PN-ABD-961

Draft 3/88

BACKGROUND PAPER

SUPPLY PARAMETER ESTIMATES AND TRENDS IN SUPPLY AND USE OF MAJOR AGRICULTURAL COMMODITIES IN JAMAICA

Prepared by S.R. Johnson, S.K. Pollard and G. Canarella, respectively, Professor of Economics and Administrator, Center for Agricultural and Rural Development, Iowa State University, and Professors, Department of Economics and Statistics, California State University, Los Angeles. The research was supported by a Cooperative Agreement between the U.S. Department of Agriculture, Office of International Cooperation and Development and the University of Missouri-Columbia (58-319R-4-073). A portion of the funding for the Cooperative Agreement was provided by USAID/Jamaica.

Draft 3/88

Background Paper 3

Supply Parameter Estimates and Trends in Supply and Use

1. Introduction

The purpose of this study is to review and provide evidence on trends in output, acreage and prices of agricultural commodities. Additionally, we report estimates of supply elasticities for over 50 agricultural commodities. This empirical analysis can be utilized for prediction of future output and price conditions as well as for evaluation of changes in agricultural price policies in Jamaica.

This study is important for many reasons. There is no analysis currently avaiable which relates agricultural production to expected demand and available resources. Such an analysis is needed to assist in preparing rational development plans and policies in Jamaica and to identify those commodities that may have potential surpluses or deficits. An analysis of the production potential coupled with the food requirements of a typical country can aid in answering such questions as the effect of population growth on food supplies and why food imports have been growing faster than food exports. Further, the role of relative price incentives for agricultural producers has not been well investigated or considered important by policymakers in Jamaica. Output price policies may not always dominate performance, but ignoring product prices and their role in

influencing the rate of return to agriculture can frequently lead to the failure of government programs designed to reduce structural constraints on agriculture production. Recent studies have demonstrated that inapproriate price policies can have a serious, deletorious impact on efficiency and output in the agricultural sector (Reca, Cuddihy, Brown, and Bale and Lutz).

This study is divided into three sections. In the next section the trends in output, acreage and producer prices are presented and discussed. The third section contains estimates of supply elasticities. Elasticities estimated for Jamaican commodities are compared to those found in other countries. Relevant bibliography is also included.

2. Major trends of agricultural commodities

The trends in production agriculture have been presented in a descriptive manner in a previous background paper. The data contained in this previous paper have been collected from a variety sources including published and unpublished reports from the Ministry of Agriculutre (MOA) and the Statistical Institute of Jamaica (STATIN). A detailed description of these data and a discussion of issues surrounding the collection and use of these data are given in the above cited background paper. In particular, an important point is the reliablity of the data in some cases is questionable and may be of a speculative nature. In this section these trends are quantified and implications of these trends are noted.

Graphical representation of these trends are presented for selected commodities in Appendix C. This analysis is quite revealing. On the whole, export crop output has remained constant or declined slowly over the period 1960-1984. Sugar production has been declining slowly since 1966 and rapidly sinc 1979. In the case of coconuts, citrus and bananas, the decline in output reflects less output being delivered to the marketing boards (whose behavior is described in Background Paper #4) and more sold on the local market, and thus not necessarily a declin in total production. Data on total banana and citrus production is not available. However, the production and exports of banana has declined dramatically, due to Hurricane Allen damage in 1980 and banana acreage taken out of production by the Board. Estimates of total coconut production shows that the Board's share of total production has declined to approximately ten percent. Nominal farmgate prices have been increasing for all export crops over most of the 1970's and 1980's, but in real terms have not generally kept pace with the inflation rate as will be shown below. In contrast, domestic food crop output in both the aggregate and its subgroups has exhibited positive output growth since 1970, with farmgate prices either keeping up with the rate of inflation or surpassing it.

Linear trends of production, acreage, and farm prices were estimated by the following equation:

$$\log Y(t) = a + b*TIME + v(t) \qquad (1)$$

where log Y is the natural logarithm of the variable being

analyzed (i.e. production, acreage, price); TIME is the actual time period; and v is the stochastic error term with zero mean and constant variance.

The estimated equations, time periods and variables are reported in Table A1 and summarized in Table 1. Examination of these values reveal two overall points. First, the growth of nominal farm prices, for commodities produced primarily for the domestic market, has exceeded 16 percent per annum and have kept up with or exceeded the inflation rate. Second, the growth rate of nominal farm prices of these same commodities have exceeded the growth rate of farm prices for commodities produced tradtionally for the export market (i.e. sugar cane, bananas, coffee, cocoa, pimento). This suggests that relative prices in agriculture have favored production of commodities for the domestic market and/or nontraditional export markets. The trends in output and acreage support this as negative growth rates of output are reported for sugar cane, bananas and oranges, while pimento production (as measured by exports) has remained constant.

Another issue is whether growth of domestic food production has been maintained at a rate consistent with increases in the growth of domestic demand. A popular view is that demand for food will always be growing faster than the supply of food because of structural constraints such as maldistribution of land, poor marketing system, poor land quality, and lack of rural infrastructure (Jefferson; Stone; USDA Report). The growth of domestic demand is due to changes in population growth and

Table 1 Summary of Growth Rates of Production, Acreage and Yields of Selected Agricultural Commodities in Jamaica

A) Commodities with production growth rates less than 1.8% per year:

Ginger, Gungo Pea, Tau Yam, Bitter Cassava, Plantain, Turnip, Irish Potato, Negro Yam, Coco, Dasheen, Sugar Cane, Bananas, Coffee, Beetroot, Calaloo, Cauliflower, Eggplant, Lettuce, Pimento, Edible Oils, Corn, Watermelon, Orange, Beef, Milk**, Pork

B) Commodities with production growth rates more than 1.8% per year:

Grapefruit, Flour, Cornmeal, Peanut*, Cabbage, Carrot*, Cho-Cho, Cucumber*, Sweet Potato, Lucea Yam, Renta Yam*, Sweet Cassava, Cocoa, Broad Bean, Sugar Bean, Cow Pea*, Red Pea*, St. Vincent Yam*, Sweet Yam*, Yellow Yam*, Pineapple, Horse Plantain, Okra*, Pumpkin*, String Bean*, Tomato*, Escallion, Onion*, Hot Pepper*, Sweet Pepper*, Thyme*, Paw-Paw, Chicken, Rice**

C) Commodities with yield growth rates less than 1.8% per year:

Hot Pepper, Thyme, Beetroot, Calaloo, Cauliflower, Lettuce, Irish Potato, Lucea Yam, Negro Yam, Renta Yam, Coco, Casheen, Sugar Cane, Cow Pea, Gungo Pea, St. Vincent Yam, Tau Yam, Yellow Yam, Bitter Cassava, Corn, Plantain, Turnip

D) Commodities with yield growth less than 1.8% per year:

Ginger, Onion, Sweet Peper, Paw-Paw, Peanut, Cabbage, Carrot, Cho-Cho, Cucumber, Egg Plant, Sweet Potato, Sweet Cassava, Broad Bean, Sugar Bean, Red Pea, Sweet Yam, Pineapple, Horse Plantain, Okra, Pumpkin, String Bean, Tomato, Escallion

Notes: *acreage increased by more than 1.8% per year
**skim milk powder imported quantity
***imported quantity

income. Population growth has averaged 1.8 percent over the period examined, while real income growth has been negative throughout the 1970's and constant over the 1980's. Thus, population growth has been the determining factor underlying demand changes. In Table 1, 1.8 percent has been used as the benchmark to divide the commodities by growth rates. As can be seen, most foodcrops have kept up with population growth and have mitigated the increase in food imports. The notable exceptions are corn, selected yams, and other tubers (such as cassava, dasheen and coco). These "strarchy" crops face heavy import competition from substitute products such as corn, rice and wheat which are desired more by consumers due to tastes and may also be cheaper forms of starch. The influence of import prices on product prices has been investigated by Pollard and Graham who report a positive correlation between domestic food prices and import prices in Jamaica for the 1970's. This will be explored further in future background papers.

The livestock and dairy sector has also experienced constant and low growth of output in the 1970's and 1980's. Beef and pork production has grown less than increases in demand (in the case of beef perhaps due to the level of imports (to help meet local demand) which has averaged 20 to 40 percent of domestic production), while milk production (measured by the growth of skim milk powder imports which make up approximately 95 percent of supply) has also lagged behind. Staples such as rice, flour and cornmeal, which rely almost entirely on imported

raw product for production, have more than kept up with increases in domestic demand.

In the case of traditional exports, production has not been sufficient to meet the growth of domestic demand, which implies that supplies for export sales are diminishing. However, it should be noted that in the case of bananas, oranges and grapefruit the production data are measuring sales to the respective parastatal export marketing agency and not production. Declines in supply to these parastatals is consistent with the notion that domestic prices are more favorable to producers than export prices at the farmgate.

Most of the increases in output, for those crops which have a growth rate higher than the population growth, have been due to increases in yields as well as in acreage. The growth of yields, while not estimated, was calculated by subtracting the estimate of growth of acreage from the estimate of the growth of output. Again, the yields of the starchy food crops have been growing at small positive rates or have been declining. Productivity increases and/or technological change has not occurred in this subgroup.

Investigation of output and farmgate price trends by aggregates developed by the MOA support the findings for the indiviual crops. Domestic foodcrop output (all 50 aggregated) has increased at an average rate of 3.5 percent, while prices have increaed by 17.7 percent over the period 1970-1986. The legume, vegetable and condiment groups have exceeded these rates.

The cereals, yams, potatoes and other tuber aggregates reveal low rates of growth of output.

3. Supply Functions

This section contains the results of the estimated supply functions for domestic food crops and export crops. In order to determine supply response, supply functions were estimated using historical data and standard statistical techniques. Agricultural supply responses in less developed countries (LDCs) have gained increasing interest in the development economics literature. Unfortunately, the exisiting evidence on agricultural supply elasticity is both biased and weak. Estimation of supply elasticities using time series data on a macro basis are beset with a host of problems such as auto-correlation, multi-collinearity and statistically seperating a demand curve from the supply curve. However, in spite of these problems there is little doubt that farmers respond to price incentives and that such response increases over time.

Most supply response studies focus on the response of acreage to changes in prices. In this study we focus on total output because acreage is not available for the export crops and estimates of acreage response functions generally gave estimates with wrong signs. Also, since we are interested in relating quantities at the retail (demand) level with quantities at the farm level, the ouput response to farm prices is of prime concern. The supply response function for output estimated was

of the following form:

$$Y(t) = a*b + (1-b)*Y(t-1) + b*c*P(t-1) + u(t) \qquad (2)$$

where Y is the natural logarithm of output and P is the natural logartitm of the farmgate price of Y deflated by the implicit GDP deflator (1974=100). Equation 2 is one of the most common models found in the literature and allows for estimation of both "short run" and "long run" elasticities of supply. The coefficient of the price variable is the short run elasticity of supply and the long run of elasticity of supply is found by dividing the short run elasticity of supply by the estimate of (1-b).

Further, the model given in eq. 2 implies that farmers have adaptive expectations as proposed by Nerlove. This formulation is utilized since farmers do not know the price they will receive at the time of planting. The farmgate price was deflated by the implicit GDP deflator because what is important is the relationship between output and relative profitability of crop production. In principle there are three ways to define relative crop output prices: prices of other crops, input prices or prices paid by farmers. However, relative profitability of crop production should take into account not only alternatives in agriculture, but non-agricultural activities available to the farmer as well. The selection of the implicit GDP deflator as the numeraire does allow for a more general measure of activities to be taken into account. Moreover, it avoids the problem of which other crop prices should be included in the supply response equation, since use of the implicit GDP deflator states that all

productive activities are substitutes for the crop production activity under consideration. Moreover, given the increases that have occurred in acreage over time for all domestic food crops, it appears that acreage is not a constraint, at present, for future production.

The estimated supply equations are presented in Table A2 and the short run and long run supply elasticities are reported in Table 2. The results of these estimations are supportive of the notion that farmers in Jamaica respond rationally to changes in relative prices. Unexpected negative elasticities were obtained for beetroot, calaloo, cucumber, iceberg lettuce, string bean, turnip, thyme, irish potato, plantains, yams (as a group), negro yam, tau yam, other yam, dasheen, and pimento. The explanation for the findings for these commodities is not straightfoward. One possible explanation may be that the data for these commodities is not very reliable. However, one would assume that errors in measurement would be found for all series and not just those with unexpected signs. One also might argue that the negative price effect would be offset by increasing yields. Reexamination of the yield growth rates reveals that only for cucumber, plantains and string bean were yields increasing at rate equal to or greater than the growth of output. Hence, increased returns per acre may compensate farmers for the negative price effects in these product lines.

The statistical significance of the short run supply elasticities, based on the t-values given in Table 2A, are indicated in Table 1. Statistical significance was determined using a critical t-value at the 10 percent level for an upper

Table 2. Supply Elasticities of Selected Agricultural Commodities in Jamaica.

Commodity	Short Run Supply Elasticity	Long Run Supply Elasticity
Domestic Food Crops	.318 *	.612
Legumes	.177 *	.469
Broad Bean	.313 *	.475
Sugar Bean	.245	.384
Cow Pea	.582 *	.601
Gungo Pea	.247 *	.359
Red Pea	.164	.439
Peanut	.376	.757
Vegetables	.625 *	2.201
Beetroot	-.188	n.c.
Cabbage	.003	.004
Calaloo	-.027	n.c.
Carrot	.695 *	1.671
Cauliflower	.742 *	2.417
Cho-Cho	.545 *	.665
Cucumber	-.196	n.c.
Egg Plant	.706 *	1.274
Iceberg Lettuce	-.579	n.c.
Other Lettuce	-.329	n.c.
Okra	.064	.143
Pumpkin	.457 *	.645
String Bean	-.007	n.c.
Tomato	.660 *	2.821
Turnip	-.249	n.c.
Escallion	.527 *	2.774
Ginger	.065	.108
Onion	.503 *	.863
Hot Pepper	.409 *	.688
Sweet Pepper	.388	n.c.
Thyme	-.007	n.c.
Paw-Paw	.500 *	1.216
Pineapple	.319 *	.816
Watermelon	1.029 *	1.994
Corn	.258 *	1.425
Horse Plantain	.745 *	1.302
Other Plantain	.119	.120
Irish Potato	-.295	n.c.
Sweet Potato	.617 *	1.092
Cereals	.042	.139
Plantains	-.071	n.c.
Potatoes	.391 *	.588
Condiments	.264	.342
Fruits	.392 *	.588
Yams	-.035	n.c.
Lucea Yam	.004	.006
Negro Yam	-.309	n.c.
Renta Yam	.074	.137
St. Vincent Yam	-.024	n.c.
Sweet Yam	.178	1.300

Commodity	Short Run Supply Elasticity	Long Run Supply Elasticity
Tau Yam	-.555	n.c.
Yellow Yam	.014	.039
Other Yam	-.424	n.c.
Other Tubers	.041	.102
Bitter Cassava	.387 *	1.423
Sweet Cassava	.890 *	3.213
Coco	.279	.419
Dasheen	-.218	n.c.
Sugar Cane	.165 *	2.661
Bananas	.307	n.c.
Cocoa	.133	.246
Coffee	.428 *	.271
Pimento	-.172	n.c.
Grapefruit	.459 *	1.075
Orange	.307 *	.777
Coconut		

Notes: * equals significant at the 10 percent level.

tail test, since the expected sign of the price coefficient is positive. The short run elasticity of aggregate domestic food crops (a weighted index of 50 food crops) is statistically significant at the 10 percent level and a similiar finding is found for the food subgroups of legumes, vegetables, potatoes, and fruits. The crops that make up these subgroups account for approximately half the output of all domestic food crops. The individual crops that make up these groups and/or the individual crops that have the largest share in these groups also have statistically significant supply elasticities. Elasticities that are not significant were found for the subgroups yams, other tubers, condiments, cereals and plantains. However, this does not imply that the individual crops in these groups had insignificant supply elasticities. For example, cassava (other tubers), corn (cereals), horse plantain (plantains), and onion, hot pepper, and escallion (condiments) all have statistically significant supply elasticities. Only for the case of the yams subgroup was no individual yam elasticity significant. Yam output accounts for approximately a third of all domestic food output. However, a major portion of yam production is for home consumption by farmers, and not for commercial consumption. Thus, one needs to make allowance for this fact, but the data do not permit this.

In the case of the traditional export crops, sugar cane, coffee, grapefruit and orange have statistically significant short run supply elasticities. The supply elasticities for

banana, coconut, cocoa are positive, but insignificant, while pimento has unexpected signs. The finding for coffee is consistent with that of Williams, who in a previous study of coffee in Jamaica reported a value of .70 as the short run supply elasticity (over the period 1953-1968). The negative result for pimento is unexpected, but was expected for coconuts given the diversion of coconuts away from the Coconut Board and to the local market despite real price increases at the farmgate by the Board.

The long run elasticity of supply was calculated by dividing the short run supply elasticity by the coefficient of lagged output. Stability requires that the absolute value of lagged output be less than one (Christ) and this is generally the case with only sweet pepper and banana having a lagged output coefficient greater than one. The long run elasticity was not calculated for those crops that had a short run negative supply elasticity. The long run elasticity exceeds the short run supply elasticity for all crops, but coffee. Again, this result is consistent with Williams, who also found a negative coefficient for lagged output.

