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Estimating Demand and Supply of Edible Oil in Pakistan

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ABSTRACT: This paper examines the demand for edible oil in Pakistan and a dynamic supply response model to show price responsiveness by sunflower oilseed farmers. The demand for edible oil is estimated by using Ordinary Least Square (OLS) technique. It has been found that an increase in the consumption of edible oil is highly affected by urbanization, increase in per capita income, relative high price of its substitutes and the rapid growth of the population. In order to estimate supply response model of oilseed (sunflower), Nerlovian partial adjustment model has been used. The dynamic supply response showed a positive price responsiveness by sunflower oilseed farmers, which is consistent with *a priori* expectation.

Edible oil is a major part of food consumption and plays a prominent role in Pakistani diet. The per capita intake of oil and fats amounts to 32.2 grams per day is significantly lower than the daily requirement considered necessary for the maintenance of good health i.e. 45 grams per day. However, daily fat consumption in Pakistan is much higher than the fat consumption in countries with similar level of per capita incomes. Fat consumption typically rises with an increase in incomes. In Pakistan it has increased from 7.95 kg (per annum) in 1980-81 to 13.22 kg (per annum) in 1992-93 when per capita income increased by Rs.916 (at constant factor cost) over the same period. Moreover, due to non-availability of animal fat the proportion of vegetable oils in total fat consumption is increasing as can be seen from the percentage share of vegetable oil in total fat consumption being 21.3 percent in 1963-64, 43 percent in 1971-72, 74 percent in 1979-80, 83 percent in 1987-88, and 94.87 percent in 1990-91 (Table 1). This is in contrast to the fact that in higher income economies, proportion of animal fat is higher in sufficient quantity (Table 2).

The demand for vegetable oil has been growing at an annual rate of 8 percent (Table 3) during the last ten years and is likely to grow at the same rate in the near future because of the substitution between animal fat and vegetable oil, urbanization, high price of substitutes, impurities in animal fat and the most importantly due to population growth rate of 3.1 percent per annum (Figure 1).

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Figure 1 . Pakistan's Vegetable Oil Consumption 1980-93

