CHAPTER III
THE CONCEPTUAL MODEL AND DATABASE MANAGEMENT

Simple economic theory discussed in Chapter 2 has provided the guidelines about the functioning of the commodity market if price stabilisation is introduced. The theoretical implications can be presented in the form of a model so that the structure of the oils and oilseeds market is empirically estimated. The first step, of course, is model specification, which is attempted in Section I of the present chapter while the derivation of the various structural relations of the model and their specification is attempted in Section II. The model and the choice of estimation procedure are described in brief in Section III.

I. MODEL SPECIFICATION

A model is a simplified picture of reality and it abstracts from reality certain characteristics in order to focus our attention on the essentials of the phenomenon of interest. The model used for the analysis of oils and oilseeds economy is the one suggested by the theory of pure competition at both the ends and traders/oil millers behaviour at the middle, i.e. at the wholesale level, where price formulation takes place. This model can be considered
as a good approximation to reality for most of the initial producers of oilseeds and the final consumers of oils. In the production-consumption chain, these individuals or entities do not appear to be able to affect market prices perceptibly, which is the essential condition of pure competition to hold. To the extent that there are exceptions in the form of large participants in the markets in the middle of the chain in the form of large firms, traders' associations etc, it is assumed that the existence of limit pricing due to possible new entrants substitutes and the Government's indirect measures like actions against illegal traders and the recent emergence of the NDDB\(^1\) to restructure the oils and oilseeds sector, all these result in approximately competitive behaviour. The desirability of considering such purely competitive model lies in its ability to predict the behaviour of endogenous variables and not because of any normative value associated with this particular market model.

In spite of close approximation of competitive behaviour with reality, a separate price relation is introduced in the middle of the production-consumption chain where price formulation takes place. This is behavioural relation for the merchants (traders/oil millers) on the

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assumptions that the merchants have a two-fold economic function of bringing supply and demand into contact and of regulating prices.

An outline of the various components of the model is presented below:

**Production**

The production process is characterised as recursive in nature and this involves two behavioural equations and one identity. The first equation represents the area response equation, while the second represents the production of oilseeds explained by acreage and non-acreage factors. The third equation is an identity which gives the domestic supply of oil after applying fixed conversion formula to derive oil from oilseed.

**Consumption**

The fourth equation explains the per capita domestic consumption of oil. This is explained by the wholesale price, prices of substitutes/complements, per capita real income and other relevant explanatory variables. Regarding the structural specification for consumption component, some researchers use price-dependent mixed demand
functions. For example, Jean-Paul and Johnson¹, Heien,² Roy and Johnson³ and Madhoo Pavaskar⁴ specify quantity-dependent demand equations. Jhala⁵ specifies price dependent demand function taking quantity of oil consumed as an independent variable which also stands for the price formulation at wholesale level. As Wold and Jureen⁶ rightly pointed out, such inverse demand functions tell nothing about the price mechanism. At best, such equations explain that if demand is known what is the price that would give rise to this demand. In this study, the quantity dependent consumption component is preferred in order to know how consumers react to changes in prices and income.

Wholesale, Farm and Retail Prices

Preliminary time services analysis of the farm, wholesale and retail prices showed that the wholesale prices lead both the farm and retail prices. Thus, the price formulation in the model is explained at the wholesale level. This is explained by the fifth equation on the understanding that wholesalers (oil millers/traders) act as regulators of price raising or price lowering depending upon whether the supply falls short or exceeds demand. The farm harvest price relation of oilseeds is specified as the sixth equation, expressing farm harvest prices of oilseeds as a function of the wholesale prices of oil. Another relation (seventh equation) gives retail oil prices as a function of the wholesale prices of oil. Both the equations (sixth and seventh) explain the price variation from wholesale to farm level and wholesale to retail level, respectively. The conceptual working of oil and oilseeds system is shown in Figure 6.
Fig. 6. Oils and Oilseeds System

- Total Demand for Oil for Various Purposes
- Traders Role in Bringing the Supply and Demand into Contact
- Supply of Oils
- Production of Oil Seeds
- Weather During Growing Season
- Acreage Under Oil Seeds
- Weather During Sowing Season
- Wholesale Prices of Oils
- Consumers Income
- Retail Prices of Oils
- Relative Farm Prices
II. SPECIFICATION OF STRUCTURAL RELATIONS

The derivations of various structural relations of the model and their specification is attempted in this section.

Acreage Response Equation

Farmers face a decision problem while allocating their land to various crops in response to price and non-price factors. The nature of acreage response to price in underdeveloped agriculture has been debated at length in the past. Various hypotheses have been formed. Behrman\(^1\) classified these hypotheses into three groups:

i. The farmers in underdeveloped agriculture respond quickly, normally and efficiently to relative price changes;

ii. The marketed production of subsistence farmers is universally related to price; and

iii. The institutional constraint are so inhibiting that any price response is insignificant.

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\(^1\) Behrman, J.R. Supply Response in Underdeveloped Agriculture, Amsterdam, North-Holland, 1988, p.3.
However, Behrman himself says that these groups are not mutually exclusive. The major proponents of the first hypothesis, namely, that farmers respond positively and effectively are Schultz\(^1\), Raj Krishna\(^2\), Dharam Narain\(^3\) and Dantwala\(^4\). According to Schultz, "The doctrine that farmers in poor countries are either indifferent or respond perversely to changes in price..... is patently false and harmful."\(^5\)

There are other important studies in India which have shown that Indian farmers are responsive to price changes. Most of these studies are based on Nerlovian distributed lag model either in its original form or in its


\(^{5}\) Schultz, J.W. Op.Cit., 9, p.49
modified form. These studies include Kamala Devi and Rajagopalan\textsuperscript{1}, Kaul and Sidhu\textsuperscript{2}, Venkataramanan and others\textsuperscript{3}, Tyagi\textsuperscript{4}, Mahendra Reddy\textsuperscript{5}, Askari and Cummings\textsuperscript{6}, George and Others\textsuperscript{7} and Jhala\textsuperscript{8}.


\textsuperscript{5} Mahendra Reddy, J., Estimation of Farmers Supply Response --A Case Study of Groundnut, Indian Journal of Agricultural Economics, Vol.25(4) 1990, pp.57-63


\textsuperscript{7} George, P.S., Srivastava, U.K. and Desai, M.M., The Oilseeds Economy of India, Delhi, Macmillan, 1999

However, it can be postulated that variations in oil seeds acreage are induced by changes in relative prices and non-price variables like yield, rainfall during sowing season, availability of water during summer season, price risk and yield risk, etc. More specifically the purpose is to get acreage response to relative prices, non-price variables and risks arising from price and yield variations in oilseeds.

Farmers find it difficult to make a hundred per cent adjustment while responding to various economic factors or to adjust instantaneously. This indicates that distributed lag model can be used for measuring the farmer's response behaviour. In the Nerlovian\(^1\) framework the long-run equilibrium supply \(Y^*\) is assumed to be a linear function of the expected price \(P^*_1\).

\[
Y^* = a + bP^*_1 + u_{11}
\]

The expected price \(P^*_1\) is adjusted in each time period by a proportion '\(\beta\)' of the difference between the previous period's actual price \(P_{1-T}\) and its expected price.