Finally, a comparison of the Jamaican results with the results of supply elasticities from other LDCs is undertaken. Supply elasticities from other LDCs are summarized in Table 3. The estimates for the aggregate food crops, subgroups and traditional export crops are all within the ranges of previous studies for other countries. The finding of the short run

Table 3: PRICE ELASTICITIES OF SUPPLY IN DEVELOPING COUNTRIES BY NUMERICAL RANGE

Food Category	Countries or Regions: Less than 0	0 to 1/3	1/3 to 2/3	2/3 to 1	More than 1
Agricultural Products		Argentina[b] India			
Rice	India Egypt[b,c]	India Pakistan Bangladesh Thailand W. Malaysia Philippines Egypt[b,d] Sri Lanka	India Peru Indonesia (Java) Iraq	Taiwan[b]	W. Malaysia[a] Iraq[a] Thailand (Thonburi only)
Wheat	India Iraq	India Pakistan Hungary Jordan Lebanon Egypt[b,c]	India Pakistan Kenya Egypt[a,d] Syria Lebanon Argentina Chile	India Egypt[a]	Syria[a] New Zealand[a] Chile[a]
Other Foodgrains	India Syria Iraq Jordan Egypt	India Pakistan Lebanon Egypt Sudan Philippines Hungary Jordan	India Hungary Sudan Lebanon Jordan Syria Brazil	India Lebanon Kenya[a]	India[a] Thailand[a] Syria[a] Kenya[b] Brazil[b]
Vegetables & Spices	Syria Jordan Lebanon Pakistan	India Jordan Egypt Syria Bangladesh	India Lebanon	India	Iraq[b] Sudan[a]
Milk & Meats		Greece	Greece		Greece
Sugar & Oils		India Nigeria Philippines	India	India	India
Coffee, Tea, Cocoa & Tobacco	Pakistan	Brazil India Bangladesh Ecuador Dom. Republic Venezuela Nigeria Colombia Kenya	Brazil Nigeria Malawi Ghana Venezuela	Brazil India Jamaica Ghana Ivory Coast Cameroon Colombia Nigeria	Brazil Nigeria Cameroon
Cotton, Jute, Sisal & Wool	Egypt Iraq	India Uganda Tanzania Bangladesh	India Uganda Tanzania Nigeria Sudan	Egypt Pakistan S. Africa Uganda	India Tanzania

a - Long-run elasticity.
b - Short-run elasticity.
c - Pre-World War II.
d - Post-World War II.

Sources: 1) Askari, H. and J.T. Cummings, "Estimating Agricultural Supply Response with the Nerlove Model: A Survey", International Economic Review, Vol. 18, No. 2, June 1977, pp. 257-292.

2) Sobhan, I., Agricultural (Price) Policy and Supply Response - A Review of Evidence and an Interpretation for Policy, World Bank, AGREP Division Working Paper, mimeo, July 18, 1977.

Reprinted from "Methodologies for Measuring Agricultural Price Intervention Effects" by Scandizzo and Bruce, World Bank Staff Working Paper No. 394.

elasticity of .318 for aggregate domestic food crops is similar to that found for all agricultural products in India and Argentina. Values of the supply elasticities for the subgroups and individual crops can also be found in other countries. This result gives credence to the finding that in Jamaica farmers respond to relative prices in an economic and rational manner.

4. Implications

The simple trend equations that were estimated for output and farmgate prices can be utilized for short run period projections. Similarly, forecasts of output given changes in relative prices can also be generated using the estimated supply functions. The estimation of supply and demand elasticities form an intergal part of the analysis to measure the welfare and economic benefits and costs and foreign exchange gains/losses from price intervention polices such as a cheap food import policy or implicit taxation of agricultural exports. These issues will form the output of future policy papers.

BIBLIOGRAPHY

1. Askari, Hossein and Cummings, John T., Agricultural Supply Response - A Survey of the Econometric Evidence. Praeger Publishers, New York, 1977.

2. Bale, Malcom D. and Lutz, Ernst, "Price Distortions in Agriculture and Their Effects: An International Comparison," American Journal of Agricultural Economics, 63, 1981, 8-22.

3. Brown, Gilbert, "Agricultural Pricing Policies in Developing Countries", in T.W. Schultz (ed.), Distortions of Agricultural Incentives. Indiana University Press, 1978.

4. Christ, Carl F., Econometric Models and Methods. John Wiley and Sons, 1966.

5. Cuddihy, William, "Agricultural Price Management in Egypt," World Bank Staff Working Paper, No. 388, March 1980.

6. Jefferson, Owen. The Post-War Economic Development of Jamaica. Kingston: ISER, 1972.

7. Nerlove, Marc, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities," Journal of Farm Economics, 1956, 38, 496-508.

8. Pollard, Stephen K. and Graham, Douglas H., "The Performance of the Food Producing Sector in Jamaica, 1962-1979: A Policy Analysis," Economic Development and Cultural Change, 1985,33, 731-754.

9. Pollard, Stephen K. and Graham, Douglas H., "Price Policy and Agricultural Export Performance in Jamaica", World Development, 1985, 13, 1067-1076.

10. Reca, Lucio G., "Argentina: Country Case Study of Agricultural Prices, Taxes and Subsidies," World Bank Staff Working Paper No. 386, April 1980.

11. Schultz, T.W. (ed.) Distortions of Agricultural Incentives. Bloomington: Indiana University, 1978.

12. Stone, Carl. Democracy and Clientelism in Jamaica. New Brunswick, N.J.: Transaction Books, 1980.

13. USDA, The Small Farmer in Jamaican Agriculture: An Assessment of Constraints and Opportunities, A report of the Agriculture Sector Assessment Team, OICD, USDA, 1978.

14. Williams, R.L., "Jamaican Coffee Supply, 1953-1968: An Exploratory Study," Social and Economic Studies, 91-103.

Table A1. Trend Equations for Selected Agricultural Commodities in Jamaica

Dependent Variables	a	b	R^2
Domestic Food Crops (1970-86)			
Production	4.075	.035	.66
Farm Price	1.679	.177	.98
Legumes (1970-86)			
Production	4.006	.046	.65
Farm Price	1.599	.195	.92
Broad Bean (1970-86)			
Production	4.612	.0346	.35
Area	6.281	.008	.03
Farm Price	.866	.191	.95
Sugar Bean (1970-86)			
Production	4.926	.022	.36
Area	6.375	.005	.02
Farm Price	1.044	.180	.95
Cow Pea (1970-86)			
Production	6.031	.030	.23
Area	6.952	.033	.24
Farm Price	.697	.201	.94
Gungo Pea (1970-86)			
Production	7.465	.013	.07
Area	9.080	-.018	.18
Farm Price	.725	.196	.92
Red Pea (1970-86)			
Production	7.128	.054	.61
Area	8.689	.027	.35
Farm Price	.719	.213	.94
Peanut (1970-86)			
Production	5.856	.085	.60
Area	6.721	.007	.65
Farm Price	.475	.194	.98
Vegetables (1970-86)			
Production	3.809	.059	.32
Farm Price	1.791	.165	.96
Beetroot (1970-86)			
Production	6.902	-.014	.09
Acreage	5.891	-.021	.17
Farm Price	.357	.153	.95
Cabbage (1970-86)			
Production	8.587	.049	.61
Acreage	8.036	.003	.01
Farm Price	1.092	.121	.82
Calaloo (1977-86)			
Production	9.389	.013	.00
Acreage	7.793	-.001	.00
Farm Price	.049	.149	.88
Carrot (1970-86)			
Production	8.018	.068	.80
Acreage	7.274	.036	.69
Farm Price	.071	.182	.96

Dependent Variables	a	b	R^2
Cauliflower (1970-86)			
Production	4.300	.005	.00
Acreage	3.612	-.013	.005
Farm Price	.494	.187	.91
Cho-Cho (1970-86)			
Production	7.723	.039	.37
Acreage	7.489	-.009	.03
Farm Price	-1.087	.188	.97
Cucumber (1970-86)			
Production	7.500	.065	.66
Acreage	6.673	.032	.37
Farm Price	-.068	.150	.95
Egg Plant (1970-86)			
Production	4.541	-.009	.003
Acreage	4.290	-.041	.16
Farm Price	-.675	.117	.87
Iceberg Lettuce (1970-86)			
Production	8.337	.043	.16
Acreage	6.430	-.030	.11
Farm Price	.324	.174	.91
Other Lettuce (1970-86)			
Production	7.362	.074	.56
Acreage	6.616	-.056	.48
Farm Price	-.115	.195	.91
Okra (1970-86)			
Productiion	6.063	.054	.59
Acreage	5.958	.031	.35
Farm Price	-.024	.154	.91
Pumpkin (1970-86)			
Production	9.427	.040	.59
Acreage	8.367	.011	.09
Farm Price	-.679	.187	.97
String Bean (1970-86)			
Production	5.453	.069	.71
Acreage	5.395	.037	.36
Farm Price	.212	.180	.97
Tomato (1970-86)			
Production	8.262	.075	.62
Acreage	7.310	.043	.58
Farm Price	.788	.151	.94
Turnip (1970-86)			
Production	7.675	-.014	.14
Acreage	6.553	-.016	.16
Farm Price	-.791	.92	.98
Condiments (1970-86)			
Production	3.601	.043	.36
Price	1.631	.195	.92
Fecallion (1970-86)			
Production	5.688	.109	.71
Acreage	5.828	.066	.67
Farm Price	.738	.154	.77

Dependent Variable	a	b	R^2
Ginger (1970-86)			
Production	6.284	.008	.01
Acreage	6.061	-.0009	.00
Farm Price	1.675	.159	.85
Onion (1970-86)			
Production	3.823	.183	.43
Acreage	2.866	.162	.42
Farm Price	-.720	.254	.90
Hot Pepper (1970-86)			
Production	5.723	.072	.67
Acreage	5.779	.059	.65
Farm Price	-1.123	.236	.94
Sweet Pepper (1970-86)			
Production	2.628	.208	
Acreage	3.071	.139	.94
Farm Price	-.133	.185	.96
Thyme (1970-86)			
Production	4.656	.030	.21
Acreage	4.766	.041	.47
Farm Price	2.043	.156	.83
Fruits (1970-86)			
Production	4.437	.019	.23
Farm Price	11.598	.187	.98
Paw-Paw (1970-86)			
Production	6.834	.036	.28
Acreage	5.963	.002	.00
Farm Price	.027	.141	.98
Pineapple (1970-86)			
Production	8.122	.026	.14
Acreage	6.975	-.0006	.00
Farm Price	-.903	.205	.98
Watermelon (1970-86)			
Production	8.021	.011	.02
Acreage	6.563	-.006	.01
Farm Price	-.625	.184	.95
Cereals (1970-86)			
Production	4.164	-.017	.04
Farm Price	2.028	.157	.70
Ordinary Corn (1970-86)			
Production	7.797	.008	.01
Acreage	8.676	-.003	.001
Farm Price	-1.426	.22	.95
Plantains (1970-86)			
Production	4.418	.027	.27
Farm Price	2.079	.153	.98
Horse Plantain (1970-86)			
Production	8.945	.043	.40
Acreage	8.001	.016	.13
Farm Price	-.271	.151	.97

Dependent Variable	a	b	R^2
Other Plantain (1970-86)			
Production	8.58	.010	.04
Acreage	7.314	.0002	.00
Farm Price	-.360	.154	.98
Potatoes (1970-86)			
Production	4.405	.017	.11
Farm Price	1.389	.20	.97
Irish Potato (1970-86)			
Production	9.993	-.035	.24
Acreage	8.676	-.043	.45
Farm Price	-.581	.209	.96
Sweet Potato (1970-86)			
Production	9.314	.044	.38
Acreage	8.445	.014	.09
Farm Price	-.429	.175	.96
Yams (1970-86)			
Production	4.154	.028	.49
Farm Price	1.624	.178	.97
Lucea Yam (1970-86)			
Production	9.192	.019	.45
Acreage	7.715	.008	.12
Farm Price	.049	.167	.95
Negro Yam (1970-86)			
Production	10.443	-.014	.11
Acreage	8.595	-.009	.06
Farm Price	-.192	.177	.98
Renta Yam (1970-86)			
Production	9.536	.029	.51
Acreage	8.114	.017	.24
Farm Price	-.638	.181	.97
St. Vincent Yam (1970-86)			
Production	8.559	.038	.48
Acreage	7.209	.027	.35
Farm Price	-.592	.181	.96
Sweet Yam (1970-86)			
Production	7.486	.69	.93
Acreage	6.464	.051	.73
Farm Price	.151	.158	.98
Tau Yam (1970-86)			
Production	9.361	-.014	.06
Acreage	7.753	-.022	.17
Farm Price	-.609	.185	.97
Yellow Yam (1970-86)			
Production	10.044	.039	.65
Acreage	8.671	.023	.44
Farm Price	-.265	.182	.96
Other Yam (1970-86)			
Production	8.774	-.020	.24
Acreage	7.845	-.059	.75
Farm Price	.103	.156	.94

Dependent Variables	a	b	R^2
Other Tubers (1970-86)			
Production	4.421	.009	.06
Farm Price	1.725	.157	.94
Bitter Cassava (1970-86)			
Production	9.959	-.020	.15
Acreage	8.663	-.036	.41
Farm Price	-.777	.164	.92
Sweet Cassava (1970-86)			
Production	8.405	.032	.24
Acreage	7.644	-.001	.00
Farm Price	-.506	.156	.98
Coco (1970-86)			
Production	9.466	.006	.04
Acreage	8.358	-.008	.05
Farm Price	-.4117	.173	.98
Dasheen (1970-86)			
Production	9.648	.008	.04
Acreage	8.363	-.014	.13
Farm Price	-.555	.172	.96
Export Oriented Crops			
Sugar Cane (1963-86)			
Production	8.704	-.036	.96
Acreage	12.1109	-.022	.84
Farm Price	.873	.116	.86
Bananas (1964-86)			
Production	20.906	-.134	.90
Farm Price	-1.200	.171	.91
Cocoa (1960-86)			
Production	11.696	.023	.37
Farm Price	.240	.126	.81
Coffee (1960-86)			
Production	12.275	.013	.21
Farm Price	-.187	.147	.92
Grapefruit (1961-85)			
Production	.711	.033	.006
Farm Price	-1.264	.082	.81
Orange (1961-85)			
Production	6.713	-.039	.65
Farm Price	-1.259	.113	.75
Pimento (1960-85)			
Production	15.244	.008	.10
Farm Price	-1.371	.074	.87

Dependent Variables	a	b	R^2
Other Domestic Commodities			
Flour (1972-86)			
Production	10.350	.069	.58
Imports (Baking)	14.936	-.126	.41
Imports (Counter)	16.004	-.129	.35
Cornmeal			
Production (1972-86)	9.229	.068	.62
Imports (1972-85)	17.474	-.173	.22
Edible Oils			
Production (1972-86)	8.003	-.007	.05
Imports (Coconut)	-2.432	.229	.84
Imports (Soybean)	7.252	.258	.61

Table A2. Estimates of Supply Equations for Selected Agricultural Commoditie in Jamaica.