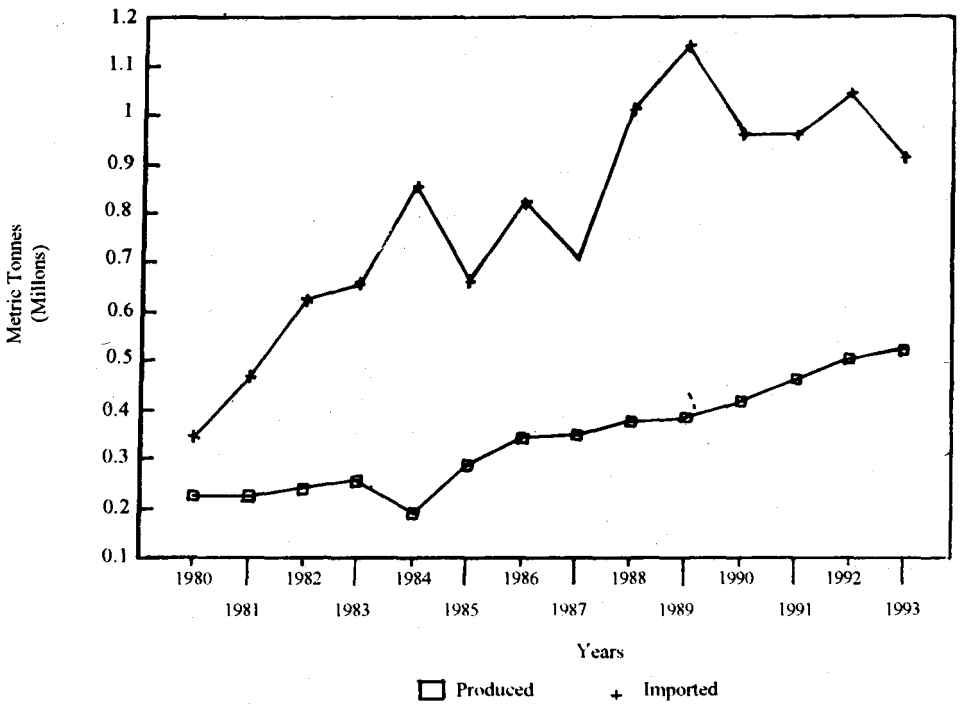


Figure 2 . Pakistan's Average Imported Vegetable Oil Prices, 1980-93

	Desi Ghee	Vegetable Ghee & Oil	Mustard Oil	Total Fat	% Share of Vegetable Oil
1963-64	0.28	0.056	0.02	0.33	21.13
1964-65	0.22	0.056	0.03	0.30	28.10
1965-66	0.30	0.072	0.05	0.42	29.00
1966-67	0.35	0.06	0.03	0.44	32.00
1968-69	0.32	0.072	0.03	0.42	24.17
1969-70	0.32	0.09	0.03	0.44	25.00
1970-71	0.31	0.20	0.03	0.54	42.6
1971-72	0.30	0.195	0.03	0.52	43.00
1979-80	0.19	0.51	0.03	0.73	74.00
1984-85	0.16	0.58	0.03	0.77	79.22
1985-86	0.16	0.58	0.03	0.77	79.22
1986-87	0.13	0.62	0.03	0.78	83.3
1987-88	0.14	0.63	0.03	0.80	83.00
1990-91	0.03	0.74	0.01	0.78	94.87

Source: Household Income and Expenditure Survey.

Table 2. An International Comparison of GNP Per Capita and Availability of Oil and Fats per Day (Grams)

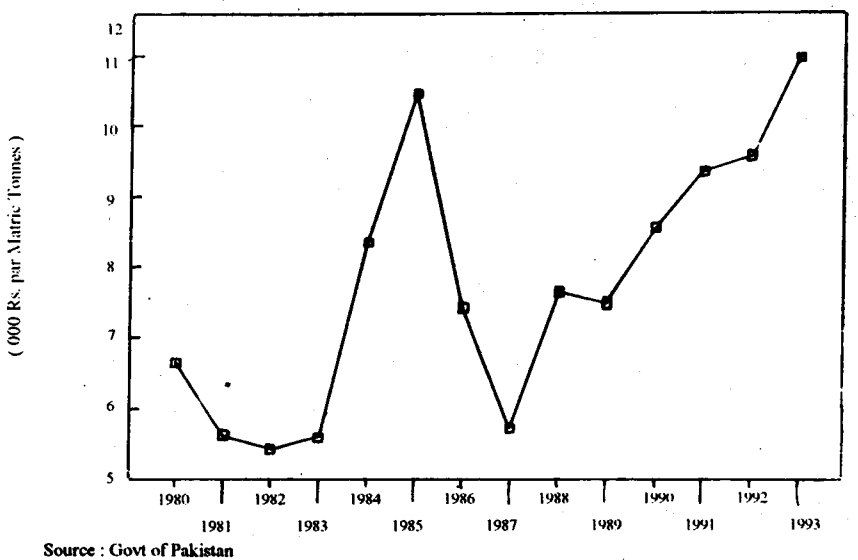
Country	1987-89			
	GNP/Per Capital Dollars (1990)	Total Oil and Fats	Vegetable Oil	Animal Fats
Somalia*	170	65.6	27.8	37.8
Uganda*	170	23.8	15.6	8.2
Nepal	180	28.8	19.9	9.3
Bangladesh*	220	17.5	14.3	3.2
India*	330	38.9	28.7	10.1
China*	370	45.5	22.0	23.5
Pakistan*	400	50.6	33.9	16.8
Ghana*	400	41.5	36.7	4.8
Sri Lanka*	500	43.3	36.9	6.1
Indonesia**	610	39.0	34.0	5.1
Turkey**	1790	84.3	66.9	17.4
Saudi Arabia***	7820	81.2	51.0	30.2
USA***	22240	166.8	73.0	93.9
Switzerland***	33610	167.3	54.2	113.2

*Low income economies, **Middle income economies, ***High income economies

Source: FAO Production Yearbook 1990
IBRD, World Development Report 1993.