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This is described as

\[ P_t^* - P_{t-1}^* = \beta(P_{t-1} - P_{t-1}^*), 0 < \beta < 1 \]  (2)

Here \( \beta \) is the rate of adjustment associated with price uncertainty and is termed by Nerlove as the coefficient of expectations.

In a similar manner, the way in which supply is adjusted towards the long run equilibrium supply is by

\[ Y_t - Y_{t-1} = \gamma(Y_t^* - Y_{t-1}), 0 < \gamma < 1 \]  (3)

Where \( \gamma \) is the coefficient of adjustment representing the proportion of the adjustment towards equilibrium which occurs in one time period. If there is no price uncertainty, which means \( \beta = 1 \), then farmers' expected price will be equal to previous year's price \( P_{t-1} \) i.e.

\[ P_t^* = P_{t-1} \]

Substituting this and value of \( Y_t^* \) in equation (3) the reduced form can be shown as

\[ Y_t = A + B P_{t-1} + CY_{t-1} + E_t \]  (4)

where \( A = a \gamma \), \( B = b \gamma \), \( C = (1-\gamma) \) and \( E_t = \gamma u_t \).
This equation (4) is the computational equation. Basically, this form would remain the same even if more independent variables are included. This model helps in the estimation of both the short and long run supply elasticities.

The Ordinary Least Squares (OLS) technique cannot be employed to the above reduced form of the equation because:

i. estimates will be inefficient as the disturbance term in the reduced form is likely to be serially correlated

ii. estimates will be inconsistent as the equation contains lagged values of the dependent variable; and

iii. the equation is overidentified

Hossein Askari and John T. Cummings have suggested a Maximum Likelihood method to get asymptotically unbiased, consistent and efficient estimates.

Using Nerlove’s adjustment lag model as the basic framework, the acreage response relationship can be estimated with the help of the following equation.
\[ Y_{1t} = a_{10} + a_{11} X_{1,t-1} + a_{12} X_{2,t-1} + a_{13} X_{3t} + a_{14} X_{4t} \\
+ a_{15} X_{5,t-1} + a_{16} X_{6,t-1} + a_{17} Y_{1,t-1} + U_{1t} \] (I)

where \( a_{11}, a_{12}, a_{13}, a_{14}, a_{17} > 0, a_{15}, a_{16} < 0 \)

and \( Y_{1t} = \) area under concerned oilseed in 000 hectares in the year \( t; \)
\( Y_{1,t-1} = \) lagged area of concerned oilseed;
\( X_{1,t-1} = \) lagged relative farm harvest price index of concerned oilseed;
\( X_{2,t-1} = \) lagged yield per hectare of concerned oilseed;
\( X_{3t} = \) actual average rainfall (in millimetres) during sowing months of concerned oilseed;
\( X_{4t} = \) percentage of area under irrigation by all crops;
\( X_{5,t-1} = \) price risk measured by ratio of the standard deviation of farm harvest price of concerned oilseed to the standard deviation of farm harvest price index of its competing crops measured over the three preceding years;
\( X_{6,t-1} = \) yield risk represented by the standard deviation of yield per hectare of concerned oilseed measured over the three preceding years;
\( U_{1t} = \) disturbance term
Production Behaviour of Oilseeds

The use of acreage as an approximation to planned output may not be a good procedure. Though acreage under cultivation is not the same thing as the actual output, it is one of the determinants of the actual output. As Nerlove argues, approximation of planned output by acreage is far from being an ideal approximation. In the case of oilseeds, more than 90 per cent of the area under oilseeds depends on the vagaries of monsoon. Once farmers allocate area (land) for oilseeds the production of oilseeds would depend on a number of non-acreage factors like rainfall during growing season, use of fertiliser and pesticides, the government's subsidy programmes and availability of quality (improved) seeds etc. Production of oilseeds also depends significantly on the extent of irrigation for oilseed crops. This is evident from the fact that for the year 1999-2000 yield per hectare of groundnut was 846 kg for kharif (rain-fed) and 1447 kg for rabi (irrigated) in Gujarat state. Thus, the production of oilseeds can be explained by the following equation.

\[ Y_{2t} = a_{20} + a_{21}Y_{1t} + a_{22}X_{7t} + a_{23}X_{8t} + a_{24}X_{9t} + a_{25}T + U_{2t} \]  

(II)
where \( a_{21}, a_{22}, a_{23}, a_{24}, a_{25} > 0 \)

and \( Y_{2t} \) = production of concerned oilseed in 000 tonnes;

\( Y_{1t} \) = area under concerned oilseed in 000 hectares;

\( X_{7t} \) = actual average rainfall during growing season of concerned oilseed (in millimetres)

\( X_{8t} \) = fertiliser consumption i.e., the consumption of N.P.K. in 000 tonnes in the year 't'

\( X_{9t} \) = percentage of irrigated area to total cropped area under oilseeds;

\( T \) = trend variable (taking 1972-73=0, 1973-74=1, 1974-75=2, 1998-99=27)

\( U_{2t} \) = disturbance term

**Domestic supply of Oils**

The entire oilseeds output is not consumed directly. Only a small portion is used for final consumption. The bulk of oilseeds is crushed to prepare oil and oilcake. The production figures of oilseeds are adjusted for seeds, direct consumption and export of kernels/seeds, etc. to derive the quantum of kernels/seeds available for crushing. The estimate of domestic production of oils is then obtained by applying the average oil recovery rate of the estimated
kernels/seeds available for crushing. These adjustments and conversions are presented in the form of the following identity:

\[ Y_{3t} = \frac{\alpha_1}{N} (\alpha Y_{2t} - \text{seeds purpose} - \text{Direct consumption} - \text{Export of seeds}) \]  

(III)

where

- \( Y_{3t} \) = estimate of domestic supply of oil under question (in kgs) on per capita basis;
- \( Y_{2t} \) = domestic production of oilseeds under question (in 000 tonnes);
- \( N \) = estimates of mid-year population;
- \( \alpha_1 \) = average oil recovery rate of concerned oilseeds (exogenously determined); and
- \( \alpha \) = conversion rate of groundnut in shell into kernels = 0.70 (exogenously determined)

The conversion rate is estimated as 0.70 on the basis of information available with Government publications. This rate is valid for groundnut only, since for other oilseeds such conversion does not take place. For the remaining oilseeds, therefore, the value of \( \alpha \) is taken to be equal to 1.
Demand Function

Demand function represents a functional relationship between quantity demanded of a commodity and price of that commodity for a given time period. The quantities purchased by a consumer are supposed to be optimal quantities, i.e. the quantities determined by maximising his utility function under a budget constraint. Supposing a consumer purchases quantities $X_1, X_2, \ldots, X_n$ from a bundle of goods, then he is supposed to maximise his utility.

$$U = f(X_1, X_2, \ldots, X_n)$$  \hspace{1cm} (1)

subject to the linear constraint

$$P_1X_1 + P_2X_2 + \ldots + P_nX_n = Y$$  \hspace{1cm} (2)

where $P_1, P_2, \ldots, P_n$ are prices of goods 1, 2, ..., n and $Y$ represents his total expenditure or income.