Commodity	Intercept	Elasticity of Supply	Q_{t-1}	Long Run Elasticity	R^2
Domestic Food Corps	1.110	.318	.480	.612	.65
	(1.400)	(1.641)	(3.117)		
Legumes	1.044	.177	.623	.469	.65
	(1.312)	(1.243)	(3.417)		
Broad Bean	2.251	.313	.341	.475	.27
	(1.605)	(1.236)	(1.356)		
Sugar Bean	2.486	.245	.362	.384	.29
	(1.906)	(1.507)	(1.677)		
Cow Pea	4.139	.582	.031	.601	.51
	(3.241)	(2.693)	(.125)		
Gungo Pea	4.343	.247	.313	.359	.22
	(2.089)	(1.495)	(1.240)		
Red Pea	2.405	.164	.627	.439	.43
	(1.176	(.874)	(2.784)		
Peanut	2.441	.376	.503	.757	.42
	(1.330)	(.681)	(2.230)		
Vegetables	-1.244	.625	.716	2.201	.90
	(1.664)	(3.665)	(8.893)		
Beetroot	8.557	-.188	-.214	n.c.	.04
	(3.395)	(.547)	(.713)		
Cabbage	6.687	.003	.302	.004	.11
	(2.145)	(.009)	(1.086)		
Calaloo	7.071	-.027	.257	n.c.	.07
	(1.821)	(.094)	(.570)		
Carrot	1.915	.695	.584	1.671	.80
	(1.781)	(3.147)	(4.821)		
Cauliflower	-1.168	.742	.693	2.417	.63
	(.731)	(1.519)	(3.671)		
Cho-Cho	5.967	.545	.181	.665	.57
	(4.829)	(2.300)	(1.031)		
Cucumber	1.106	-.196	.929	n.c.	.68
	(.464)	(.461)	(4.449)		
Egg Plant	.957	.706	.446	1.274	.17
	(.442)	(1.368)	(1.152)		
Iceburg Lettuce	6.236	-.579	.399	n.c.	.37
	(1.541)	(.839)	(1.292)		
Other Lettuce	3.480	-.329	.576	n.c.	.51
	(2.038)	(1.223)	(2.778)		
Okra	3.076	.064	.554	.143	.56
	(2.568)	(.269)	(4.015)		
Pumpkin	6.231	.457	.291	.645	.49
	(3.666)	(2.086)	(1.585)		
String Bean	1.195	-.007	.839	n.c.	.65
	(.820)	(.018)	(4.655)		
Tomato	.304	.660	.766	2.821	.78
	(.206)	(2.281)	(6.549)		

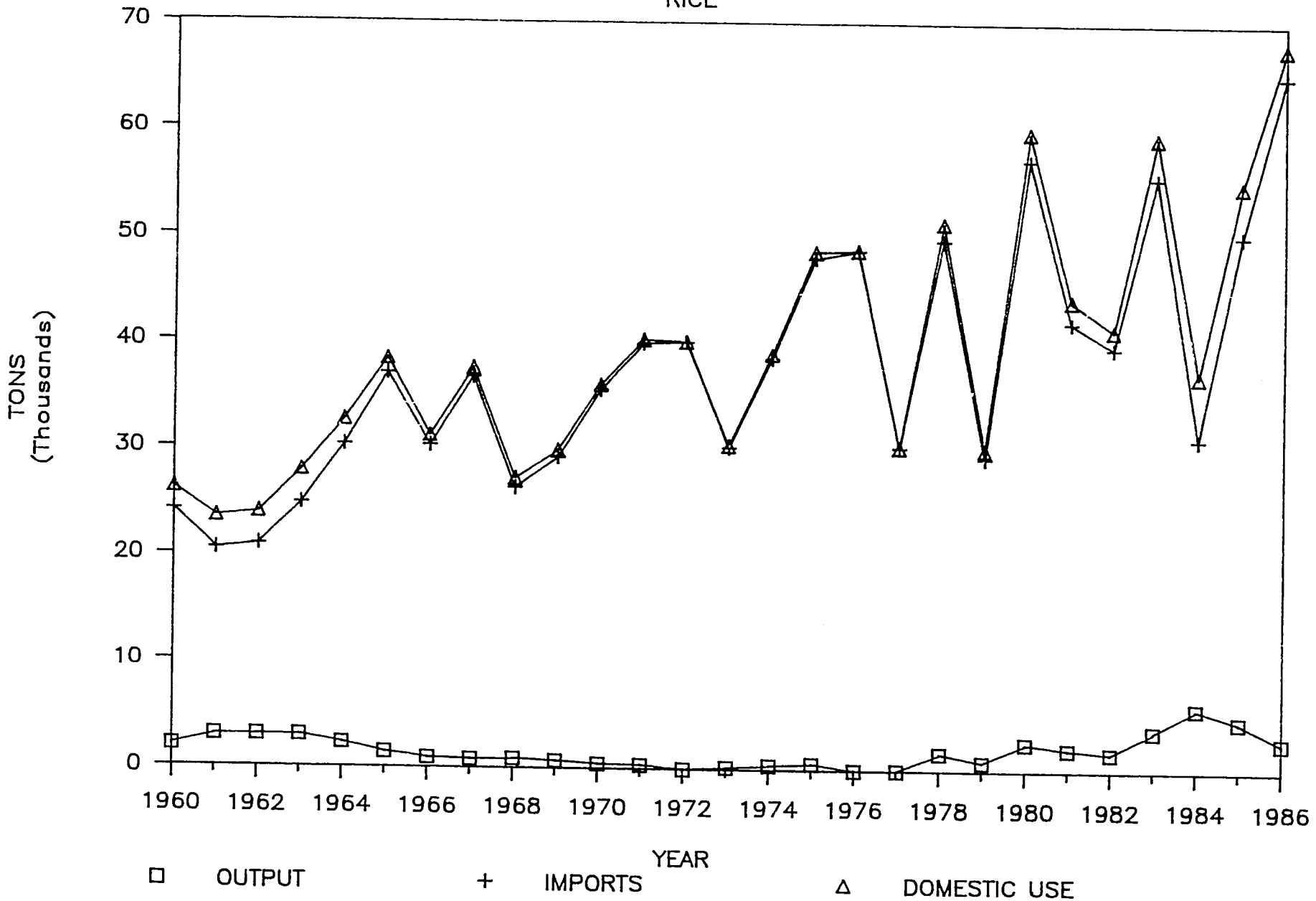
Commodity	Intercept	Elasticity of Supply	Q_{t-1}	Long Range Elasticity	R^2
Turnip	8.142	-.249	-.022	n.c.	.08
	(3.220)	(1.001)	(.073)		
Escallion	-.421	.527	.810	2.774	.82
	(.039)	(3.121)	(7.395)		
Ginger	3.665	.065	.397	.108	.12
	(1.366)	(.227)	(1.276)		
Onion	2.744	.503	.417	.863	.75
	(3.525)	(1.596)	(2.818)		
Hot Pepper	3.170	.409	.406	.688	.66
	(2.979)	(2.810)	(2.428)		
Sweet Pepper	-.893	.388	1.005	n.c.	.93
	(1.010)	(1.149)	(11.275)		
Thyme	4.627	-.007	.134	n.c.	.05
	(4.564)	(.054)	(.845)		
Paw-Paw	2.094	.50	.589	1.216	.57
	(1.547)	(1.576)	(4.052)		
Pineapple	2.644	.319	.609	.816	.44
	(1.412)	(1.297)	(2.921)		
Watermelon	1.909	1.029	.484	1.994	.24
	(.611)	(1.737)	(1.760)		
Ordinary Corn	.862	.258	.819	1.425	.83
	(.986)	(2.342)	(7.606)		
Horse Plantain	4.151	.745	.428	1.302	.41
	(2.138)	(1.803)	(2.353)		
Other Plantain	8.769	.119	.008	.120	.00
	(3.995)	(.234)	(.035)		
Irish Potato	11.133	-.295	-.105	n.c.	.05
	(2.867)	(.781)	(.303)		
Sweet Potato	4.369	.617	.435	1.092	.38
	(2.004)	(1.847)	(2.202)		
Cereals	.988	.042	.698	.139	.52
	(.965)	(.235)	(3.68)		
Plantains	3.473	-.071	.368	n.c.	.21
	(1.938)	(.179)	(1.812)		
Potatoes	2.836	.391	.033	.404	.18
	(1.943)	(1.701)	(.146)		
Condiments	2.212	.264	.227	.342	.18
	(1.668)	(1.121)	(.938)		
Fruit	1.438	.392	.334	.588	.49
	(.911)	(1.580)	(1.420)		
Yams	2.714	-.035	.462	n.c.	.38
	(3.168)	(.203)	(2.613)		
Lucea Yam	6.074	.004	.367	.006	.18
	(2.868)	(.025)	(1.719)		
Negro Yam	8.811	-.309	.211	n.c.	.08
	(2.838)	(.901)	(.775)		
Renta Yam	5.353	.074	.460	.137	.74
	(5.909)	(.813)	(4.623)		
St. Vincent Yam	5.645	-.024	.404	n.c.	.56
	(5.783)	(.169)	(3.266)		

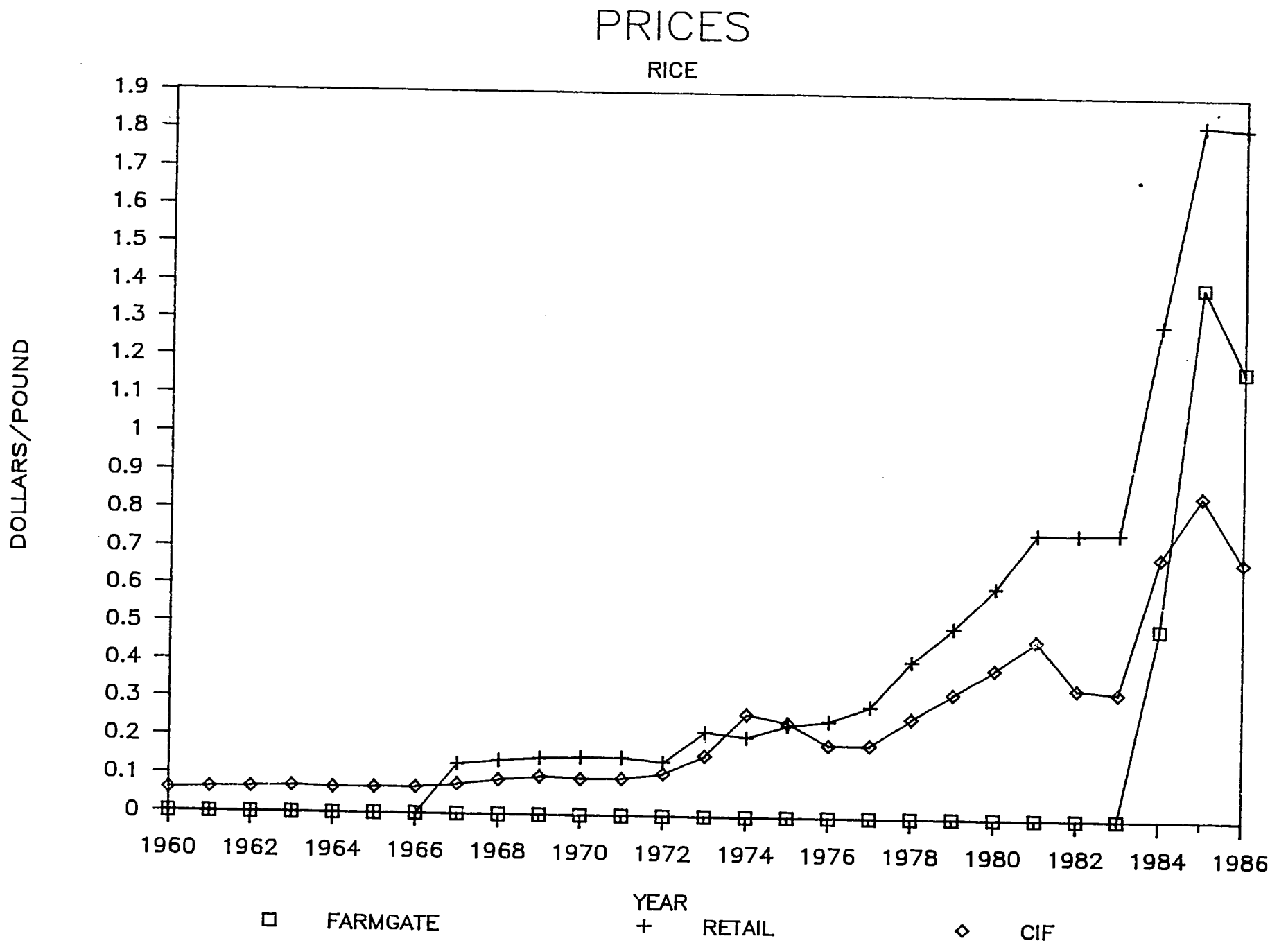
Commodity	Intercept	Elasticity of Supply	Q_{t-1}	Long Run Elasticity	R^2
Sweet Yam	.832	.178	.863	1.30	.87
	(.813)	(.711)	(.9480)		
Tau Yam	7.657	-.555	.304	n.c.	.39
	(4.399)	(2.496)	(1.632)		
Yellow Yam	3.839	.014	.646	.039	.50
	(1.957)	(.079)	(3.368)		
Other Yam	4.460	-4.24	.594	n.c.	.28
	(2.254)	(1.648)	(2.184)		
Other Tubers	1.696	.041	.598	.102	.43
	(1.178)	(.173)	(3.070)		
Bitter Cassava	1.911	.387	.728	1.423	.65
	(1.136)	(1.834)	(4.037)		
Sweet Cassava	.853	.890	.723	3.213	.61
	(.462)	(1.874)	(4.252)		
Coco	5.754	.279	.334	.419	.12
	(1.987)	(.885)	(1.246)		
Dasheen	6.874	-.210	.347	n.c.	.26
	(4.307)	(1.226)	(2.037)		
Sugar Cane	.075	.165	.938	2.661	.94
	(.159)	(2.197)	(14.085)		
Banana	-1.687	.307	1.060	n.c.	.91
	(.697)	(.789)	(9.788)		
Cocoa	6.289	.133	.459	.246	.26
	(3.079)	(.792)	(2.774)		
Coffee	18.904	.428	-.579	.271	.43
	(9.164)	(3.403)	(3.391)		
Pimento	15.605	-.172	-.019	n.c.	.09
	(4.799)	(1.406)	(.918)		
Grapefruit	2.681	.459	.573	1.075	.77
	(2.520)	(3.154)	(3.385)		
Orange	2.337	.307	.605	.777	.56
	(2.471)	(1.602)	(3.868)		
Coconut	-3.151	.290	1.193	n.c.	.94
	(2.000)	(.964)	(13.073)		

NOTE: Absolute T-values in parentheses.
n.c. = not calculated.