The rapid increase in consumption of edible oil, rising burden of budgetary subsidies and near stagnation in domestic output of edible oil has resulted in an import bill of Rs. 10.03 million in 1992-93 (Figure 2), as the world edible oils market has become increasingly unstable and Pakistan balance of payments problem has been further aggravated by this trend.

Figure 2 : Pakistan's Average Imported Vegetable Oil Prices, 1980-93



Source : Govt of Pakistan

The supply of edible oils fell short of its demand for the first time in early sixties. Though domestic production constituted 78.3 percent of total supplies in 1971-72, it was as low as 31.81 percent by 1991-92 (Table 3). Cotton-seed oil, a by-product of cotton crop, accounts for 80.15 percent of total oil supplies in Pakistan. Rape and mustard seed are the other main traditional oilseed crops but its production remained stagnant over the last thirty years. Introduction of non-traditional oilseed crops particularly sun-flower was initiated in early sixties mainly in Punjab and Sindh, had very little impact on the supplies (Aslam and Akhtar, 1986). Despite the fact that the Ghee Corporation of Pakistan (GCP) and Seed Division, Lahore have tried to popularise non-traditional seeds, the production remains low due to the use of unimproved cultivators, low germination seeds,

Table 3. Supply of Edible Oils in Pakistan

Years	Domestic Production (000, Tonnes)	% Share	Imports (000, Tonnes)	% Share	Per Capita (Kg)	Total Supply (000, Tonnes)
1973-74	223	59.0	155	41.00	5.31	378
1974-75	198	50.51	194	49.49	5.37	392
1975-76	179	42.72	240	57.28	5.60	419
1976-77	172	42.57	232	57.43	5.27	404
1977-78	181	34.22	348	67.78	6.70	529
1978-79	156	24.07	492	75.93	7.67	648
1979-80	225	33.48	447	66.52	7.59	672
1980-81	225	33.09	455	66.91	8.08	680
1981-82	240	29.52	573	70.48	9.05	813
1982-83	256	28.86	663	72.14	9.95	919
1983-84	190	23.17	630	76.83	8.57	820
1984-85	289	30.49	569	69.51	9.76	948
1985-86	344	25.90	984	79.10	10.84	1328
1986-87	350	36.19	617	63.80	11.72	967
1987-88	377	30.00	882	70.00	12.05	1259
1988-89	386	29.00	943	71.00	12.20	1329
1989-90	418	31.12	925	68.88	12.92	1343
1990-91	463	32.88	945	67.12	12.36	1408
1991-92	480	32.87	1029	67.12	13.06	1509

*Trend Growth Rate = 8.0% (1973-74 –1990-91)

Oil production from groundnut and seasam seed is negligible.

Source: Government of Pakistan.

inadequate control of weeds, damage from disease, losses to birds, equipment problem, and problems to market the harvested crop.

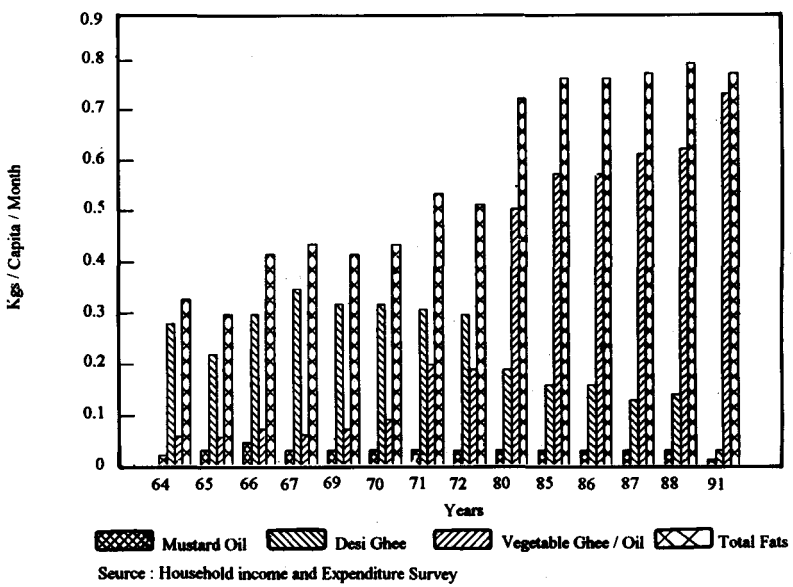
The vegetable oil industry was nationalized in September 1973. The import and price of vegetable oil were, however, liberalized in April 1986. While the

retail prices have increased from Rs. 13.0 per/kg in 1985-86 to Rs. 24.00 per/kg in 1992-93, after the liberalization, the cultivated area under oilseed and domestic production did not increase mainly because the wheat prices also increase by the same proportion[1], and because sunflower is a risky enterprise with large variations in profitability[2]