All prices are supposed to be given and the consumer cannot influence them. To find the first order condition for a maximum we form the Lagrangian function

$$L = U - \lambda (\sum_{i=1}^{n} P_iX_i - Y)$$  \hspace{1cm} (3)
where $\lambda$ is a Lagrangian multiplier. Differentiating $L$ with respect to $X_1$'s and $\lambda$, we get

$$\frac{\partial L}{\partial X_i} = \frac{\partial U}{\partial X_i} - \lambda P_i \quad i=1,2,...,n$$  \hspace{1cm} (4)

$$\frac{\partial L}{\partial \lambda} = \sum_{i=1}^{n} P_i X_i - Y$$

Putting all the derivatives equal to zero, we obtain the $(n+1)$ first order conditions.

$$\frac{\partial U}{\partial X_i} = \lambda P_i \text{ for all } i \leq n$$

$$\sum_{i=1}^{n} P_i X_i = Y \quad i=1,...,n$$  \hspace{1cm} (5)

On the assumption that the conditions for global maximum are satisfied, system (5) gives us the 'n' optimal values of $X_i$ and the equilibrium value of $\lambda$. The 'n' equilibrium values of $X_i$'s appear as functions of all prices and income, i.e.

$$X_i = f(P_1, P_2, ..., P_n, Y) \quad i=1,2,...,n$$  \hspace{1cm} (6)

These functions are the demand functions which describe the behaviour of the consumer in the market.
Applied consumption analysis, can be undertaken with the help of two types of data, namely, cross-section data and/or time series data. The cross-section data relate to household budgets showing all expenditures on consumer goods and services made by individual families. They relate to one point of time so that prices do not have any scope for change. They are supposed to be constant. It is assumed in this mode of analysis that there are no spatial variations in prices. On the other hand, time series data give information about the numerical values from period to period, i.e. at different points of time. With the change in time, prices as well as income vary. Thus in the case of cross-section data, demand function is primarily a function of income and in the case of time series data, demand function is primarily a function of prices.

For estimating demand functions a number of studies have used time series data. Schultz, Stone, Klein and Rubin and Wold and Jureen provide some illustrations of demand analysis based on time series data. Schultz's\textsuperscript{1} book, The Theory and Measurement of Demand, is generally considered as the pioneering and monumental work in the field of time series analysis. It contains studies on

\textsuperscript{1} Schultz, H., The theory and Measurement of Demand, Chicago, Chicago University Press, 1958.
demand in the United states for agricultural products, viz., sugar, wheat, cotton and potatoes. The observed relationship between quantities and prices can be identified as demand equation when the demand curve is stable while the supply curve is subject to shifts.\(^1\) Thus, Schultz's estimated relations belong to demand equations as supply of agricultural products is subject to large variations due to uncertain weather conditions. His two alternative specifications of the demand equation are:

(a) Linear

\[ X_{it} = a_t + b_t P_{it} + C_t + \epsilon_{it} \]

(b) Log-Linear

\[ X_{it} = A_i P_{it} \alpha \epsilon^\beta it + \epsilon_{it} \]

where \( X_{it} \) is the per capita consumption of \( i \)th commodity, \( P_{it} \) is price index of the commodity divided by a general price index and 't' measures time (t=0,1,2,....) Time trend 't' catches the influence of all other variables like changing tastes, prices of other commodities, income and change in the population.

Stone considered that the use of time trend to catch the influence of all variables, other than the price of the commodity is not appropriate. He has introduced along with the trend, a number of prices of complementary and substitute goods and per capita income in his regression equation.

His double logarithmic demand functions are as follows:

$$\log x_i = \log \alpha_i + r_i \log Y_t^* + \varepsilon B_j \log p_j + \delta_t + E_{it}$$

where $Y_t^*$ is ratio of nominal income to a general price index.

As income and prices move together over time, Stone uses the extraneous information to get statistically significant estimates of both $r_i$'s and $B_{jt}$'s. He replaced $r_i$ by estimate of income coefficient obtained from surveys on British household budgets. This use of extraneous estimates has been critised by Kuh and Meyer on the ground that the


income elasticities derived from budget studies are simple (total) elasticities while \( r_i' \)'s are partial elasticities. Similarly, Wold and Jureen\(^1\) in their Demand Analysis used both time series and cross-section data to estimate demand for agricultural products. In the absence of proper data on consumption, market statistics, i.e. time series data on quantities bought and sold, prices, income, etc., have been used. Thus, national totals which refer to production after making necessary corrections for imports exports and changes in stocks have been taken as quantities consumed.

The estimation of demand function in the present study also based itself on Wold's market statistics approach to arrive at data on consumption as we have the same difficulty of obtaining direct data on consumption. So the production data have been adjusted for seeds, other purposes, imports and exports to arrive at data on consumption demand since no significant stocks have been maintained in the case of oils and oilseeds.

Thus, using consumer demand theory, by maximising consumer's utility function subject to his total budget constraints, a complete demand equation can be obtained. Due

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to large number of independent parameters entering these equations, direct estimation of a complete demand system is generally not feasible. This needs reduction in the number of independent parameters. The usual approach is to include only certain variables in the specified relation, i.e. to set some of the cross derivatives equal to zero. Thus, economic theory suggests that the demand for a commodity is a function (homogeneous of degree zero) of price of that commodity, prices of all other commodities and of consumer's income. The demand function for commodity $X_i$ is given by

$$X_i = f(P_i, P_j, P_k, Y, T, U)$$

where $P_i$ is the price of $i^{th}$ commodity. $P_j$ and $P_k$ are prices of close substitutes and close complements respectively. $Y$ is consumer's income, $T$ is trend variable and $U$ is disturbance term. The latter represents the influence of omitted variables. In the demand function specified presently the prices are relative prices and income is real income to satisfy the homogeneity condition, i.e. the quantities demanded remain unchanged when all prices and income increase or decrease proportionately. To take account of changes in tastes and preferences, a time trend is introduced to represent the effect of continuous unidirectional changes in tastes.
The demand for each of the edible oils may be divided into four categories:

i. Direct demand for food, i.e. liquid consumption;
ii. Demand for vanaspati preparation;
iii. Demand for industrial use in preparation of soap, paints and varnishes; and
iv. Demand for exports.

There have been frequent changes in the Government's policy since 1980 regarding the use of edible oils and oilseeds products in vanaspati and other industries. This is reflected in the introduction of various restrictions and quota systems because of short supply of these oils and oilseeds in the country. For instance, in the early 1980s the groundnut oil accounted for over 85 per cent of the total oil output used in the manufacture of vanaspati. Later, to meet the groundnut oil shortage, the industry was supplied with cheaper imported oils like soyabean and palm oils from 1985 onwards. Since 1996 the vanaspati industry was required to restrict its usage of groundnut oil to only 25 per cent of its total consumption. Very recently, i.e. from 1997-98 onwards, the vanaspati industry has been virtually prohibited from using groundnut oil. The industry was also prohibited from using the
indigenous rape/mustard oils altogether. The use of sesamum oil is also fixed at the statutory minimum level of 5 per cent. At present, the bulk of its requirements is met by the STC through the supply of cheaper imported oils. As a result of these measures, even the exporters of various oilseeds and their products are exogenously determined. Therefore, the estimation of demand function for these oils for each of the components, such as vanaspati preparation, industrial use and exports, is not a fruitful exercise. Hence, it is decided to estimate the per capita total domestic consumption for each of the specified oils under question. This domestic consumption includes edible oil consumed for direct consumption for food, in vanaspati preparation, in soap, paints, varnish industries etc.

