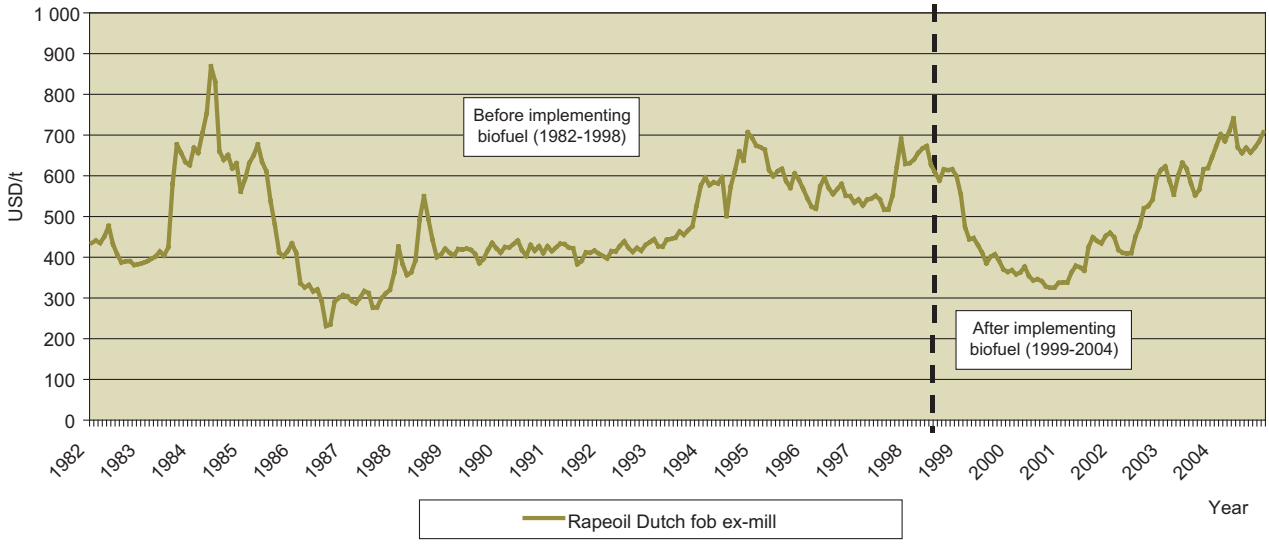


*Figure 6. Price of RSO (1982:1-2004:12).*

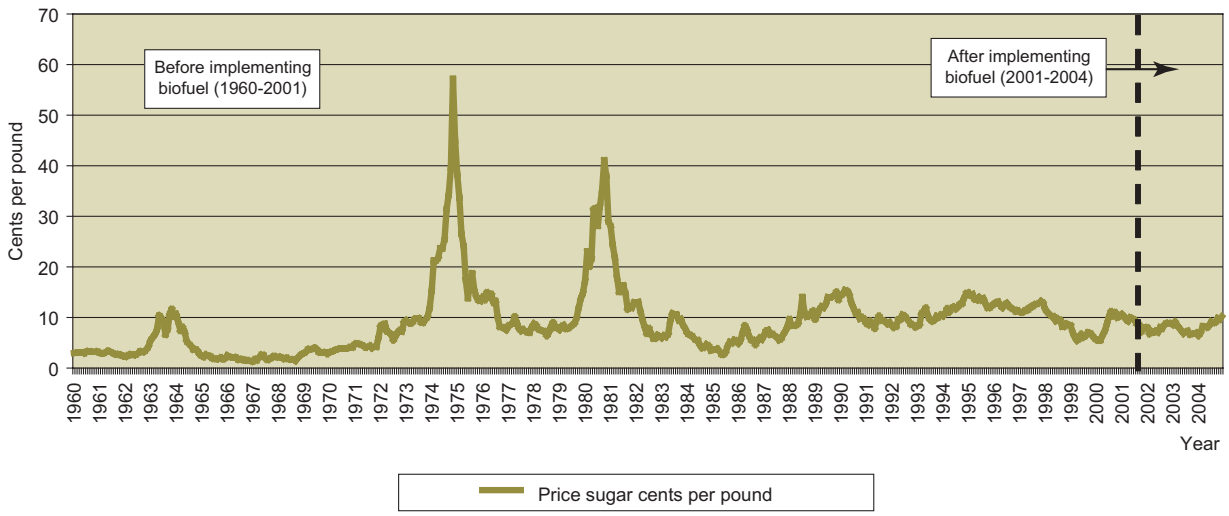


*Figure 7. Price of sugar (1960-2004).*