Pattern and Trends in Edible Oil Consumption

Demand for oil and fat in Pakistan is increasing over time because these are required for edible as well as non edible purposes. Edible oil/ghee is available in two forms (i) poly-unsaturated oil and (ii) vanaspati ghee. The raw oil is used as an input in many consumer goods, therefore its industrial demand is also increasing. The total production of vegetable oil now constitutes at least 94.87 percent of total edible oil (Table 1). It seems that the demand for vegetable oil in future will be dominated over the demand for aggregate edible oil and fat (Figure 3).

Figure 3 . Monthly Per Capita Consumption of Fats in Pakistan (Kg).



Source : Household income and Expenditure Survey

The increase in vegetable oil consumption with a trend growth rate of 8.0 percent (Table 3) may be attributed to four factors viz, rapid population growth, urbanization, improvement in per capital income, and lower prices relative to desi ghee, a butter fat based product manufactured at home and in cottage industry from liquid milk.

[1]Wheat and oilseeds are competing crops in the *Rabi* cycle.

[2]There were negative net returns (900 Rs/ha) to sunflower (oilseed) farmers in 1988 and in 1989, net returns were much higher averaging (4640 Rs/ha).

Due to urbanization cooking media has shifted from desi ghee to vegetable ghee/oil. Over the period of the last thirty years we can see that in total fat consumption the share of per capita, consumption of desi ghee is decreasing and the share of vegetable ghee/oil is increasing. As is discernable the share of vegetable ghee/oil is 21 percent in 1963-64 and 94 percent 1990-91 (Table 2) This may be due to the fact that those who migrated to urban areas do not have easy availability of desi ghee or they do not keep animals for milk and fat purposes. Another implication is that demand for milk increased in urban areas and the substitution of ghee for milk continued over this period. Now the effect of urbanization is not as important as it was during the last thirty years because there is a little difference between the consumption pattern of urban and rural.

High price of its substitute that is desi ghee. increases very smoothly over this period. The price ratio of desi ghee to vegetable ghee/oil increased from 2.4 to 3.7 between the period 1960-61 to 1980-81. In 1992-93 desi ghee was 4.1 times more expensive than vegetable ghee/oil. This is accompanied with a sharp fall in the share of desi ghee in edible oil consumption dropped from 58 percent in 1972-73 to about 3.8 percent in 1990-91 (Goldman *et al.*, 1990).

The increase in real per capita income is also a factor in the increase in consumption. As we know that edible oil is a normal good and an important part of Pakistani diet, so an increase in real income increases its consumption.

An international comparison of total fat, vegetable oil and animal fat availability over the time, shown in Table 2, reveals that per capita oil and fat availability in Pakistan is much higher than in other developing countries. During 1987-89, the availability of total fat equalling to 50.6 grams per day in Pakistan and animal fat 16.8 grams per day, the availability of total fat in India and China was 38.9 grams and 45.5 grams per day respectively (FAO, 1990).

The Data and the Estimation Methodology

This study is based on the macro level data for the years 1960-61 to 1991-92. It has been hypothesized that the demand for vegetable oil depends upon real income, own price, price of substitute and urbanization. Other factors like age, education and occupation, are assumed to have no effect on consumption. The demand structure may therefore, be described by the following relationships.

GP = f(PS, UP, PY, PR, D)
GP = per capita vegetable oil consumption
PY = per capita income in rupees
UP = urbanization (urban population divided by total population)
PR = real price of vegetable oil (retail price of vegetable oil divided by consumer price index)

PS = price of substitute that is desi ghee
D = dummy variable, 1 for the price control period, zero otherwise.