Following economic theory, the total domestic demand for specific under question is hypothesized as negatively related to the price of that oil and the price of complements and positively related to close substitutes and disposable income. Population, a demand shifter, can be introduced directly as a variable or indirectly by expressing the relevant variables on per capita basis. A trend variable is introduced in the demand equation to represent the shifts in quantity demanded due to changes in
non-economic factors such as increasing knowledge about nutritional content of diets and dietary requirements, quality and convenience factors, tastes and preferences.

Thus, per capita total domestic demand for each of the specific oils under question is explained by the following equation.

\[ Y_{4t} = a_{40} + a_{41} Y_{5t} + a_{42} X_{10t} + a_{43} X_{11t} + a_{44} X_{12t} + a_{45} T + U_{4t} \] (IV)

where \( a_{44}, a_{45} > 0, a_{41} < 0 \)

and \( Y_{4t} = \) per capita domestic consumption of concerned oil in kg. in the year 't' (domestic production of concerned oil - exports + Imports, divided by mid-year population)

\( Y_{5t} = \) real wholesale price index of concerned oil;

\( Y_{10t} = \) real wholesale price index of related oil (substitute/complements)

\( X_{11t} = \) real wholesale price index of another related oil

\( X_{12t} = \) per capita real income at 1990-91 prices;

\( T = \) time-trend variable (taking 1972-73 = 0, 1973-74=1 1974-75=2, ..., 1998-99=27)

\( U_{rt} = \) disturbance term
Price Formulation

The prices of most farm products, particularly of oilseeds and oils, vary considerably within the season as well as from one season to another as supply varies in response to changes in weather etc. These fluctuations confuse the farmers and quite often the Government has taken ad hoc measures to stabilise the prices. But these efforts have been in vain. One possible method is the cost of production approach. For this, Shepherd\(^1\) argues that the cost of production has continued to be a fruitful source of controversy but has not been found adequate or workable as a basis for agricultural prices. He further pleads that under free competition, business does not start with the cost of production. It starts with what the consumer wants and will pay for.

The realistic and economic basis for setting prices according to Shephered is the supply and demand price. This equilibrium price is based not on dozens of estimates of production but upon supply and demand of related products in the market. This is based upon action of producers, traders/oil millers (distributors) and consumers.

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\(^1\) Shephered, G.S., Agricultural Price Analysis (Sixth Edn.) Amsterdam, Iowa State University Press, 1988, p.184.
In the case of edible oils market traders/oil millers speculative operations are very strong and they make undue profit. Because the traders are few in number with sizable control on the market, they operate under conditions of oligopsony rather than free competition. In such a case there is free enterprise but not free competition.

The behaviour of foodgrain prices in India\(^1\) has been examined by a number of research workers. All of them have come to the conclusion that the demand functions for foodgrain are price inelastic and past upward trends and price fluctuations are largely due to steadily rising demand pressure and change in the quantity supplied. Jhala\(^2\) has analysed the price behaviour of edible oils using general equilibrium approach and partial equilibrium approach for the period 1982-89. He has concluded that variation in price were largely due to excess demand and particularly in 1986, the edible oil prices shot up by 21 per cent, of which as much as 18 per cent was accounted for by demand pull. In the case of edible oil markets, it appears that the domestic production of oil i.e., domestic supply of oil plays a

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1 Mellor, John W and Dar, Ashok, Determinants and Development Implications of Foodgrains Prices, American Journal of Agricultural Economics, Vol.50(4) 1988, pp.962-73

crucial role in determining as well as stabilising the prices of edible oils. For instance, within a fortnight in the month of October 2001, the price of groundnut oil tumbled to Rs.200 from Rs.300 per 16 kg tin. This fall in price is not associated with any sudden decrease in demand or shift in consumer's preferences from consumption of groundnut oil to other edible oils. In fact, this fall in price is due to the fact that new groundnut crop started appearing in the markets in greater quantities during this period. Even in case of off season when supply was short, the Government's decision to import edible oil made sufficient impact on edible oil prices in the market. It happened in the case of sugar when the Government made available sufficient quantity of imported sugar to the market during September 2001 and thus the prices of sugar remained stable even during the Dussehra and Diwali festivals when there was great demand for sugar.

Following Herman Wold who argues that although it is possible to determine the market price by equation supply and demand, a more penetrating exploration of price formation requires formulation of an explicit price strategy.

and a separate price equation. The changes in edible oil prices are mostly explained by the likely changes in the supply over the previous year's demand. If the change is positive then there will be a downward pressure on the edible oil prices. If the changes is negative then there will be an upward pressure on the edible oil prices.

This kind of price mechanism is a behavioural relation for the merchants (traders/oil millers) on the assumption that the merchants have a two-fold economic function of bringing supply and demand into contact and of regulating prices. This price formulation is explained at the wholesale level since the wholesale prices lead both the farm and the retail prices.

The price level desired to be brought about by traders/oil millers in any period is determined as a linear function of the likely difference between the quantity supplied in any period and the quantity demanded in the previous period i.e.

\[ P^*_t = a_0 + a_1 (S_t - D_{t-1}) + U_t \]  

where \( P^*_t \) = wholesale price of concerned oil intended to be set by traders in the year 't'
\( S_t = \) supply of concerned oil of traders/oil millers in the year 't'

\( D_{t-1} = \) Demand for concerned oil in the year \( t-1 \)

It is assumed that given the level of difference between domestic supply in any period \( (S_t) \) and domestic demand in its previous period \( (D_{t-1}) \) traders/oil millers tend to determine prices with negligible error in line with supply relation basing their approximation on the belief that the consumer demand in the current period would be the same as during the previous period.

The actual change brought about in the price level, however, is only a partial realisation of the desired change. This may happen because of the structural difficulties, imperfect market conditions and other factors outside the control of traders. Thus the partial adjustment mechanism towards desired changes can be expressed in a linear form as follows:

\[
P_t - P_{t-1} = \mu(P^*_t = P_{t-1})
\]

or

\[
P^*_t = N P_t + (1 - N') P_{t-1}
\]

where

\[
N' = \frac{1}{\mu}
\]
Here \( \nu \) measures the magnitude of adjustment that could be made by traders. Generally \( \nu \) can be expected to vary between zero and unity. If \( \nu = 1 \), traders have realised their desired level of price and if \( \nu = 0 \), no change in the prices over the previous level. However, previous policy measures taken by the Government at times of continuous rise in prices prevent traders/oil millers from realising the desired increase in the price level. This requires \( \nu \) to be less than unity.