OUTPUT AND USE

RICE

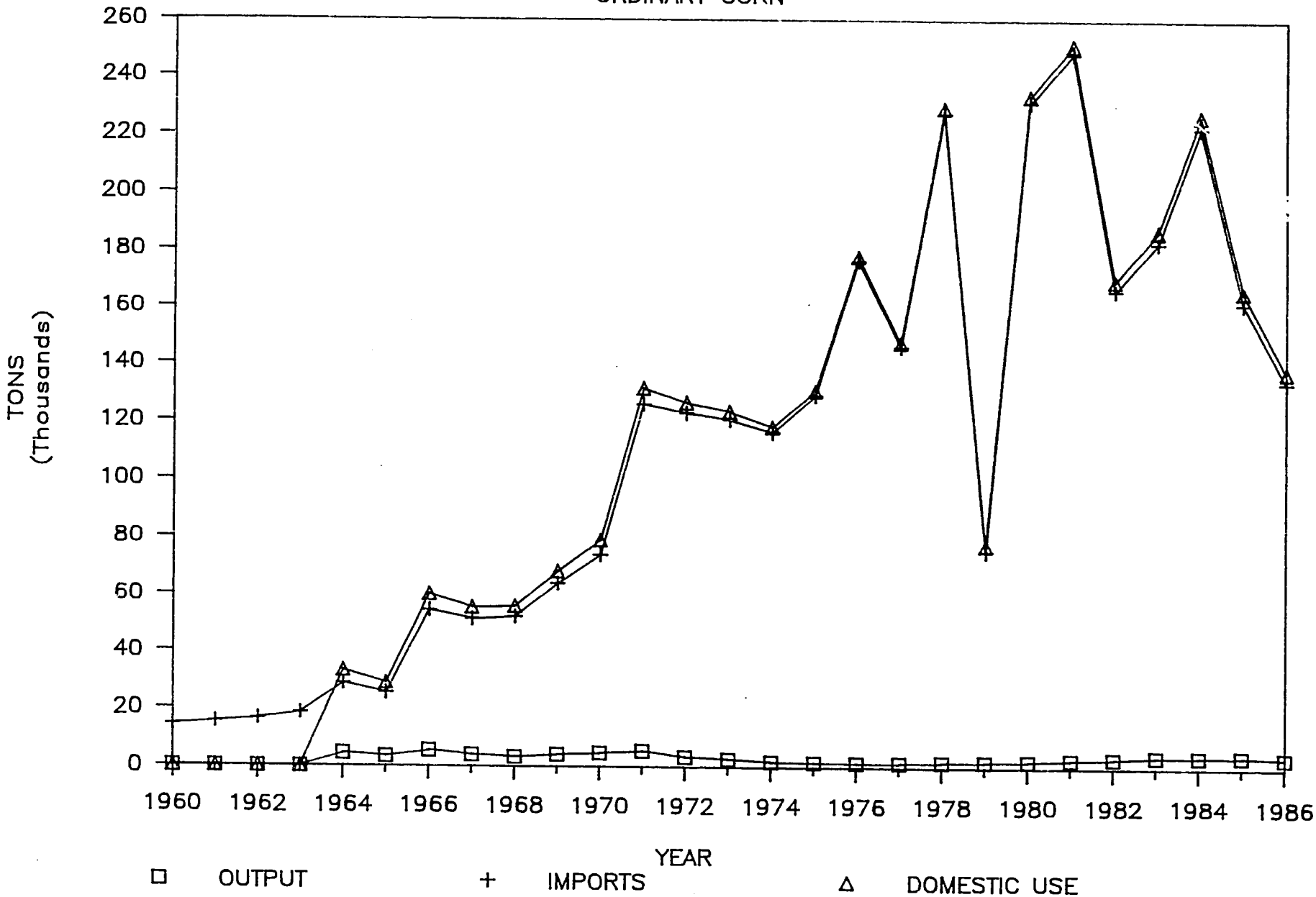



PRICES
RICE
DOLLARS/POUND
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
FARMGATE
RETAIL
CIF

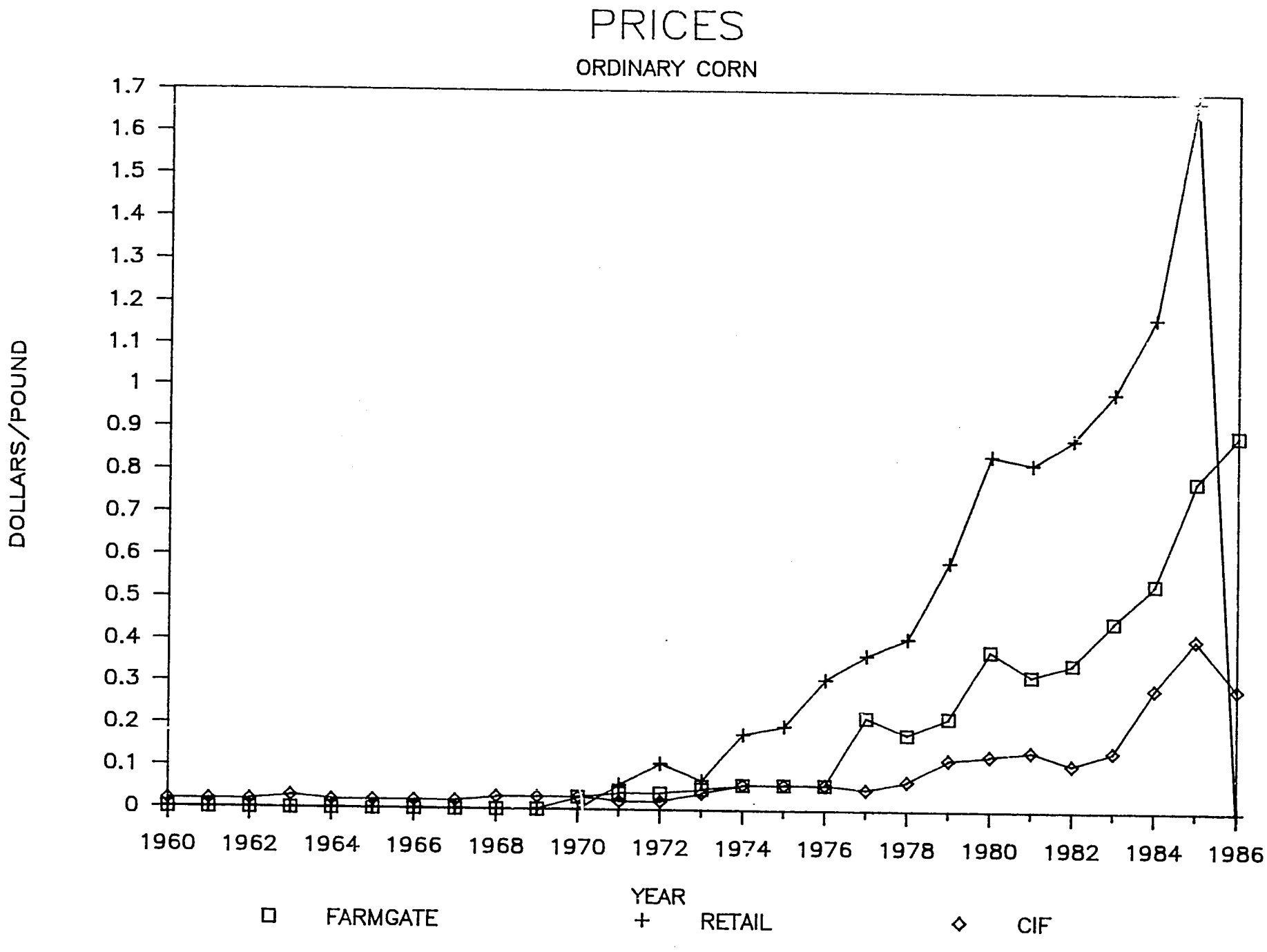
28

OUTPUT AND USE

ORDINARY CORN



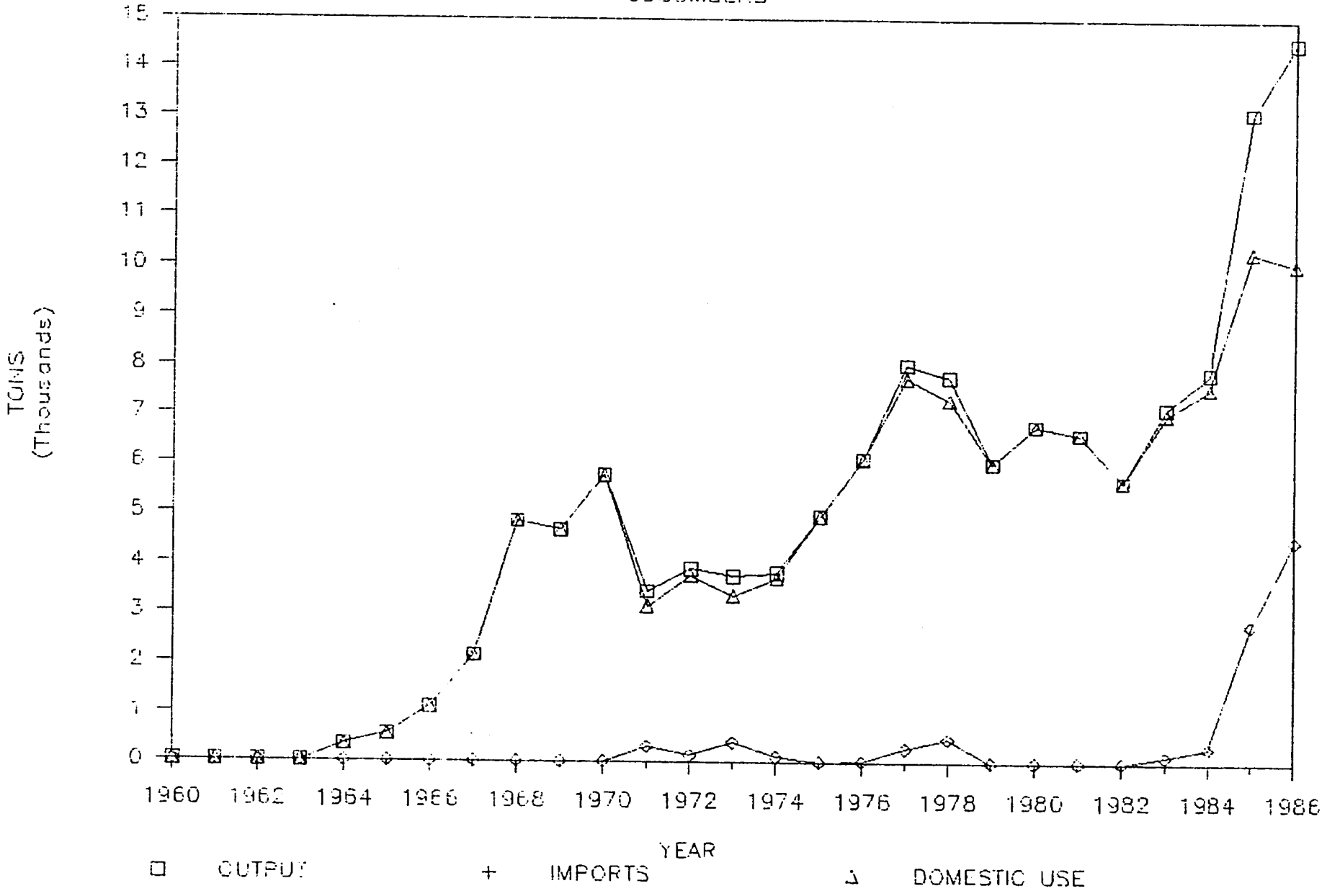
67

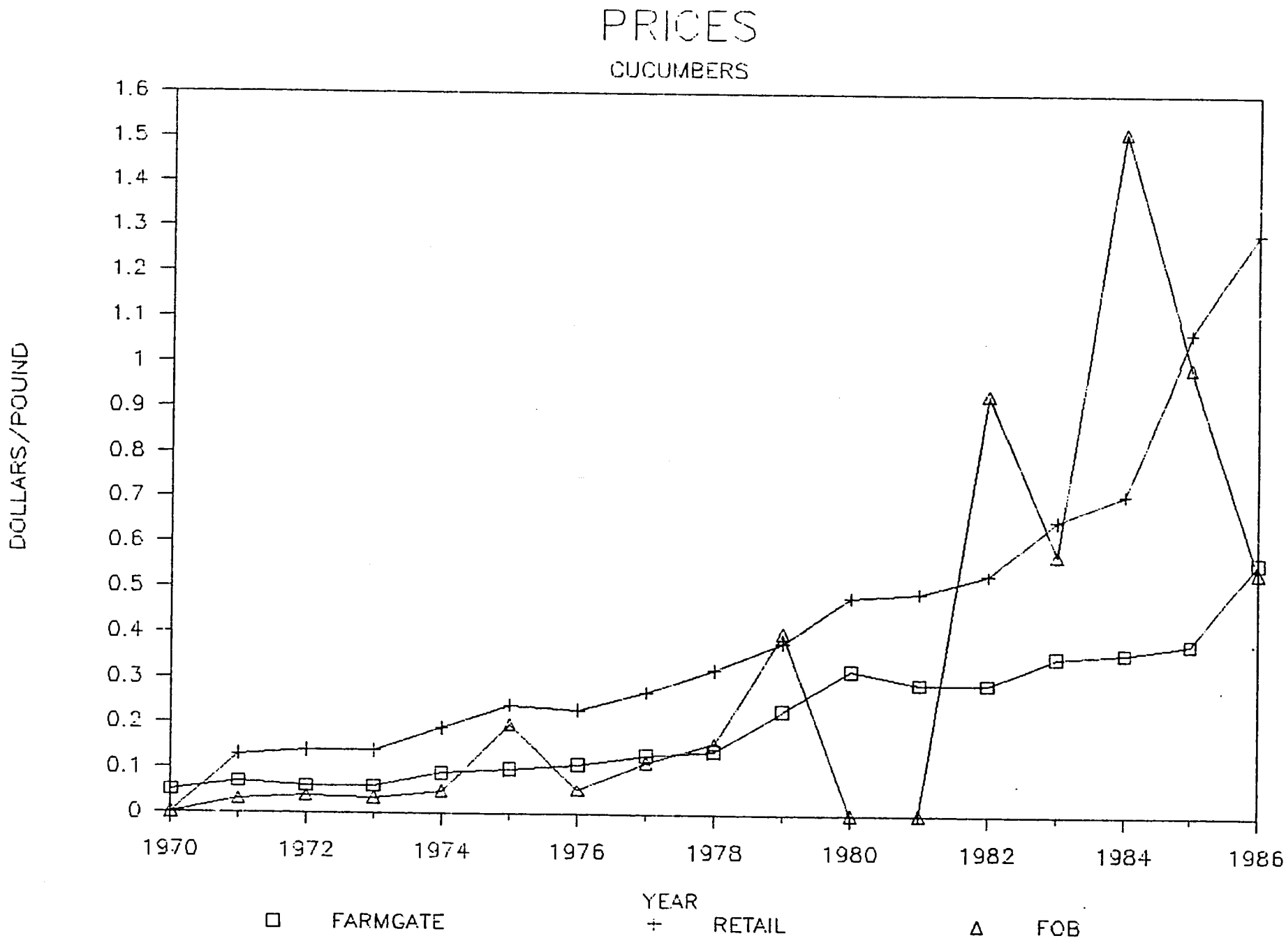

PRICES
ORDINARY CORN
DOLLARS/POUND
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
FARMGATE
RETAIL