Estimation of this equation is done by the Ordinary Least Square (OLS) method. Data for this model is taken from different issues of Pakistan Economic Survey and Pakistan Statistical Year Book.

In order to estimate supply response model (oilseed, sunflower) the specific version of the Nerlove Supply Model (Gujrati, 1978) used in this study is given below:

$$A^*_t = a_o + a_1 P_t + a_2 Y_t + a_3 V_p + a_4 V_y + a_5 R \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$A_t - A_{t-1} = b(A^*_t - A_{t-1}),\ 0 \le b \le 1 \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$P^e_t - P^e_{t-1} = c\,(P_t - P^e_{t-1}),\ 0 \le c \le 1 \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$Y^e_t - Y^e_{t-1} = d(Y_t - Y^e_{t-1}),\ 0 \le d \le 1 \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

where

A^*_t = Desired area under the crop
A_t = Actual area planted under the crop
P_t = Actual relative price of the crop; actual price of the crop deflated by an index of the actual price of the competing crop (wheat)
P^e_t = Expected relative price of the crop i.e. the support price of the crop deflated by an index of the support price of the competing crop (wheat)
Y_t = Actual relative yield of the crop; actual yield of the crop deflated by an index of the actual yield of the competing crop (wheat)
Y^e_t = Expected relative yield of the crop, expected yield of the crop deflated by an index of the expected yield of the competing crop (wheat)
V_p = Price variability is examined to measure the price risk

$$V_p = \sum_{i-1}^{n} \left[\frac{P^e_t - P^e_{t-1}}{P^e_{t-1}}\right] \times 100$$

V_y = Yield variability is examined to measure the yield risk,

$$V_y = \sum_{i-1}^{n} \left[\frac{Y^e_t - Y^e_{t-1}}{Y^e_{t-1}}\right] \times 100$$

R_d = Deviation of normal rainfall during sowing season

The coefficients b, c and d are adjustment and expectations coefficients, respectively.

Equation (1) relates the factors influencing desired area. Equation (2) represents a partial area adjustment mechanism, equation (3) is the price expectation equation and equation (4) is the yield expectation equation.

Equation (1) is the specific version of the Nerlove (1958) supply model used in this study. The area that cultivator wish to plant in a particular crop is presented as a function of the expected relative yield (Y^e_t), expected relative price (P^e_t) and other exogenous factors affecting supply, such as price and yield risks and rainfall. The use of area planted as the dependent variable in a supply response model stems from the fact that time series estimates of planned output are not available, some proxy must be used. One possible proxy is the area actually planted in a particular crop which is under farmers' control and thus, presumably a much better index of planned production (Behrman, 1968). The expected relative price and yield of the crops are expected to be positively related with actual area planted.

However, equation (1) cannot be directly estimated because it includes unobservable variables, we specify a partial adjustment mechanism which is given in equation (2). It is argued that because of the technological or financial constraints actual change in the planted area in any one period is only a fraction of the desired change. If equation (1) is substituted in equation (2) and then algebraically manipulated, we obtain:

$$A_t = a_0 b + a_1 b\, P^e_t + a_{2b}\, Y^e_t + a_3 b\, V_p + a_4 b\, V_y + a_5 b\, R + (1 - b)\, A_{t-1} \quad \ldots(5)$$

The model developed above involves four independent variables (P^e_t, Y^e_t, V_p and V_Y) which are unobservables, and should be modified into observable forms. It is hypothesized that farmers' expectations are formed according to the adaptive expectation model which are given in equation (3) and (4). Equation (3) represents relative price expectation while equation (4) deals with relative yield expectations. Two scenarios are considered by Khan and Iqbal (1991).

a) Perfect foresight: c = d = 1. In that case, the equation 5 can be written as:

$$A_t = a_0 b + a_1 b\, P_t + a_{2b}\, Y_t + a_3 b\, V_p + a_4 b\, V_y + a_5 b\, R + (1 - b)\, A_{t-1} \quad \ldots (6)$$

If we assume c = 1 and d = 1 then equation (3) and (4) reduce to perfect foresight as given below:

$$P^e_t = P_t \quad \ldots \quad (7)$$
$$Y^e_t = Y_t \quad \ldots \quad (8)$$

i.e. expected prices are equal to actual prices and expected yield is equal to actual yield. So equation (5) under perfect foresight is expressed as above in equation (6).