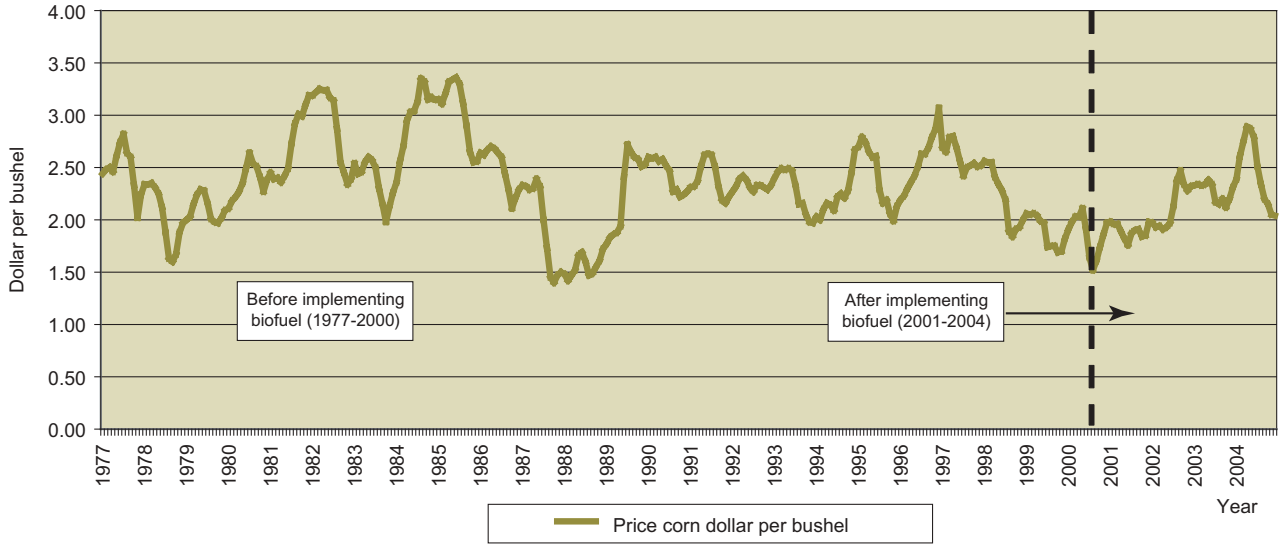


*Figure 8. Price of corn (1977-2004).*

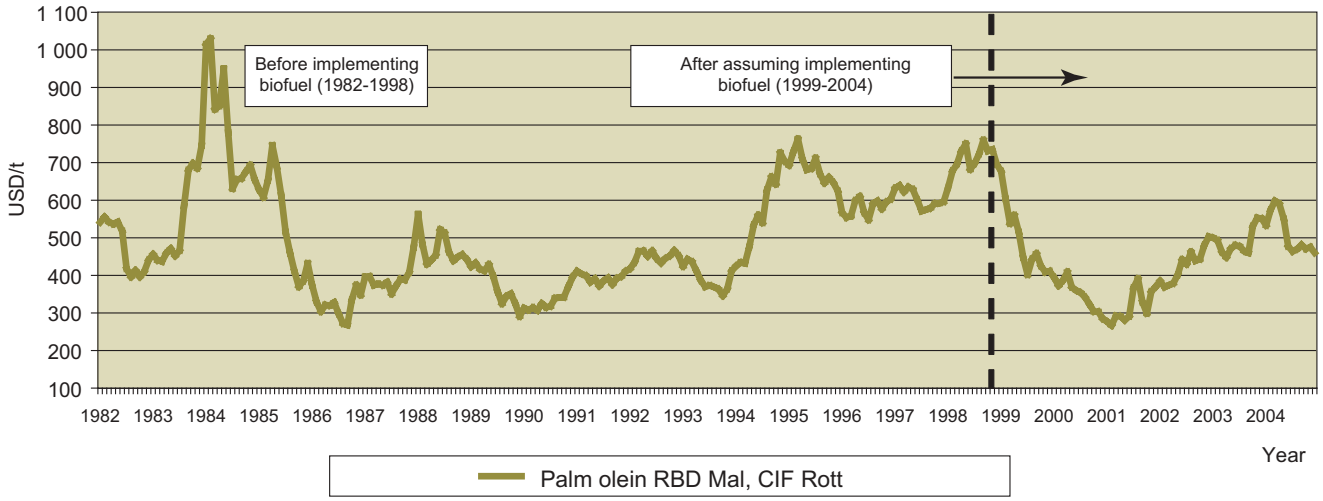


*Figure 9. Price of RBD palm olein (1982-2004).*