CIF

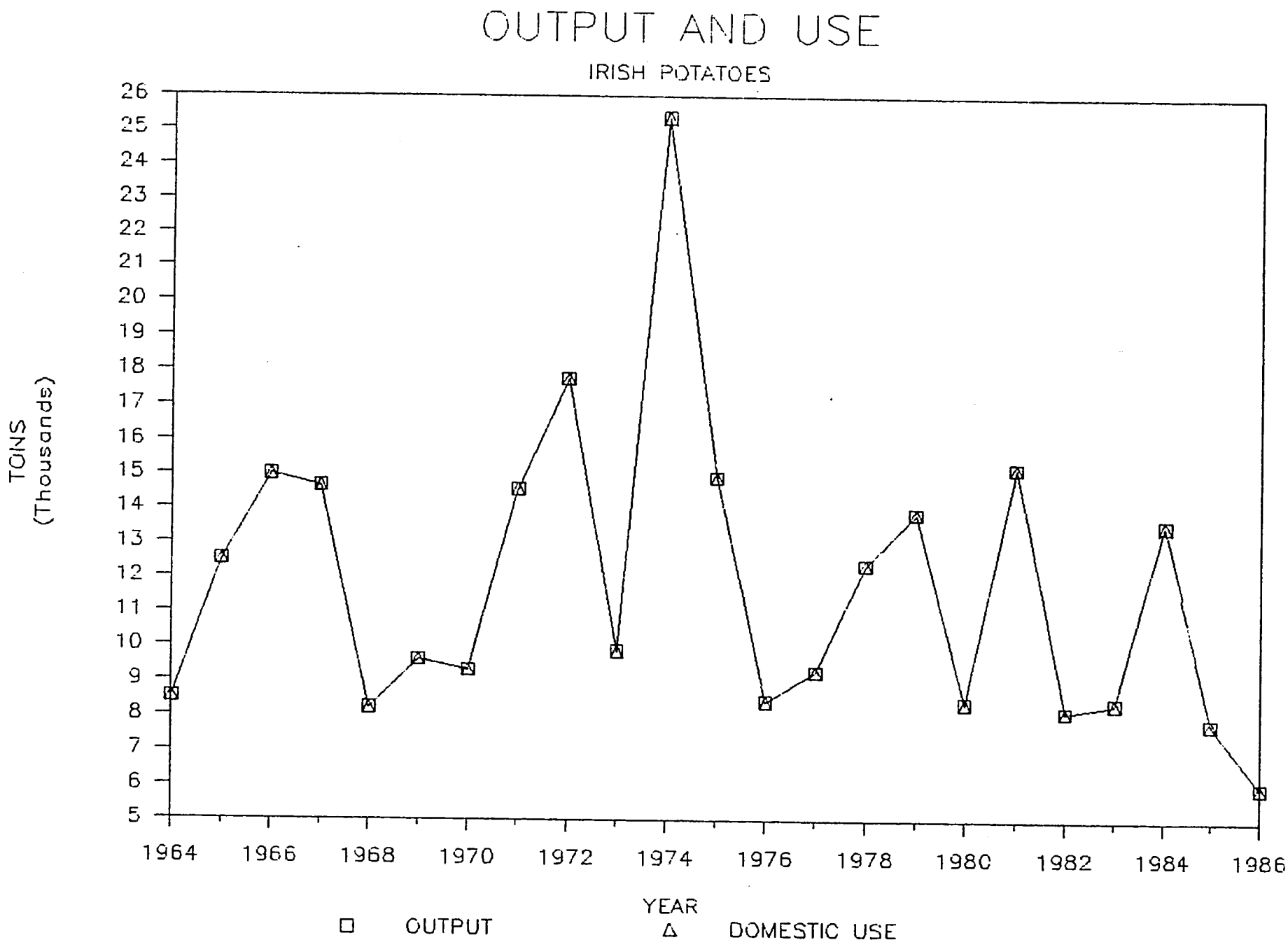
20

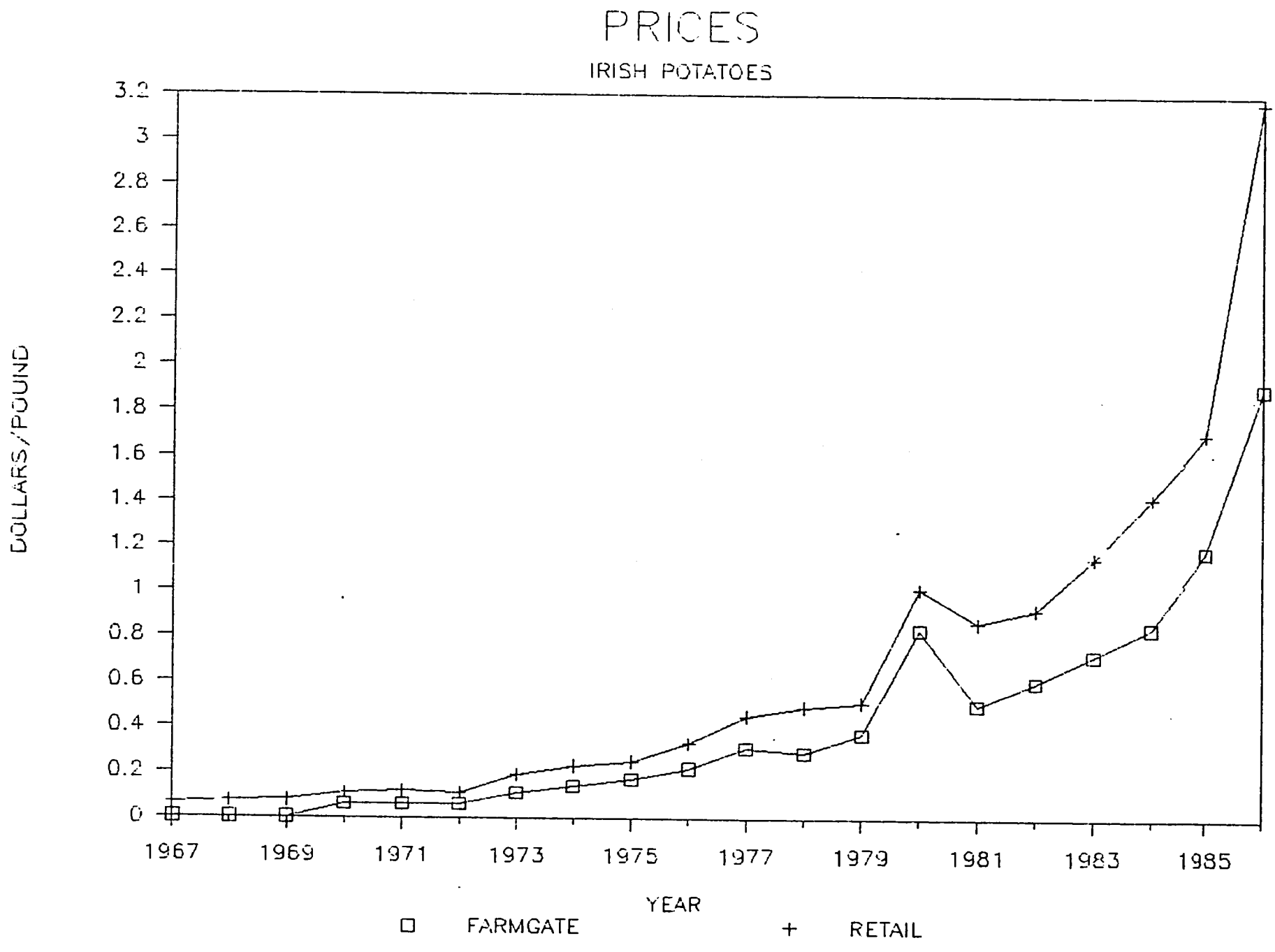
OUTPUT AND USE

CUCUMBERS



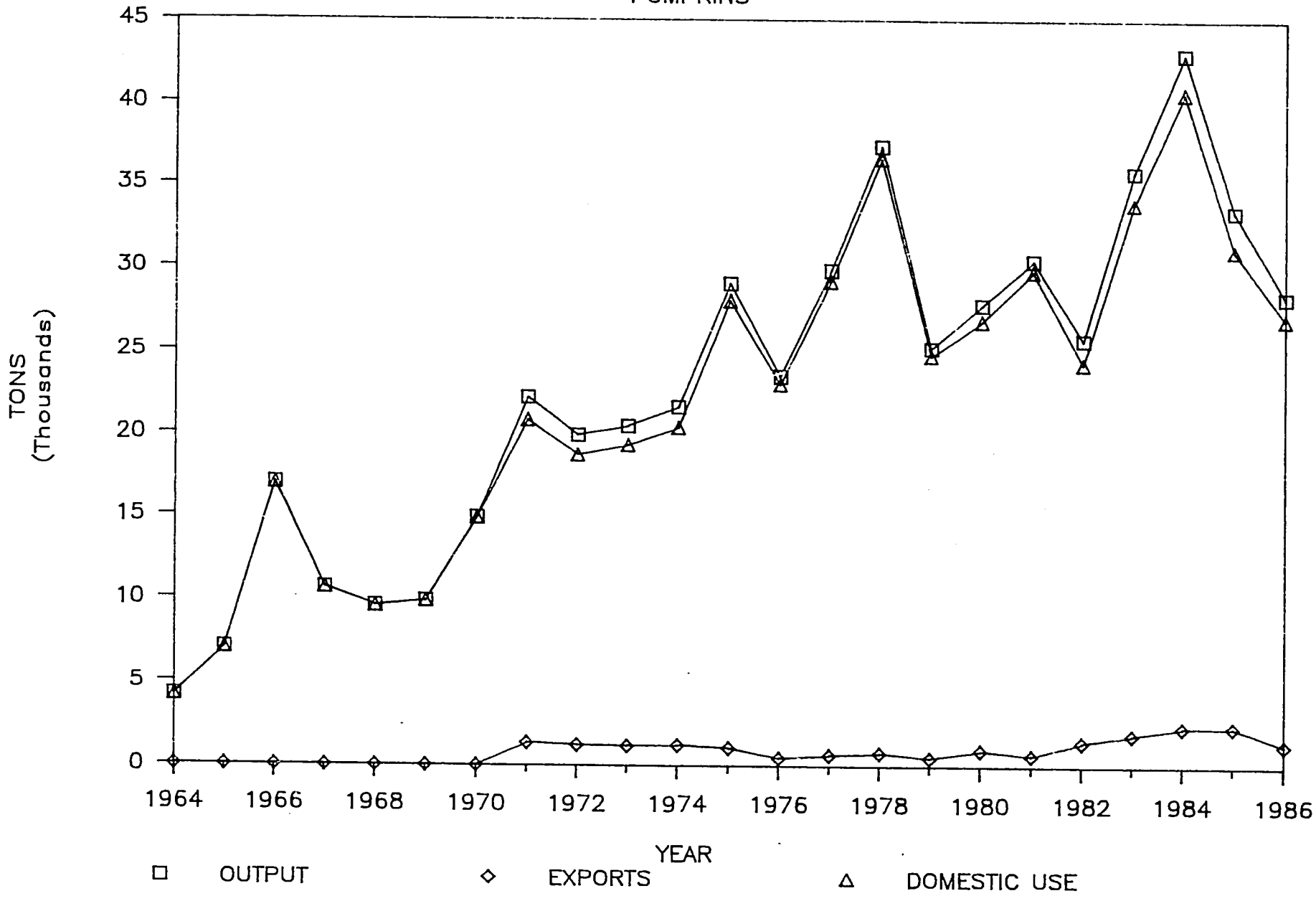

PRICES
CUCUMBERS
DOLLARS/POUND
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
FARMGATE
RETAIL
FOB

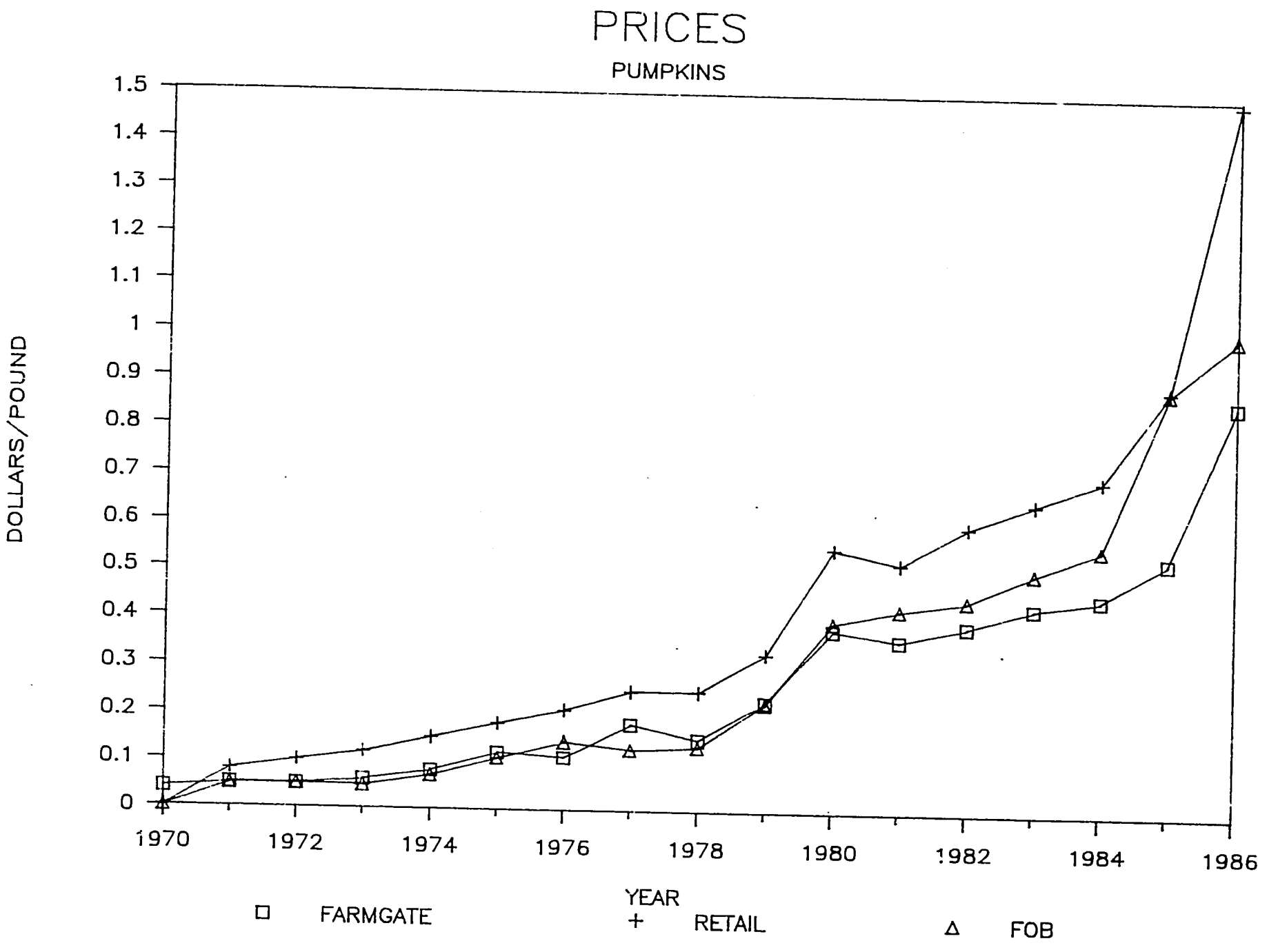

OUTPUT AND USE
IRISH POTATOES
TONS
(Thousands)
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
OUTPUT
DOMESTIC USE