The above equations (1) and (2) can be reduced to a single equation in terms of observable variables in the following form:

\[
P_t = a_0 + a_1 (S_{t-D_{t-1}}) + a_2 P_{t-1}
\]

(3)

where \( a_2 = 1 - \nu \)

In the actual working out of the model, \( D_{t-1} \) is considered as gross availability of concerned oil to the consumers in the previous year. The price equation, therefore, is expressed in the following form along with other explanatory variables:

\[
Y_{5t} = a_{50} + a_{51} (Y_{3t} - Y_{4t-1}) + a_{52} X_{12t} + a_{53} X_{13t} \\
+ a_{54} Y_{5t-1} + a_{55} X_{14t} + U_{5t}
\]

(4)
where \( a_{52}, a_{54} a_{55} > 0, a_{51}, a_{53} < 0 \)

and \( Y_{5t} = \) real wholesale price index of concerned oil in the year 't'

\( Y_{3t} = \) per capita domestic supply of concerned oil (in kg) in the year 't';

\( Y_{4, t-1} = \) per capita domestic consumption of concerned oil (in kg) in the year (t-1)

\( X_{12t} = \) per capita income at 1990-91 prices;

\( X_{13t} = \) quantity of palm and soyabean oils imported in the country (in 000 tonnes)

\( X_{14t} = \) dummy variable representing the number of traders/oil millers involved in illegal activities like hoarding, speculation, data-trading, etc. takes the value;

1 if there are large numbers of traders/oil miller involved;

0 otherwise;

\( U_{5t} = \) disturbance term

The coefficients of this equation show the short term effect on price level. The equilibrium price or long term effect of the variables on the price level can be obtained by equating \( Y_{5, t-1} \) to \( Y_{5t} \) or dividing the
coefficients of the right hand side variables (other than \( Y_5, t-1 \)) by the difference between the coefficient of \( Y_5, t-1 \) and unity. The importance of this relation, however, rests on the fact that:

1. it gives idea of the probable levels of each of these oil prices that can in general be obtained under various hypotheses about the level of major factors that are influencing them; and

2. in turn, given the magnitude of future price line, say at certain level, the changes that may be required in the influencing factors to bring about the desired price level can be estimated.

**Farm Prices and Retail Prices**

Since farm prices and retail prices are made to depend on wholesale prices, the price variation aspect is studied firstly at farm-wholesale level and secondly at retail-wholesale level. Thus, the equations explaining the prices at farm and retail levels in terms of wholesale prices are as follows:

\[
Y_6t = a_{60} + a_{61} Y_{5t} + U_{5t}
\]

(VI)
where \( a_{61} > 0 \)

and \( Y_{6t} \) = real farm harvest price index of concerned oilseed

\( Y_{5t} \) = real wholesale price index of concerned oil;

\( U_{6t} \) = disturbance term

Retail prices of oil

\[
Y_{7t} = a_{70} + a_{71} Y_{5t} + U_{7t} \tag{VII}
\]

where \( a_{71} > 0 \)

and \( Y_{7t} \) = real retail price index of concerned oil;

\( Y_{5t} \) = real wholesale price index of concerned oil;

\( U_{7t} \) = disturbance term

THE MODEL IN NUTSHELL AND ESTIMATION PROCEDURE

The equations of the model discussed so far are put together in a nutshell (in functional form) along with the expected direction of influences of explanatory variables over the dependent variables as under:

Equations of the Model

1. Acreage Response (Supply) Relation for Concerned Oilseed

\[
Y_{1t} = F(X_{1,t-1}, X_{2,t-1}, X_{3t}, X_{4t}, X_{5,t-1}, X_{6,t-1}, Y_{1,t-1})
\]
2. Domestic Production of Concerned Oilseed

\[ Y_{2t} = F(Y_{1t}, X_{7t}, X_{8t}, X_{9t}, T) \]

3. Domestic Supply of Concerned Oil (Identity)

\[ Y_{3t} = \frac{\alpha}{N}[\alpha Y_{2t} - \text{seeds purpose} - \text{Direct purpose} - \text{Export of seeds}] \]

4. Demand for Concerned Oil

\[ Y_{4t} = F(Y_{5t}, X_{10t}, X_{11t}, X_{12t}, T) \]

5. Price formulation or Market Clearance Equation of Concerned Oil

\[ Y_{5t} = F[(Y_{3t} - Y_{4,t-1})/\text{or } Y_{3t}, Y_{4,t-1}, X_{12t}, X_{13t}, \]

\[ X_{14t}, Y_{5, t-1}] \]

6. Farm Price Relation with concerned Wholesale price of Oil

\[ Y_{6t} = F(Y_{5t}) \]

7. Retail Price Relation with Concerned Wholesale Price of Oil

\[ Y_{7t} = F(Y_{5t}) \]

All the behavioural relations of the model involve additive disturbance terms.
Variables of Model

Endogenous Variables

1. $Y_{1t}$ = Area under concerned oilseed (in 000 hectares)
2. $Y_{2t}$ = Production of concerned oilseed (in 000 tonnes)
3. $Y_{3t}$ = Per capita domestic supply of concerned oil (in kg)
4. $Y_{4t}$ = per capita domestic consumption ($Y_{3t} - \text{Exports} + \text{imports of oil}$) of concerned oil (in kg)
5. $Y_{5t}$ = Real wholesale price index of concerned oil based to 1990-91 = 100.
6. $Y_{6t}$ = Real farm harvest price index of concerned oilseed based on 1990-91 = 100
7. $Y_{7t}$ = Real retail price index of concerned oil based to 1990-91 = 100.

Exogenous Variables

1. $X_{1,t-1}$ = Relative lagged farm harvest price index of concerned oilseed based to 1990-91 = 100
2. $X_{2,t-1}$ = Lagged yield per hectare of concerned oilseed (in kg).
3. $X_{3t}$ = Average rainfall during sowing months of concerned oilseed (in millimetres)
4. $X_{4t}$ = Percentage of area under irrigation by all crops.

5. $X_{5t-1}$ = price risk measured by ratio of standard deviation of farm harvest price of concerned oil seed to the standard deviation of farm harvest price of competing crops measured over past three years.

6. $X_{6t-1}$ = Yield risk represented by standard deviation of yield per hectare of concerned oilseeds measured over past three years.

7. $X_{7t}$ = Average rainfall during growing season of concerned oilseed (in millimetres)

8. $X_{8t}$ = Fertilisers consumption in India, i.e. consumption of N.P.K. (in 000 tonnes)

9. $X_{9t}$ = Percentage of irrigated area to the total cropped area under oilseeds

10. $X_{10t}$ = Real wholesale price index of related (substitute/complement) oil

11. $X_{11t}$ = Real wholesale price index of another related oil

12. $X_{12t}$ = Per capita real income at 1990-91 prices

13. $X_{13t}$ = Quantity of palm and soyabean oil imported in the country (in 000 tonnes)
14. $X_{14t}$ = Dummy variable representing the number of traders/oil millers involved in illegal activities like hoarding, speculation, data trading etc.
1 if there are large numbers of traders/oil millers involved
0 otherwise

15. $T$ = Trend variable taking values 1972-73=0, 1973-74=1, 1974-75=2, .... 1998-99 = 27

16. $N$ = Estimate of mid-year population

17. $Ex$ = Exports of castor oil (in 000 tonnes)

Parameters

$\omega$ = Conversion rate of groundnut in shell into kernels (seeds) which is equal to 0.70 (Exogenously determined).