b) Static Expectations c = d = 0

$$A_t = a_0 b + a_1 b\, P_{t-1} + a_{2b}\, Y_{t-1} + a_3 b\, V_p + a_4 b\, V_y + a_5 b\, R + (1 - b)\, A_{t-1} \quad \ldots (9)$$
$$P^e_t = P^e_{t-1} = P_{t-1} \quad \ldots \quad (10)$$
$$Y^e_t = Y^e_{t-1} = Y_{t-1} \quad \ldots \quad (11)$$

It is assumed that current level of expectations equal to last year expectations.

So equation (5) under static expectation is expressed as above in equation (9).

The data corresponding to the area, yield and prices are taken from various issues of Agricultural Statistics of Pakistan. The rainfall data are taken from the various issues of Weather and Crop Report, Quarterly and Agricultural Statistics of Pakistan.

Results

This section discusses the results of the demand equation.

$$GP = -11.19 + 0.076\,PS + 0.36UP - 0.009\,PR + 0.014\,PY + 0.025\,D$$
$$(2.27)^* \quad (49.93)^* \quad (-2.02)^* \quad (4.8)^* \quad (0.112)$$
$$R^2 = 0.99 \quad D.W = 2.24 \quad F\text{–statistics} = 1341.19$$

* Significant at 5% level.

The per capita consumption of vegetable oil is estimated by using annual time-series data for the period 1956-60 to 1991-92 with the help of Ordinary least Square (OLS) Technique. To remove autocorrelation, Cochrane-Orcutt procedure is used.

The coefficient of the urbanization is statistically significant which shows that during the period of study, urbanization causes to increase the per capita consumption of vegetable oil. It has been said that if a good is normal then an increase in real income increases its consumption. A positively significant coefficient of per capita income confirms this expectation.

The calculated price elasticity of demand for vegetable oil in Pakistan is more inelastic and approximately –0.37, with an income elasticity 01.26.[3]

A USDA/ERS Study of food demand in Sri Lanka and other studies in India, Thailand and Indonesia suggest that the price elasticity of edible oil demand in Pakistan is more inelastic and may be approximately –0.6, with an income elasticity of demand of between 1.1 and 1.3 (USAID, 1984). USAID (1985) calculated the price elasticity –0.54 with an income elasticity 1.08. As a matter, these elasticities assume that Pakistani consumer regard vegetable oils as a food necessity and consume them at an increasing rate as income increases. The price variable is also significant with negative sign. It shows that a sharp increase in price decreases per capita consumption.

The coefficient of price of substitute turned out to be statistically significant

[3]Elasticities: Price Elasticity P = PR/GP. b = 294.1/7.087 × (–.009) = –0.37. Income elasticity y = PY/GP. b. = 641.67/7.087 × (0.014) = 1.26 where b is coefficient of that variables.

with expected positive sign, i.e. increase in the price of substitute increases the consumption of vegetable oil.

In this model it is assumed that the price control period is one of the reasons in raising demand of vegetable oil. The insignificant coefficient of dummy variable implies that it is not responsible for raising demand but some other factors, for example, non-availability of substitute, etc.

To forecast per capita demand for vegetable oil (1999-2000) the projected growth rate of explanatory variables are calculated (Table 4). Using these growth rates the future values of independent variables are obtained. By substituting the future values of independent variables into estimated equation, the forecast values of per capita vegetable oil are obtained. By multiplying it with the projected values of population we obtained the total demand for vegetable oil. The coefficient of dummy variable is removed because its value is equal to zero for future period. The forecast values of total demand and per capita demand have a smooth increasing trend. The future expansion of aggregate vegetable oil demand will not attain the trend growth rate of 8 percent of the 1974–91 period. Nevertheless, with population continuing to grow rapidly, the projected growth rate of aggregate demand could approach 6 percent annually. To bridge the gap between demand and supply, imports will be continued.