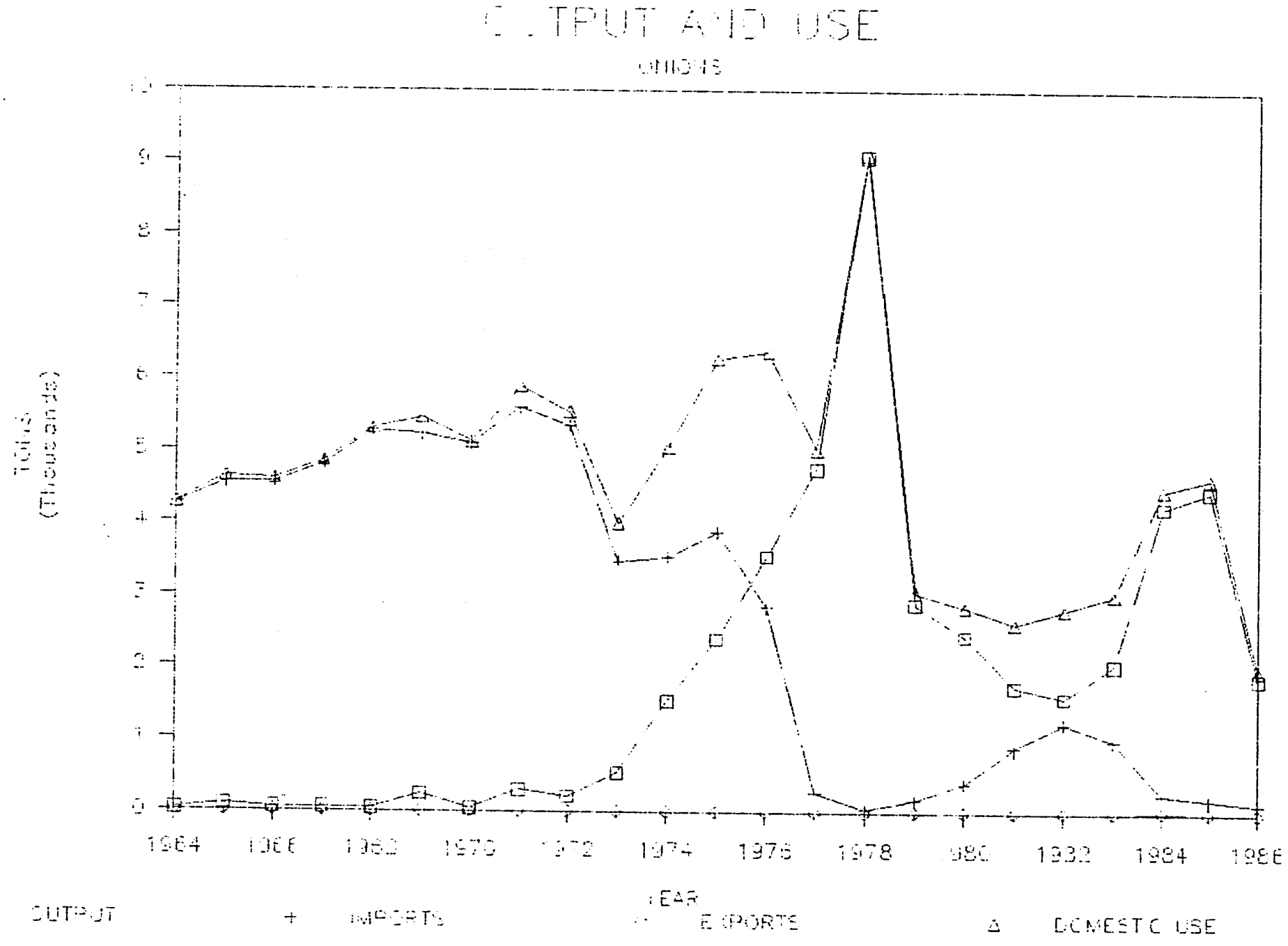

PRICES
IRISH POTATOES
DOLLARS/POUND
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
YEAR
FARMGATE
RETAIL

OUTPUT AND USE

PUMPKINS

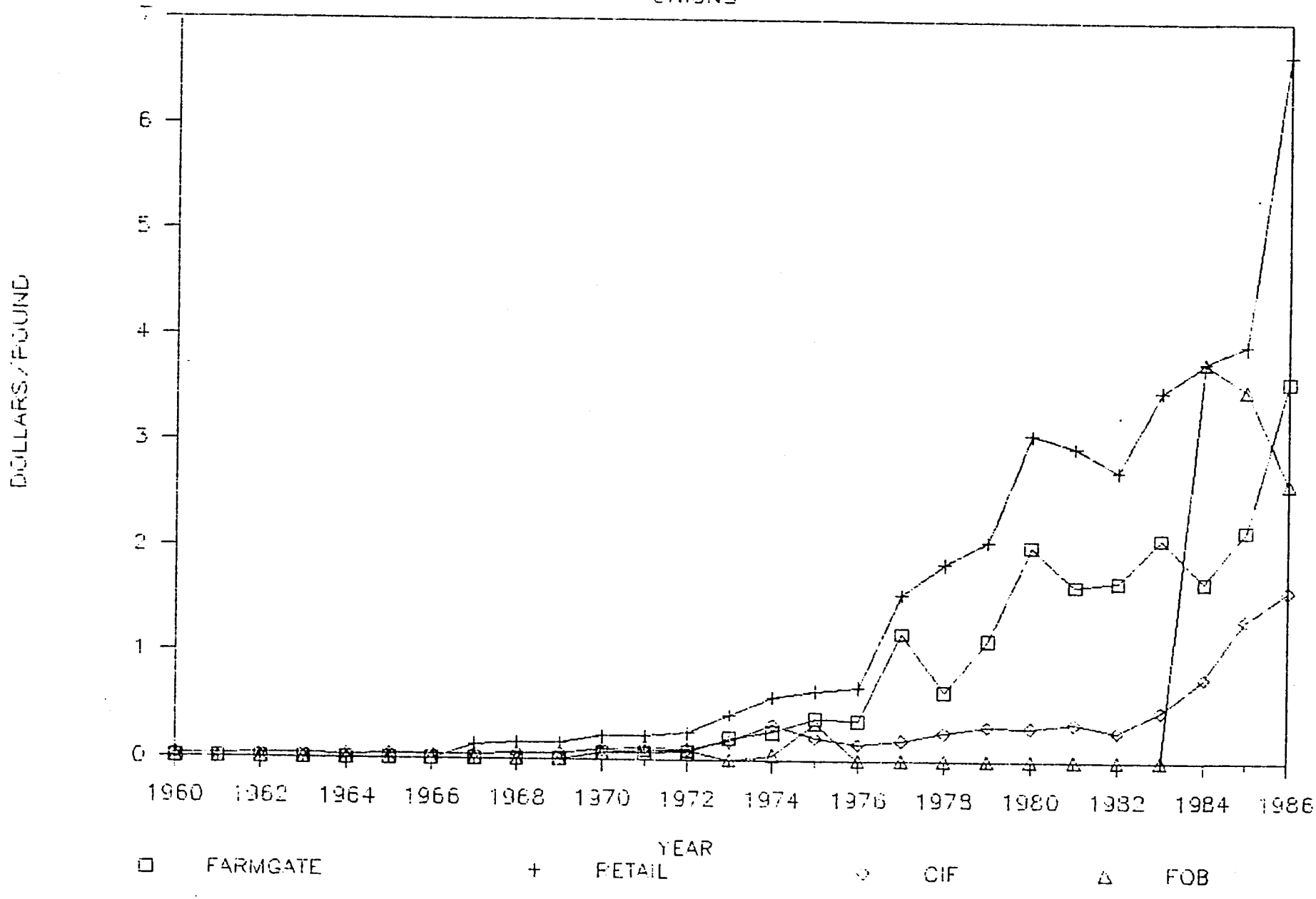


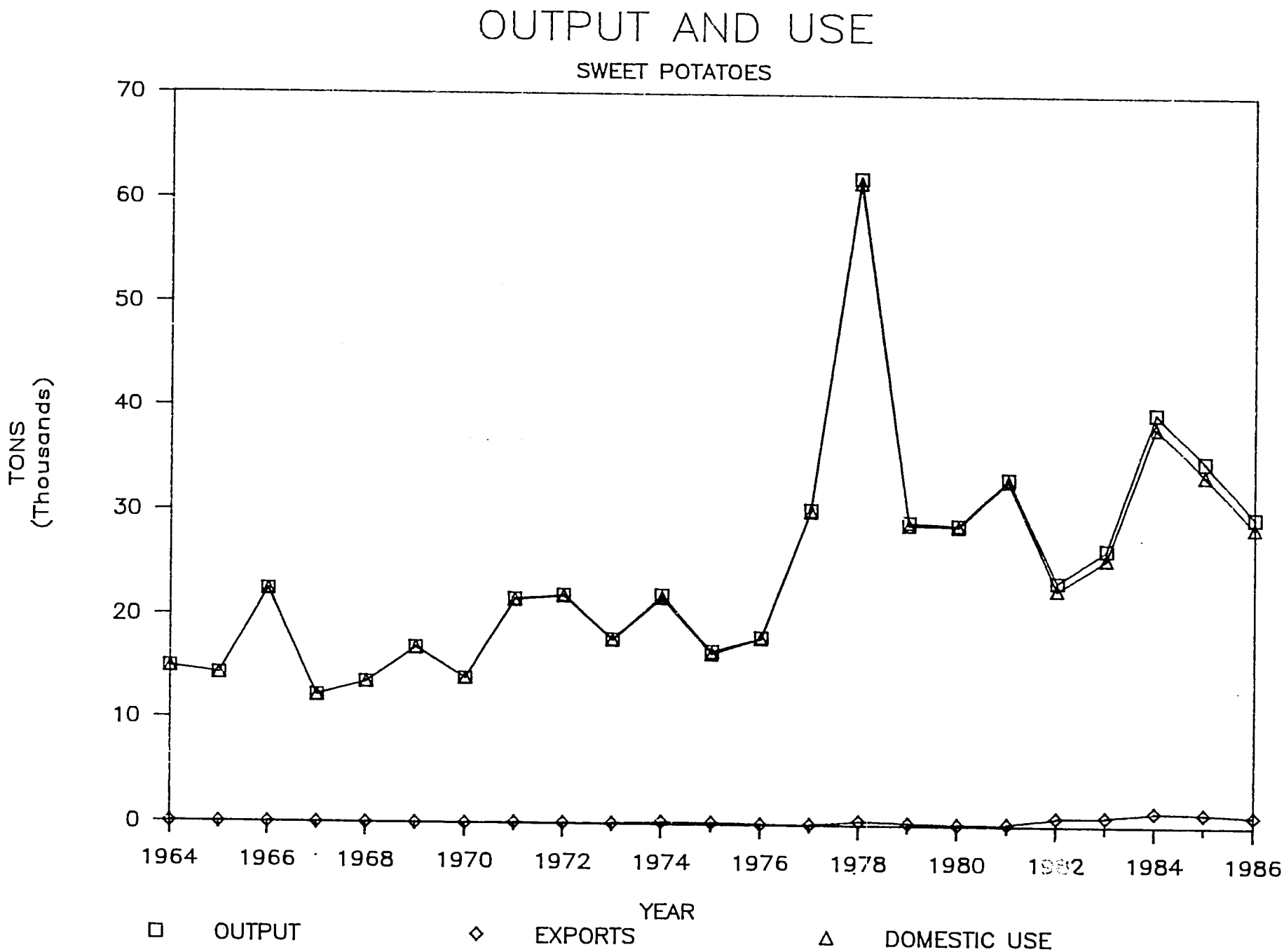

PRICES
PUMPKINS
DOLLARS/POUND
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
FARMGATE
RETAIL
FOB

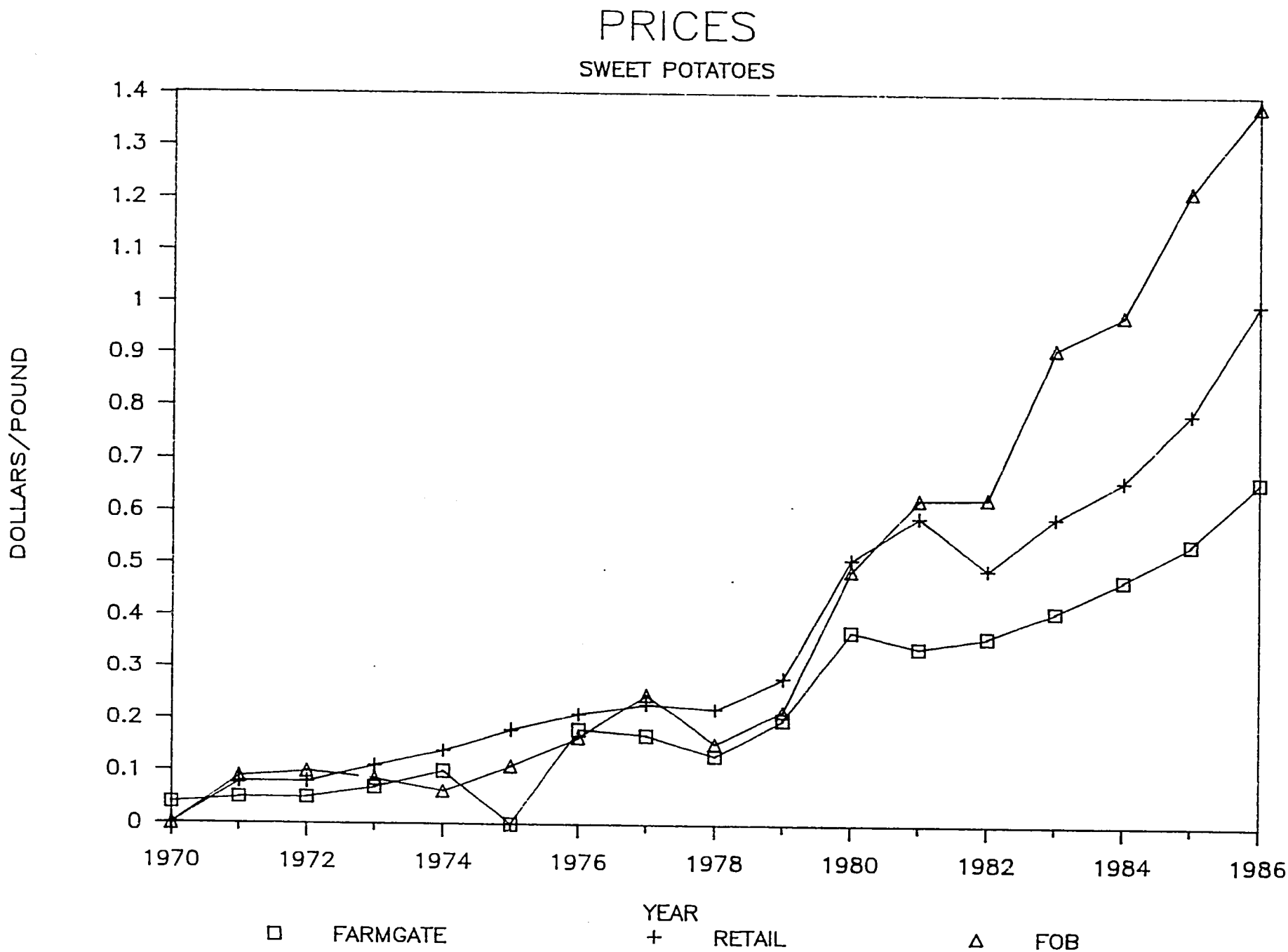

OUTPUT AND USE
UNITS
TONS
(Thousands)
0
1
2
3
4
5
6
7
8
9
10
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
OUTPUT
IMPORTS
EXPORTS
DOMESTIC USE

PRICES

ONIONS

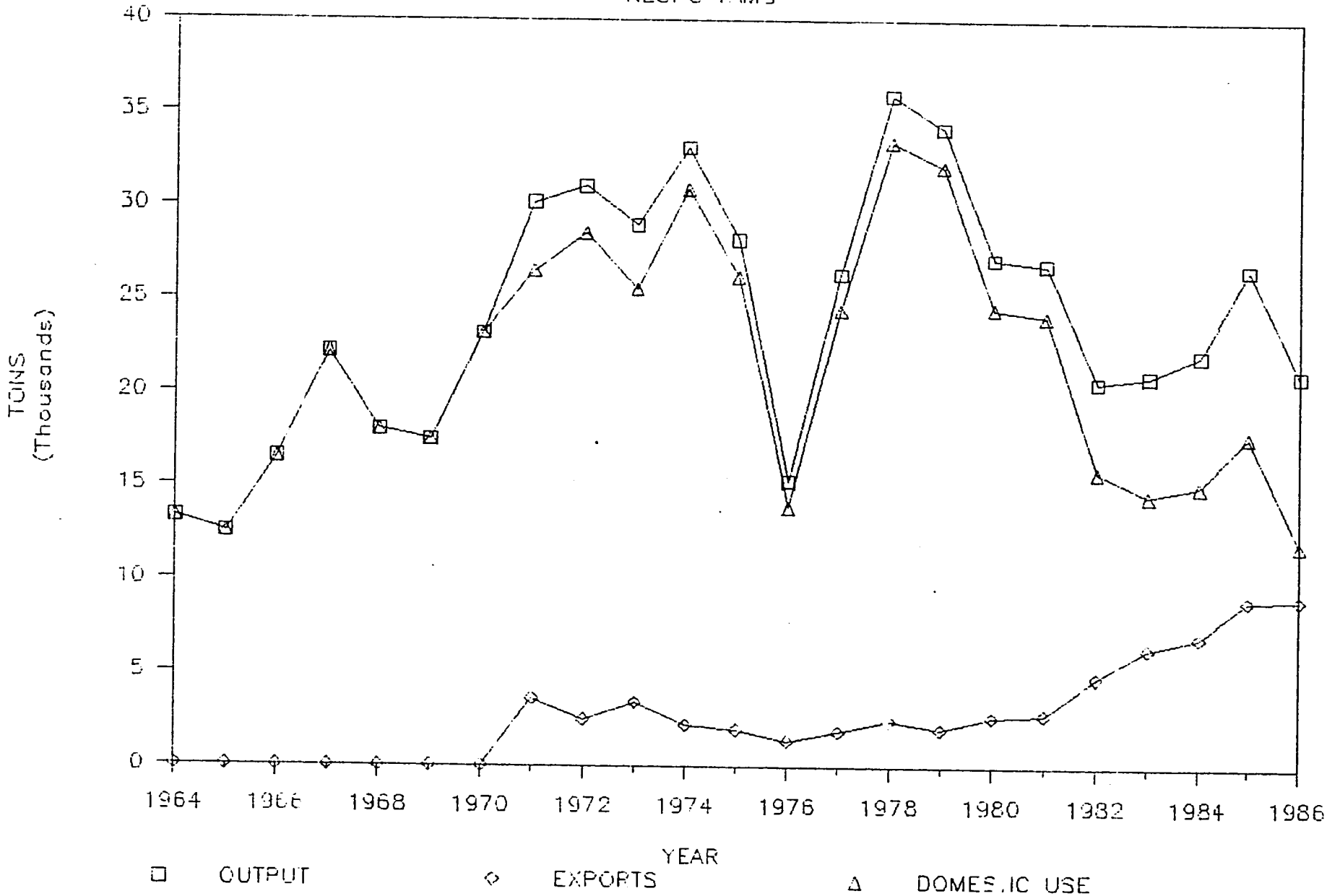


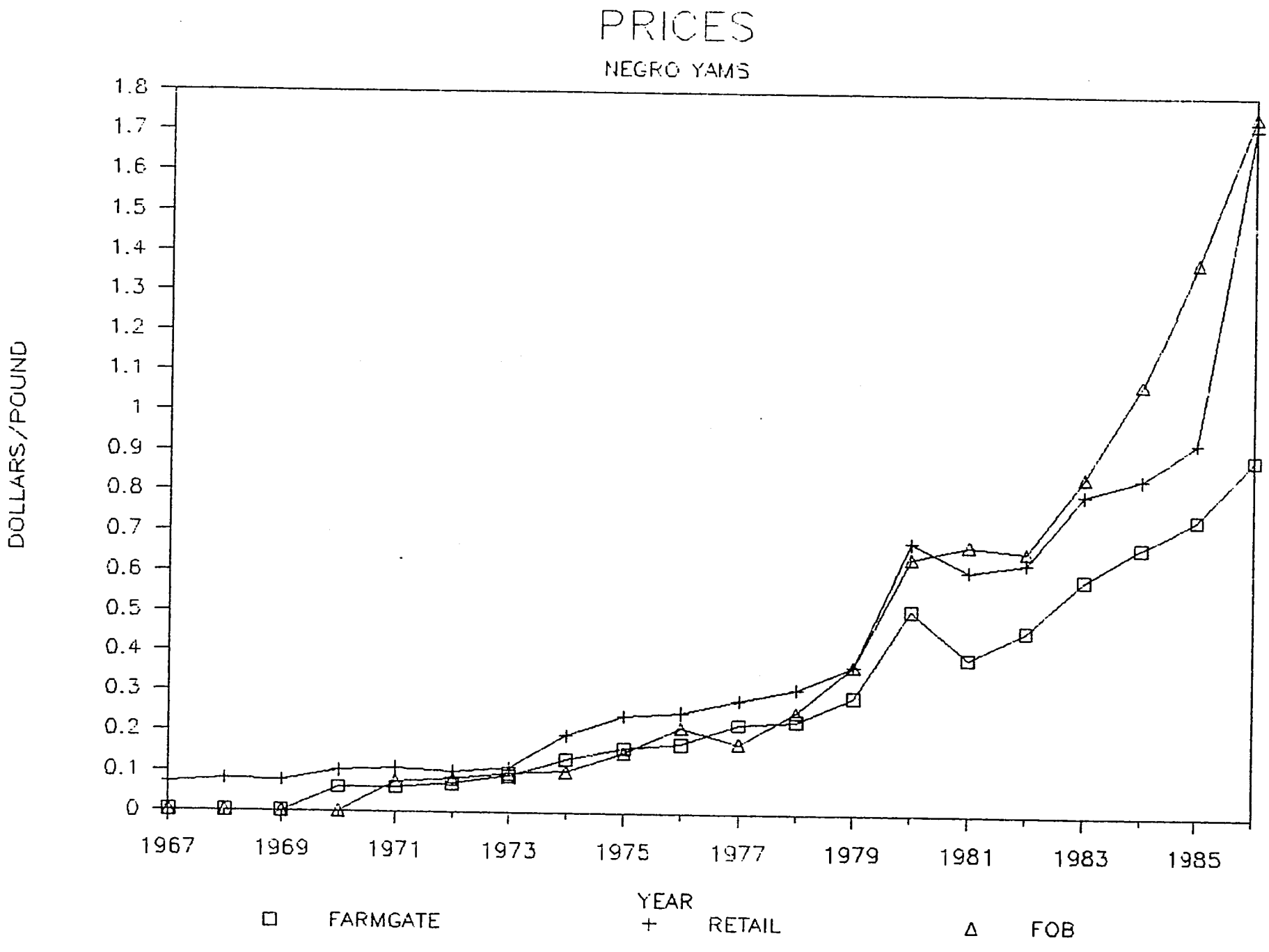

OUTPUT AND USE
SWEET POTATOES
TONS
(Thousands)
70
60
50
40
30
20
10
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
OUTPUT
EXPORTS
DOMESTIC USE