$\omega_1$ = The average oil recovery rate of concerned oilseeds (Exogenously determined)

The following table describes the expected direction of influences of explanatory variables over the dependent variables in the behavioural equations of the model.
The model presented in this section describes the various relations of the oils and oilseeds economy of India. Since the model is of recursive type, the problem of identifying the structural relations does not arise. The relations of the model can be estimated sequentially by using Simple Classical Linear Regression Model and consistent and unbiased estimators may be obtained. But there is serious and well known difficulty of finding an appropriate estimation procedure in estimating equations (I) and (V) of the model. Equation (I) is the reduced form equation of the area adjustment equation where the lagged
acreage \( (Y_1, t-1) \) appears on the right hand side of the equation. Equation (V) is the reduced form equation of the price adjustment equation where lagged price \( (Y_5, t-1) \) appears on the right hand side of the equation. This causes the estimation problem of getting consistent estimators due to the possible correlation between the disturbance and the lagged endogenous variable.

The difficulty of the appropriate estimation procedure varies considerably with different assumptions about the disturbance term in the reduced form equations (I) and (V). If statistically consistent and unbiased estimators of the parameters in equation (I) and (V) are to be obtained by using Classical Linear Regression Model, the residuals \( U_{1t} \)'s and \( U_{5t} \)'s must be independent in the respective equations, i.e. \( U_{1t} \)'s are not serially correlated and so also are \( U_{5t} \)'s. It is this difficulty that forced Nerlove and most users of Nerlovian adjustment model (Rao, Jai Krishna, Tyagi etc) to make the following set of assumptions about the reduced form disturbances terms \( U_{t} \)'s. They are: \( U_{t} \) is distributed with zero mean, diagonal variance covariance matrix with a constant own variance and that this disturbance term and the contemporaneous elements of \( Y_{1t} \) matrix (\( Y_{5t} \)) are distributed independently.
In most studies the Durbin-Watson test has been applied to test serial correlation. However, the Durbin-Watson test is inappropriate in those situations when lagged endogenous variables are presented on the right hand side of the equation. The serial correlation is therefore tested in equations (I) and (V) through 'h' statistics. Since 'h' statistics in equations (I) and (V) revealed insignificance of serial correlation in the disturbance terms, the use of Classical Linear Regression Model incorporating the above-stated assumptions yielded satisfactory results. The relations of the model are tried in linear and long-linear forms based on annual time series observations covering the period 1972-73 to 1998-99. As time series data on retail prices are available only from 1983 onwards, it is decided to study the price variation aspect from 1993 onwards. The study covers the important oilseeds grown in India, namely, groundnut, rape/mustard, sesamum, linseed, castorseed, and cottonseed.
DATABASE MANAGEMENT

The equations, developed for the proposed model of estimate the parameters of the various relations such as acreage response relation, production relation, demand relation and relations for price mechanism and price variations for each of the six major oilseed crops grown in India have been described in previous chapter. The success of the model is, however constrained by availability of data which most suited to variables conceptually specified in the model. The subject of this chapter relates to the statistical data used in the estimation of various (above-mentioned) relations of oils and oilseeds economy of India. Besides the sources of data, some preliminary calculations to derive measurement of relevant variables are also described.

The important variables used in this study are acreages, productions, and yields of six major oilseed crops and their major competing crops, farm harvest prices, wholesale and retail oil prices, rainfall during sowing and growing seasons, technological variables like fertilisers consumption and percentage of irrigation, per capita income,
estimates of population, exports and imports of oils and actions against illegal traders/oil millers. All the variables used in the study relate to national level of aggregation.

**Acreage (Y\(_{1t}\)), Production (Y\(_{2t}\)) and Yield (X\(_2\), t-1)**

Estimates of the acreage sown (in hectares) and yield per hectare (in kg) for each of the six major oilseeds and their major substitute crops are required for the estimation of acreage response relation. Reliable time series data for the period 1970-71 to 1999-99 on the State and National level of aggregations are available from the following publications of the Government of India, Directorate of Economics and Statistics, Ministry of Food and Agriculture.

a. *Estimates of Area and Production of Principal Crops in India, Vol.II*

b. *Bulletin on Commercial crops statistics (Various issues)*

c. *Indian Agricultural Statistics, Vols.I and II;*

d. *Agricultural situations in India (monthly) (various issues).*
On the basis of preliminary analysis of State level data, regional preferences, etc., the crops that are considered as major competing crops for each of the six major oilseeds are presented in Table 1.

**TABLE 1**

MAJOR OILSEEDS AND THEIR COMPETING CROPS GROWN IN INDIA

<table>
<thead>
<tr>
<th>Oilseeds</th>
<th>Competing Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut</td>
<td>Jowar, Bajra, Maize, Ragi and Cotton</td>
</tr>
<tr>
<td>Rape/Mustard</td>
<td>Jowar, Gram, Wheat and Barley</td>
</tr>
<tr>
<td>Sesamum</td>
<td>Jowar, Maize, Bajra, Gram and Cotton</td>
</tr>
<tr>
<td>Castorseed</td>
<td>Jowar, Bajra and Maize</td>
</tr>
<tr>
<td>Cotton (Seed)</td>
<td>Jowar, Wheat, Sesamum and Groundnut</td>
</tr>
</tbody>
</table>

Relative Lagged Farm Harvest Prices \( (X_{t-1}, t-1) \)

Farm harvest prices are received by farmers during post-harvest period of the concerned crop. The post-harvest period includes six to eight weeks after the normal harvesting period. Since most of the farmers sell their cash crops soon after the harvest the farm harvest prices are considered as more suitable to represent the true prices
received by the farmers Z.Y. Jasadanwala and S.L.Bapna have arrived at this very conclusion. For the purpose of estimating acreage response relation, these prices are considered for the present study. The state level farm harvest prices of each of the six oilseed crops and of their major competing crops were taken from various issues of the following publications of the Government of India, Directorate of Economics and Statistics, Ministry of food and Agriculture.

a. Farm Harvest Prices of Principal crops in India (Periodicals).

b. Agricultural Prices in India

c. Agricultural situation in India (various issues).

Then, the relative farm harvest prices for each of the six oilseeds were computed by dividing individual oilseed's farm harvest prices by the farm harvest price index of competing crops. In the case of groundnut, this is described as follows:

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1 Jasadanwala, Z.Y., Marketing Efficiency in Indian agriculture, Bombay, Allied Publishers, 1986

First, all India weighted average farm harvest prices of groundnut were obtained by using the production figures of the major producing States as weights. The major groundnut producing states are: (a) Andhra Pradesh, (b) Tamil Nadu; (c) Gujarat; (d) Karnataka; (e) Maharashtra; (f) Madhya Pradesh and (g) Uttar Pradesh. These States together produce more than 90 per cent of the total production.

Similarly, all India weighted average farm harvest prices of major competing crops were obtained by using production figures of the major producing States as weights. Then, weighted average farm harvest price index for the competing crops (price index of competing crops) were obtained by taking acreages under each of these (competing) crops as weights. For all these crops, the prices are expressed in rupees per quintal.

Then the relative farm harvest prices for groundnut were obtained by deflating the farm harvest price of groundnut by the price index of competing crops. Thus

\[
X_{t-1} = \frac{\text{Farm harvest price of groundnut}}{\text{Price index of competing crops}}
\]
Then, the index of these relative prices were worked out by taking 1990-91 as the base year i.e. 1990-91=100.

Similar calculations have been carried out to get relative farm harvest price indices for rape/mustard, sesamum, linseed, castor and cotton, considering the major producing States of each of the oilseeds.