Table 4. Forecasting of Future Demand for Vegetable Oils

(000, tonnes)

Years	Per Capita Demand (Kg)	Population (Millions)	Total Demand	Imports or Deficit	Domestic Supply
1992-93	13.22	120.84	1597	1086	511
1993-94	13.88	124.46	1727	1183	544
1994-95	14.43	128.20	1850	1271	579
1995-96	14.99	132.04	1979	1362	617
1996-97	15.57	136.01	2118	1461	567
1997-98	16.15	140.09	2262	1563	699
1998-99	16.74	144.29	2415	1670	745
1999-2000	17.33	148.62	2575	1785	786
% Growth Rate	3.44	3.1	6.1	6.4	5.50

Explanatory Variables		Growth Rates
UP	=	1.013 UP (–1)
PR	=	1.019 PR (–1)
PY	=	1.028 PY (–1)
PS	=	1.060 PS (–1)
D	=	0

B) Supply of Edible Oil

Equations (6) and (9) represent acreage function under perfect foresight and

static expectations. These were estimated using time-series data for the period 1970-71 to 1990-91 with the help of Ordinary Least Squares (OLS) estimation technique. To detect first-order serial correlation in this autoregressive model, h-statistic is used. The estimates showed that perfect foresight expectations model performed better than the static expectations model in terms of both R^2 values and the rationality of the individual regressors. Thus it may be concluded that farmers may not consider past observations to arrive at the expectation for the current period, instead they may consider only recent observations because their decision to cultivate sunflower oilseed depends on its support price. Because of the low R^2 values, the estimates obtained with static expectations model are not reproduced here.

The results in the form of estimated equation is as follows:

$$A_t = \underset{-(1.75)}{-10.62} + \underset{(1.86)^*}{0.55\ P_t} + \underset{(9.14)^*}{105.85\ Y_t} + \underset{(0.42)}{0.032\ V_p} + \underset{(1.10)}{0.18\ V_y} -$$

$$\underset{-(0.59)}{.023\ R_d} + \underset{(1.45)}{0.16\ A_{t-1}}$$

$R^2 = 0.99$ h-Statistic = 0.64 (D.W. 1.76)

Coefficient of Adjustment = 0.84

* Significant at 5 percent level.

The Estimates of the coefficient of relative price of sunflower oilseed to relative price of wheat turned out to be statistically significant with expected positive sign, i.e. changes in the relative price has been influencing the farmer's acreage allocation decision. The relative yield variable is very significant with positive sign. It is argued that farmers might have accelerated cultivation of sunflower in new areas and substitution of wheat by sunflower (oilseed).

The two risk variables (price, yield) were found to be positive but non-significant. The positive coefficients of yield risk and price risk is due to the continuous trend in the yield and price level. Rainfall has no impact on acreage determination as farmers grow sunflower oilseed with assured irrigation facilities.

The shot-run and the long-run price elasticities calculated at the mean value are ranged from 0.86 to 1.03. The short-run and the long-run elasticities differ slightly due to high value of the coefficient of adjustment. This indicates that the farmers have very promptly adjusted their sunflower oilseeds acreage in accordance with the change in economic environment and thereby implies that the farmers are more responsive to the change in prices. The short-run and the long-run yield elasticities are 0.54 and 0.66, respectively.

Conclusions

The consumption of edible oils in Pakistan has been rising rapidly at an annual growth rate of 8.0 percent (Table 3) due to unabated rise in population.

urbanization, increase in household incomes, relatively high price of its substitutes and lastly of the scarcity of animal fats for lack of progress in livestock industry. The increasing demand for vegetable oil, rising burden of budgetary subsidies and near stagnation in domestic output of edible oil has resulted an import bill of Rs. 10.03 million in 1992-93.

In Pakistan both traditional and non-traditional oilseed crops are grown which meet about 32.8 percent of total edible oil requirement. Cottonseed and rapeseed/mustard are the two main source of edible oil accounting for about 94.3 percent of the local availability. Except sunflower, production of non-traditional oilseed crops did not pick up any significant momentum. A dynamic supply response model shows a positive price responsiveness by sunflower oilseed farmers. An appropriate policy will therefore require that the farmers should be assured of (1) a good but stable return from the crop, and (b) necessary infrastructural facilities for ushering in modern agriculture with new agricultural practices.

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