PRICES
SWEET POTATOES
DOLLARS/POUND
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
FARMGATE
RETAIL
FOB

OUTPUT AND USE

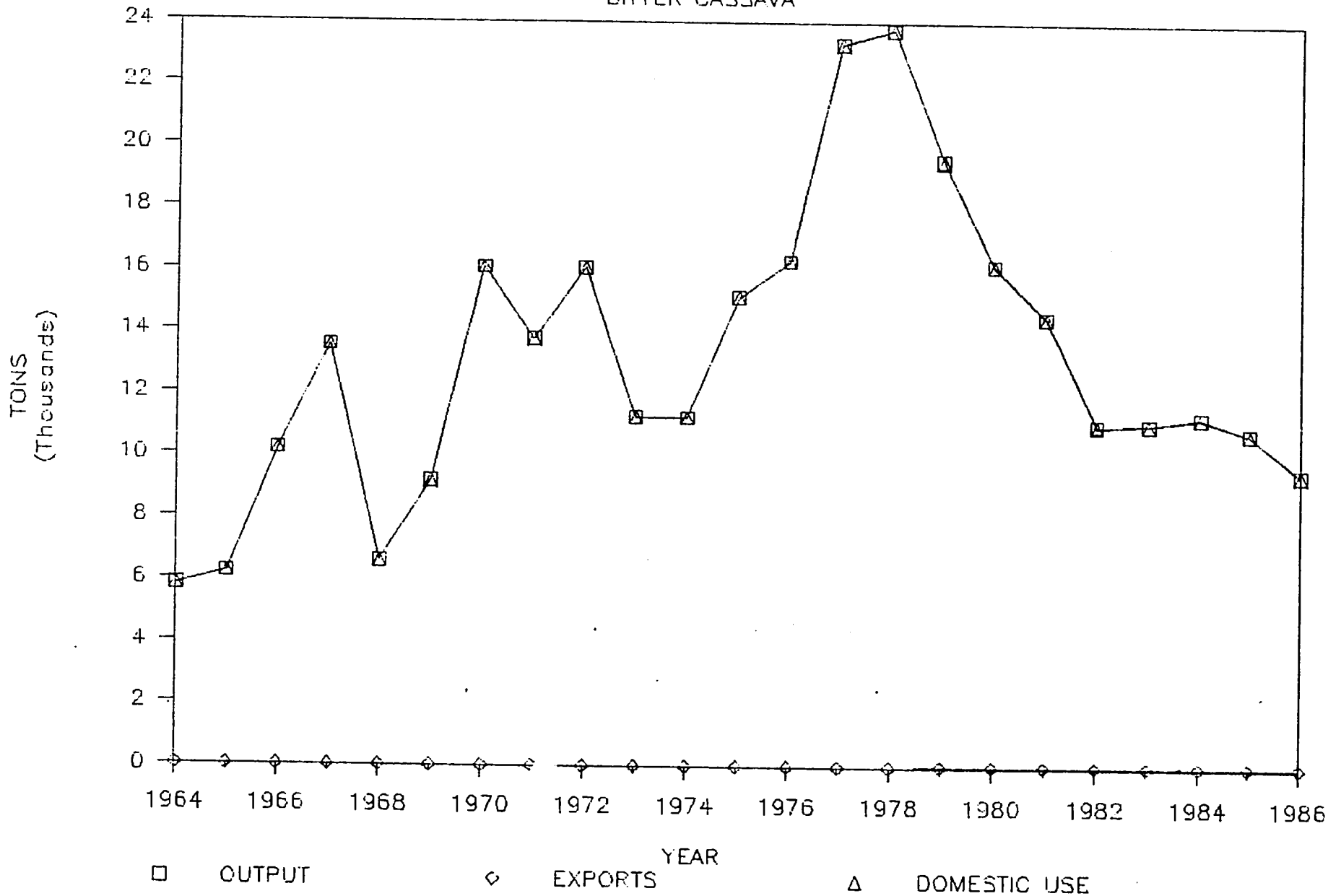
NEGRO YAMS

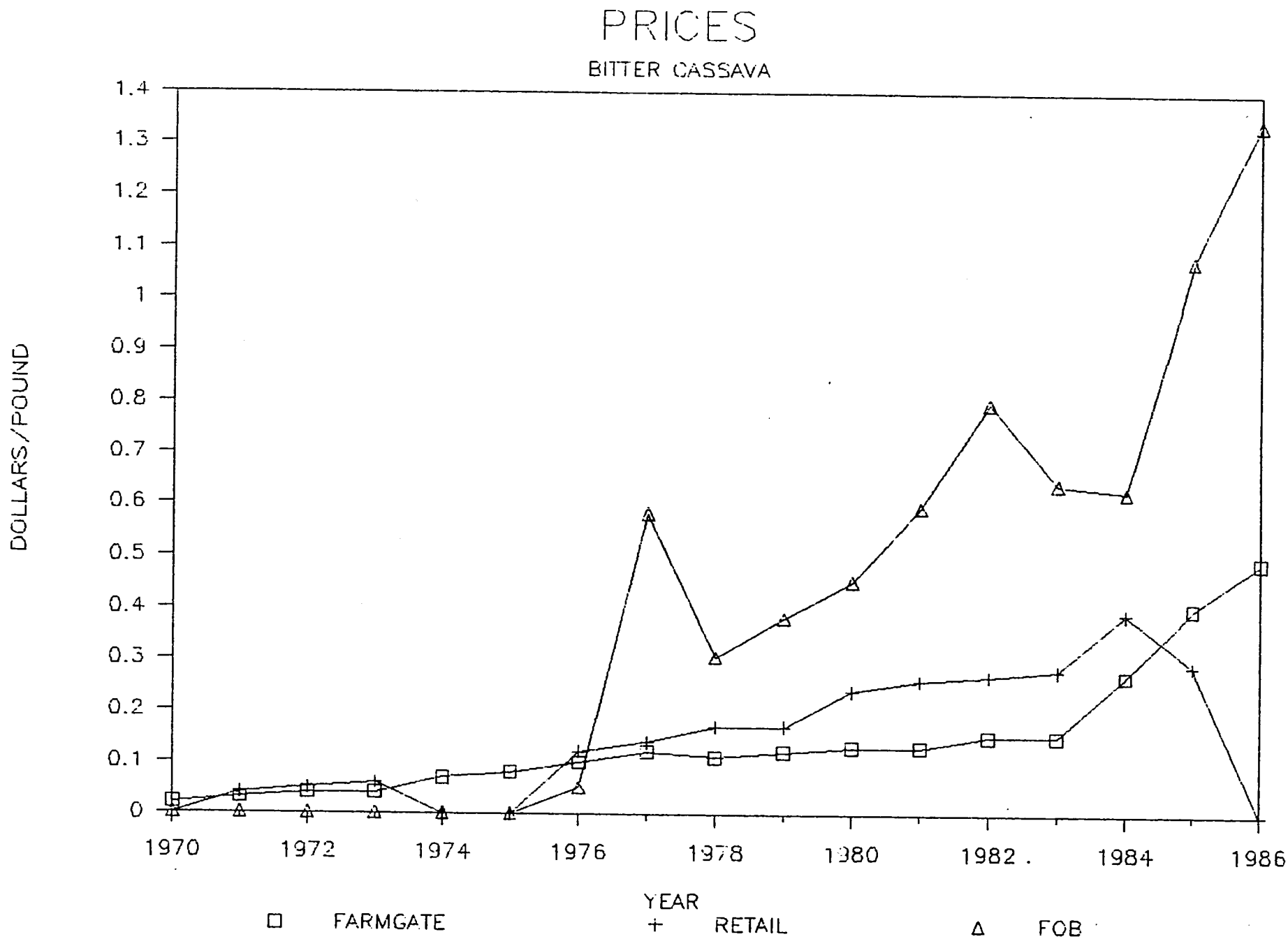



PRICES
NEGRO YAMS
DOLLARS/POUND
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
YEAR
FARMGATE
RETAIL
FOB

OUTPUT AND USE

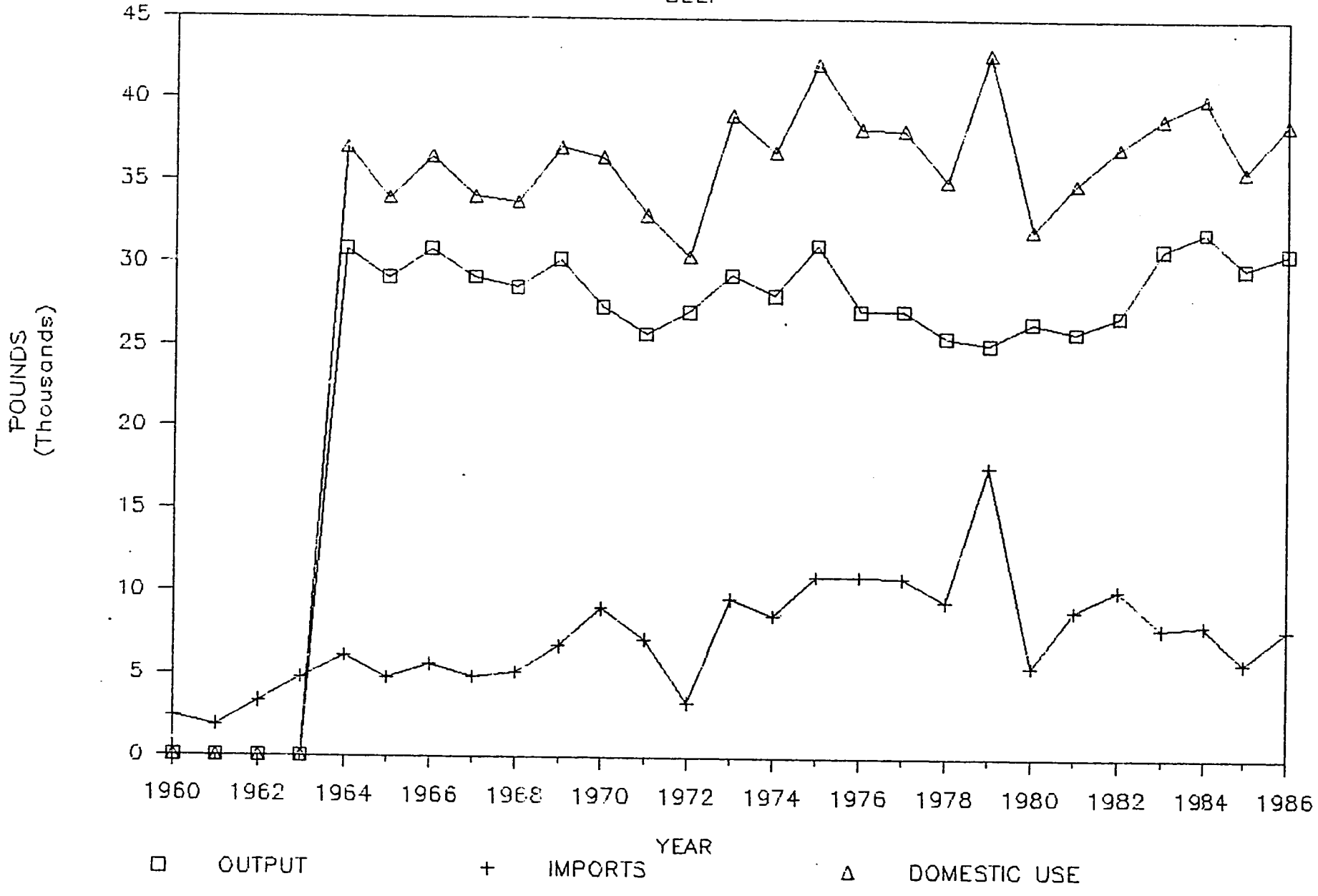
BITTER CASSAVA

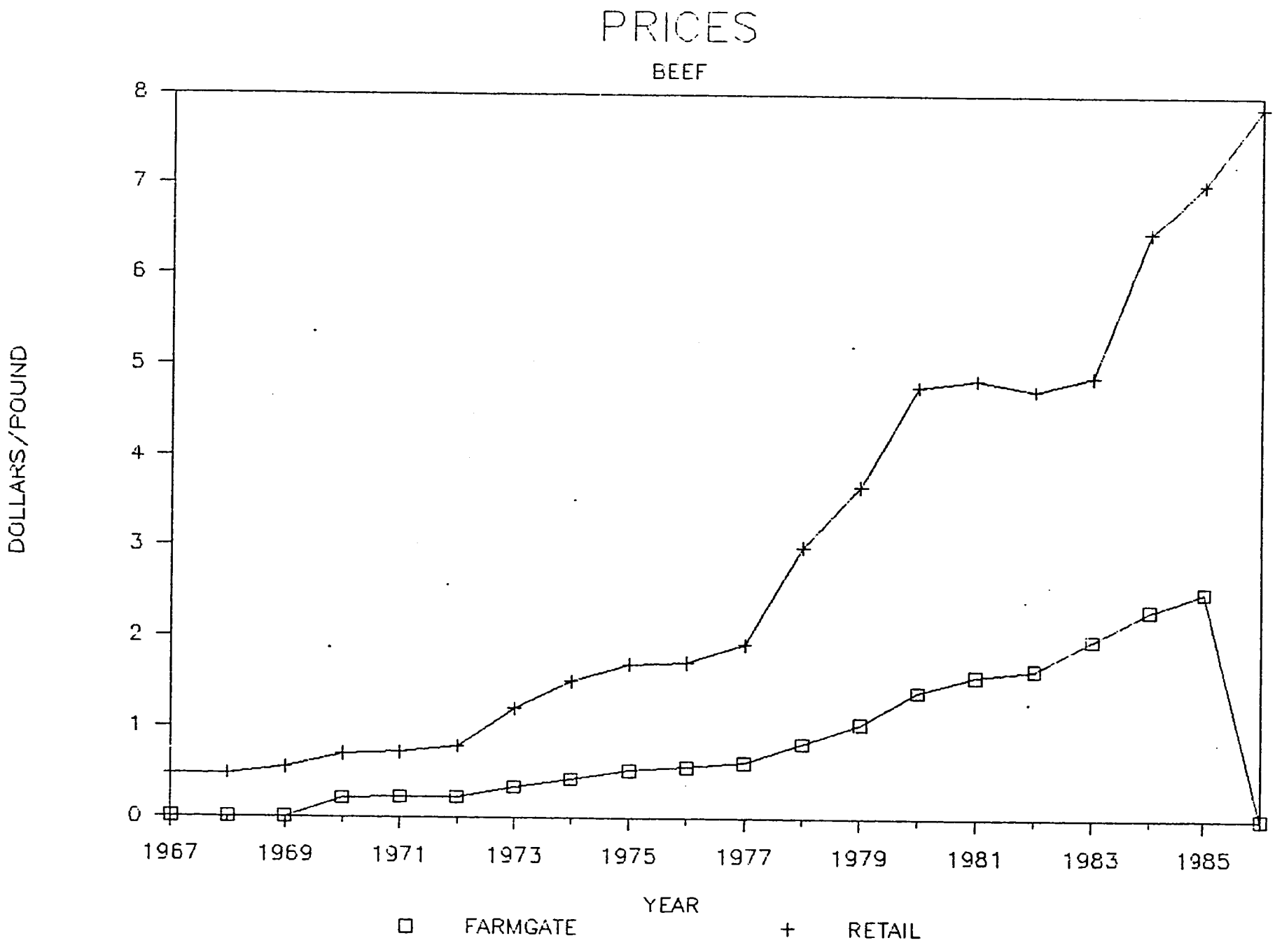



PRICES
BITTER CASSAVA
DOLLARS/POUND
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