**Sowing and Growing Season's Rainfall** ($X_{3t}$ and $X_{7t}$)

Oilseeds are mostly rainfed crops in India. Past experience shows that fluctuations in area and production are broadly similar to the pattern of fluctuations in rainfall, particularly during sowing and growing seasons. An analysis of the impact of rainfall distribution pattern during sowing and growing stages of the crops is crucial.\(^1\) Instead of considering the annual rainfall, an attempt has been made to isolate that component of the annual rainfall which is relevant or effective for acreage allocation and production of oilseed under question. For acreage allocation, rainfall during sowing period is considered and

---

\(^1\) Batra, Madan Mohan, *Agricultural Production Prices and Technology*, New Delhi, Allied Publishers, 1998
for estimating production relation rainfall during growing season is considered as relevant and effective.

The actual monthly rainfall statistics were collected from the reports of the Indian Meteorological Department, Poona, as published in various issues of Agricultural Situation in India and Bulletins on Commercial crops Statistics published by the Government of India, Directorate of Economics and Statistics. These rainfall figures are expressed in millimetres.

The rainfall indices for these two periods were obtained as weighted average rainfall of major producing States for each of the respective periods of six oilseeds. The weighted average rainfall figures during sowing season were computed by taking the average of the State's actual rainfall with acreage under each of the oilseed crops in each of the major producing States as weights. Similar analysis has been carried out to work out the weighted average rainfall figures for the national level during growing season for each of the six oilseeds using production figures as weights. The sowing season months, growing season months, the weights used and major producing States of each of the six oilseeds are presented in Table 2.
<table>
<thead>
<tr>
<th>Oilseed</th>
<th>Sowing Season months</th>
<th>Growing season months</th>
<th>Major Producing States</th>
<th>Weights used in calculating average rainfall</th>
<th>Sowing Season</th>
<th>Growing Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut</td>
<td>June, July</td>
<td>July, August September</td>
<td>Gujarat, Tamilnadu Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh and Uttar Pradesh</td>
<td>Acreage under groundnut</td>
<td></td>
<td>Production of groundnut</td>
</tr>
<tr>
<td>Rape/Mustard</td>
<td>September, October, October, November, December</td>
<td></td>
<td>Uttar Pradesh, Rajasthan, Madhya Pradesh, Punjab, Assam, Bihar</td>
<td>Acreage under rape/mustard</td>
<td></td>
<td>Production of rape/mustard</td>
</tr>
<tr>
<td>Sesamum</td>
<td>June, July</td>
<td>July, August September</td>
<td>Uttar Pradesh, Madhya Pradesh, Gujarat, Andhra Pradesh, Maharashtra, Tamilnadu, Karnataka, Rajasthan</td>
<td>Acreage under sesamum</td>
<td></td>
<td>Production of sesamum</td>
</tr>
<tr>
<td>Linseed</td>
<td>October, November</td>
<td>November, December January</td>
<td>Bihar, Uttar Pradesh, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh</td>
<td>Acreage under linseed</td>
<td></td>
<td>Production of linseed</td>
</tr>
</tbody>
</table>

contd....
Table 2 contd..

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Castorseed</td>
<td>Cotton</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July, August,</td>
<td>July, August,</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>September</td>
<td>September</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>October, November</td>
<td>October, November</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>December</td>
<td>December</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bihar, Maharashtra,</td>
<td>Gujarat, Madhya</td>
<td></td>
<td>Acreage under Castorseed</td>
<td>Production of Castorseed</td>
</tr>
<tr>
<td></td>
<td>Andhra Pradesh,</td>
<td>Pradesh, Andhra</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Karnataka, Tamilnadu</td>
<td>Pradesh, Tamilnadu</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>Karnataka, Punjab,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rajasthan</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Areas Under Irrigation \((X_{4t}, X_{9t})\)

Irregular monsoon and lack of assured water supply are two main factors responsible for wide fluctuations in agricultural production.\(^1\) The extension of irrigation facilities plays a vital role in enhancing the agricultural production and cropping intensity.\(^2\) The area under irrigation has an important bearing on acreage allocation and production of oilseed crops. For acreage response relation, the irrigation variable is measured by the percentage of area under irrigation at the national level. This will help us to know to what extent a given increase in the national level of irrigation goes in favour of a particular oilseed crop under question. The percentage of area under irrigation by all crops is taken to the ratio of gross irrigated area to gross sown area, i.e.

Percentage of Irrigation in the year \(t\) \((X_{4t})\)

\[
= \frac{\text{Gross Irrigated Area}}{\text{Gross sown area}}
\]

---


In the case of production relation, the irrigation variable used is the percentage of concerned oilseed area under irrigation to the total area under that crop. This helps us to know the effect of irrigated area on production. This variable is defined as:

\[
\frac{\text{Irrigated area of concerned oilseed}}{\text{Total area under concerned oilseed}} = \frac{\text{Percentage of Irrigated area to the total cropped area of concerned oilseed in the year 't'}}{\text{Total area under concerned oilseed}}
\]

The data on irrigation were collected by referring to various issues of Bulletin on Commercial Crops Statistics, Agricultural Situation in India, Estimates of Area, Production of Principal Crops, published by the Government of India, Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation.

**Price Risk** \( (X_5, t-1) \) and **Yield Risk** \( (X_6, t-1) \)

In acreage response relation a crude representation of farmers' behaviour regarding risk aversion factors is introduced. Behrman,\(^1\) for the first time, has introduced these variables in the form of standard deviations of price and yield in his modified Nerlovian

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dynamic supply response model. The three yearly standard deviations for farm harvest price of the concerned oilseed, relative to the three yearly standard deviations form harvest price index of competing crops and standard deviations for yields measured over the past three years, are included as proxies for the variability measures of the subjective probability distributions for prices and yields respectively. Since the farm prices of concerned oilseeds and price indices of competing crops for each of the six oilseeds were already calculated, the three yearly moving standard deviations were computed without much difficulty. Similarly, three yearly moving standard deviations for the yield were worked out.

**Fertiliser Consumption (X_{8t})**

The chemical fertiliser is considered to be one of the important determinants of crop yield.

The actual consumption of N.P.K. has been considered to measure the impact of chemical fertiliser on production of oilseeds. Data on fertiliser consumption has been taken from the fertiliser Association of India, New Delhi.
Domestic Supply of Oil ($Y_{3t}$)

Domestic supply of oil under question is taken to be a constant proportion of seeds/kernels available for crushing after adjusting that part of production which is used for the purpose of direct consumption and exports. In the case of groundnuts, the production figures are adjusted as follows to get the estimated indigenous production of oil. The groundnuts in shell are required to convert into kernels. According to official estimates, the standard conversion rate of shells into kernels is 70 per cent.\(^1\) The seeds/kernels are then adjusted for seeds purpose, direct consumption and export purposes to get the kernels available for crushing. The figures for seeds purpose and direct consumption were taken from various issues of Oilseeds in India, Bulletin on Commercial Crops Statistics published by the Government of India which gives the utilisation of oilseeds for such purposes. The standard rates (in percentage) of utilisation of oilseeds for various purposes are presented in Table 3.
TABLE 3

ESTIMATED CONSUMPTION OF SELECTED OILSEEDS FOR SEEDS AND DIRECT CONSUMPTION

<table>
<thead>
<tr>
<th>Oilseeds</th>
<th>Seeds purpose</th>
<th>Direct consumption</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut</td>
<td>12.00</td>
<td>6.50</td>
<td>18.50</td>
</tr>
<tr>
<td>Rape/Mustard</td>
<td>1.50</td>
<td>6.60</td>
<td>8.10</td>
</tr>
<tr>
<td>Sesamum</td>
<td>2.30</td>
<td>20.00</td>
<td>22.30</td>
</tr>
<tr>
<td>Linseed</td>
<td>5.00</td>
<td>6.30</td>
<td>11.30</td>
</tr>
<tr>
<td>Castorseed</td>
<td>6.00</td>
<td>--</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Source: Bulletin on Commercial Crops Statistics, Govt. of India.

Applying the average oil recovery rates to the estimated seeds/kernels available for crushing, we get the estimated domestic supply of oil. The oil recovery rates for various oilseeds are assumed to be constant throughout the period. These rates are presented in Table 4.
TABLE 4

PROPORTION OF OIL AND OILCAKE FOR SELECTED OILSEEDS

<table>
<thead>
<tr>
<th>Oilseed</th>
<th>Proportion of oil</th>
<th>Proportion of cake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut</td>
<td>44</td>
<td>56</td>
</tr>
<tr>
<td>Rape/Mustard</td>
<td>33</td>
<td>67</td>
</tr>
<tr>
<td>Sesamum</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Linseed</td>
<td>33</td>
<td>67</td>
</tr>
<tr>
<td>Castorseed</td>
<td>37</td>
<td>63</td>
</tr>
</tbody>
</table>


These rates are based on the rates reported in various issues of Bulletin on Commercial Crops Statistics published by the Government of India. Data on imports of palm/soyabean oils ($X_{13t}$) and also data on imports and exports of seeds/kernels and oil were taken from the various issues of Monthly Statistics of the Foreign Trade of India (D.G.C.I. & S). Ministry of Commerce and Industry, Calcutta.

**Per Capita Annual Domestic Consumption of Oil ($Y_{4t}$)**

In the absence of data on consumption of different oils, the estimates of apparent consumption were derived as
residual after adjusting the domestic production of oil to imports and exports.\(^1\) Estimates of per capita domestic apparent consumption of oil under question for all purposes (domestic and industrial purposes) in the year 't' was worked out on the basis of gross availability of oil (under question) in that year. Thus:

\[
\text{Gross Availability} = \text{Domestic Production} + \text{Imports} - \text{Exports}
\]

The gross availability of oil under question is expressed on per capita basis in terms of kg, dividing the gross availability of oil by mid-year population estimates, except castor oil. The consumption of castor oil is expressed in absolute quantity in terms of 000 tonnes per year. Statistics on stocks of oils and oilseeds are not maintained and even if they are available they are very negligible in quantity. Thus the apparent consumption of oil under question in the year 't' is equivalent to the gross availability of that oil in that year. The variation in the time period for which the data are available also poses a problem. For example, the data on production relate

to agriculture years ending June while import and export figures are for calendar or financial years. Suitable adjustments were, however, made for these differences on accounting period while estimating apparent consumption.

Wholesale (Y_{5t}), Retail (Y_{7t}) Prices of Oils and Farm Harvest Price (Y_{6t}) of Oilseeds

The data on wholesale and retail oil prices published by the Ministry of Food and Agriculture, Government of India are based on weekly price series collected from different market centres in the country. The required data on prices were collected from the following publications:

a. Bulletin of Agricultural prices (various issues)

b. Agricultural Prices in India (various issues)

c. Agricultural Situation in India (various issues)

In the absence of continuous series of data on wholesale and retail oil prices for various market centres, it is decided to take the prices prevailing at important market centres. In the case of groundnut oil, we have considered the prices prevailing at two most important market centres, namely, Mumbai and Chennai, where required
data are available for the whole period continuously. The Mumbai market is the most important and effective market for the groundnut oil and oilseeds. It exerts great influence over many oils and oilseeds markets of North, west and central parts of the country. Similarly, Chennai market also is equally effective and exerts sufficient influence over many oils and oilseeds markets of the southern part of the country. So all India average wholesale and retail oil price indices for groundnut oil were based on the prices prevailing at Mumbai and Chennai market centres.

In the case of rape/mustard oil, all-India average wholesale and retail oil price indices were worked out on the basis of prices prevailing at important market centres like Kanpur and Kolkotta. For sesamum these price indices were worked out on the basis of prices prevailing at Mumbai and Chennai Centres. For linseed, the prices prevailing at Kanpur and Kolkotta were considered to get all-India average wholesale and retail oil price indices. In the case of castor oil, these price indices were based on the prices prevailing at Hyderabad, Mumbai and Kanpur. In the case of cottonseed, the analysis is restricted to acreage response and production behaviour relations only for the simple reason that cottonseed oil has yet to establish its
creditability for direct consumption by masses of people (due to odour and tastes). The estimation of demand and price mechanism relations are not attempted for this promising oilseed. Therefore, the problems of collecting prices of this oilseed did not arise. All these prices refer to calendar year prices. These price series were deflated by the wholesale price index of all commodities based on 1990-91=100 to get the real prices. Then the price indices of these real prices were worked out taking 1990-91=100 as the base i.e. 1990-91=100. The wholesale price index of all commodities (calendar year) is taken from the Monthly bulletin on Wholesale prices in India, published by the Office of the Economic Adviser, Ministry of Industries, Government of India.

The most appropriate prices that should be used for the purpose of estimating consumption price relationship seem to be the retail oil prices. However, the data on retail oil prices are not available for the entire period i.e. for the period 1971-72 to 1998-99. The retail prices of oil are available only from 1983 onwards. This necessitated the use of wholesale oil price index in the consumption relation.¹ The weighted farm harvest prices of concerned

¹ NCAER, Op.Cit. 8(i) p.78
oilseed were deflated by the wholesale price index of all commodities based to 1990-91=100 to get the real farm harvest price index.

**Per Capita Income \( (X_{12t}) \)**

The estimates of per capita income at 1990-91 prices were used in the analysis of demand and price mechanism relations. These estimates were taken from the reports of the Economic Survey 2000-2001 as estimated by the Expert Committee set up by the Planning Commission, Government of India.

**Population \( (N) \)**

Estimates of population figures refer to mid-year estimates. These population estimates from 1991 onwards refer to the latest projections made by the Expert Committee set up by the Planning Commission, Government of India. Upto 1990, these estimates of population refer to the estimates made by the office of the Registrar-General of India.

**Traders/Oil Millers Involvement in Illegal Activities \( (X_{14t}) \)**

The Forward Market Commission takes regularly the actions against illegal traders and oil millers whenever traders/oil millers involve in illegal activities like
hoarding, daba trading, etc. Such actions are reported regularly in the Forward Market Bulletins. As a proxy to represent the traders/oil millers behaviour, this dummy variable has been introduced in the price behavioural relation. Such reported actions were taken from various issues of Forward Market Bulletin from 1976 onwards. This dummy variable takes the value one if there were large number of traders/oil millers involved in illegal activities in a given year 't' and takes value zero otherwise.