FARMGATE
RETAIL
FOB

OUTPUT AND USE

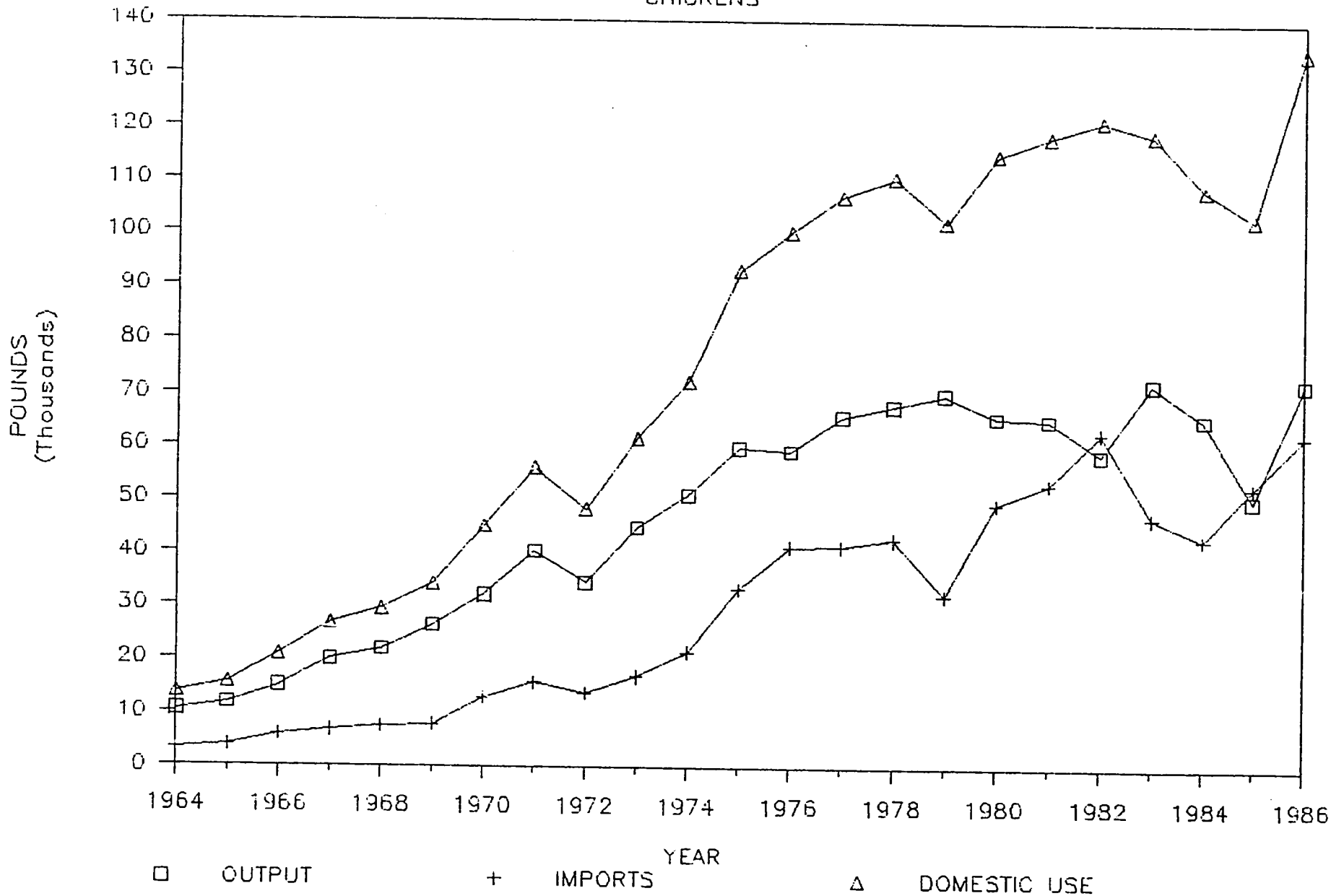
BEEF

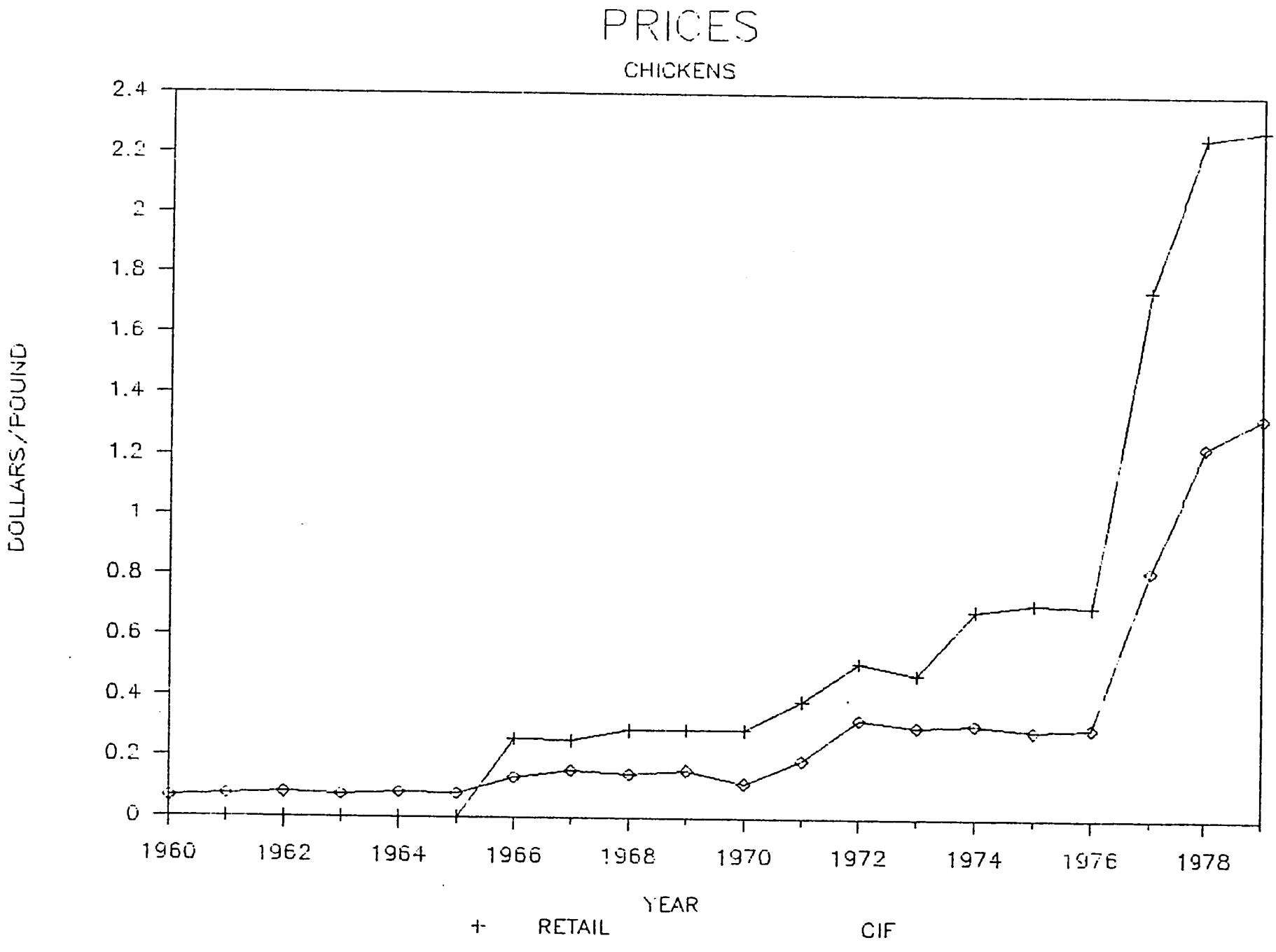


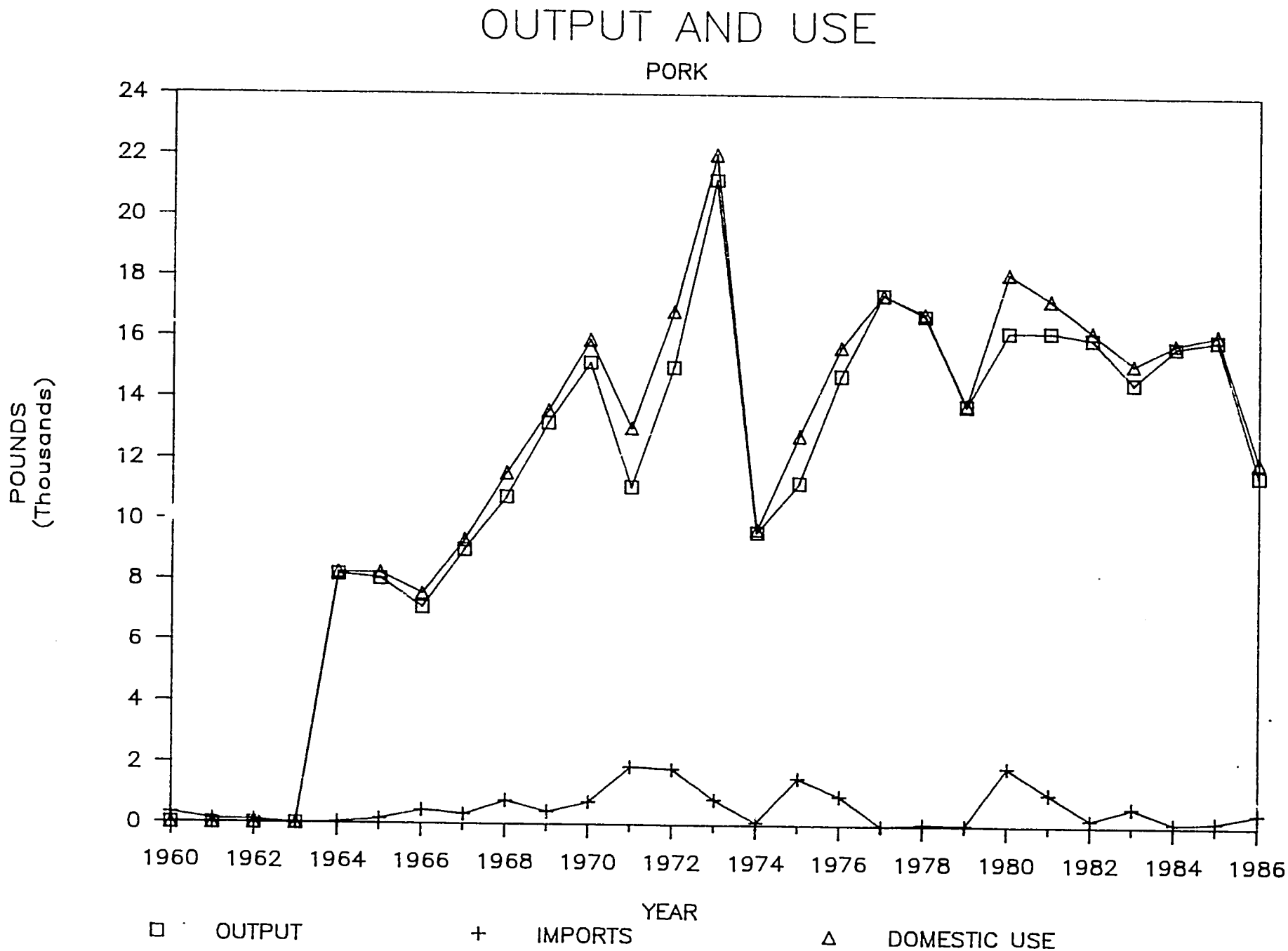

PRICES
BEEF
DOLLARS/POUND
0
1
2
3
4
5
6
7
8
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
YEAR
FARMGATE
RETAIL

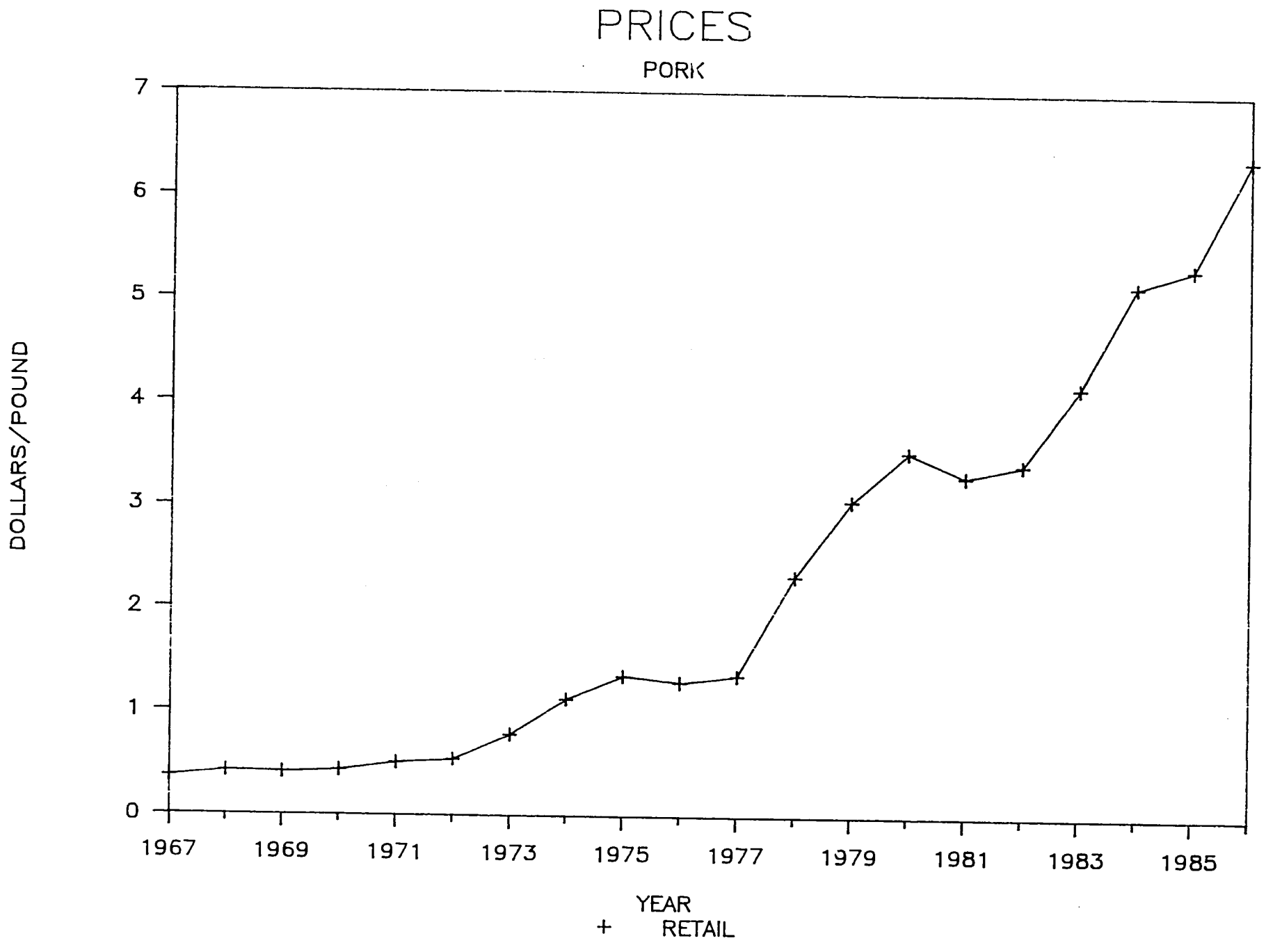
OUTPUT AND USE

CHICKENS



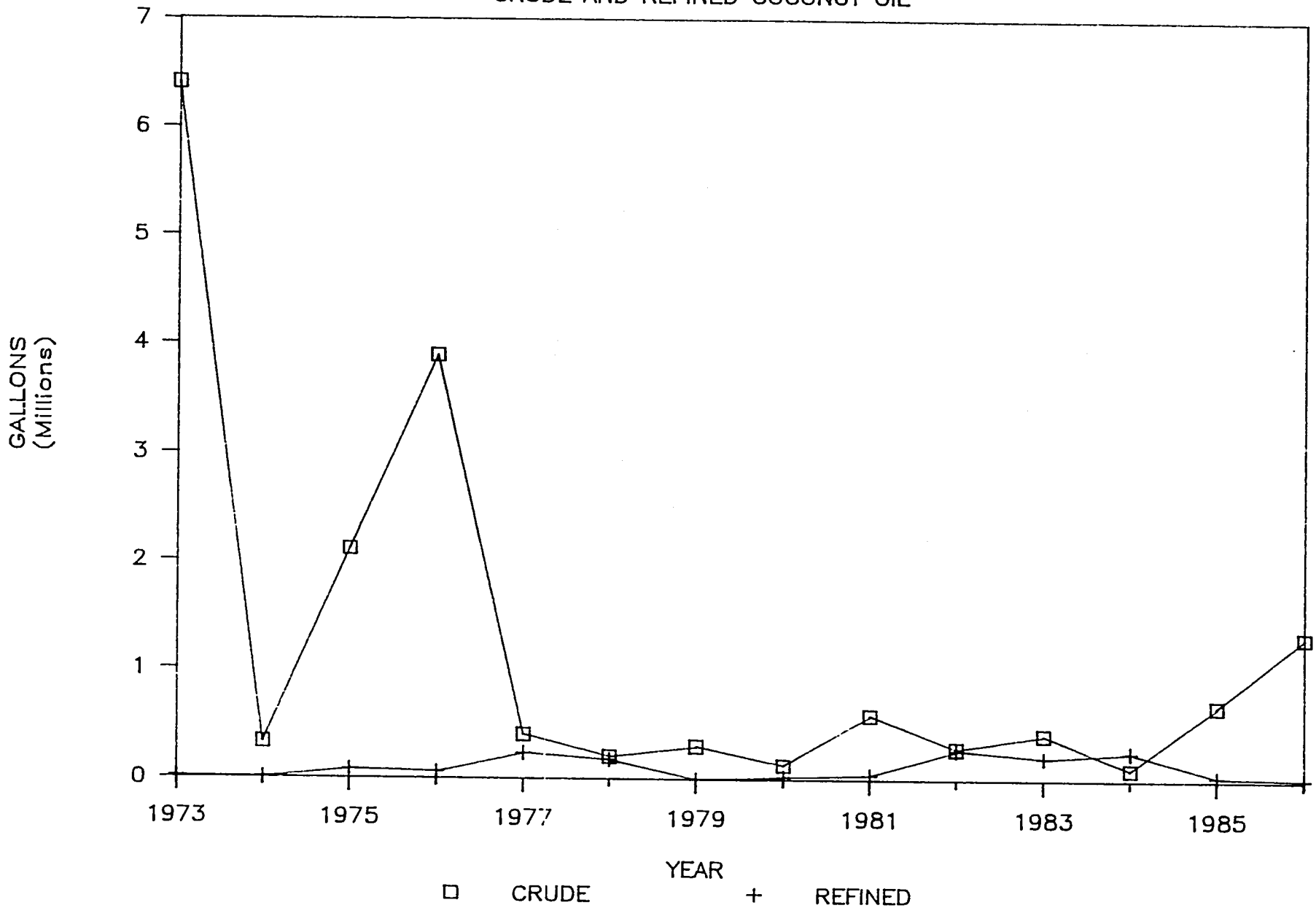

PRICES
CHICKENS
DOLLARS/POUND
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
YEAR
+ RETAIL
CIF

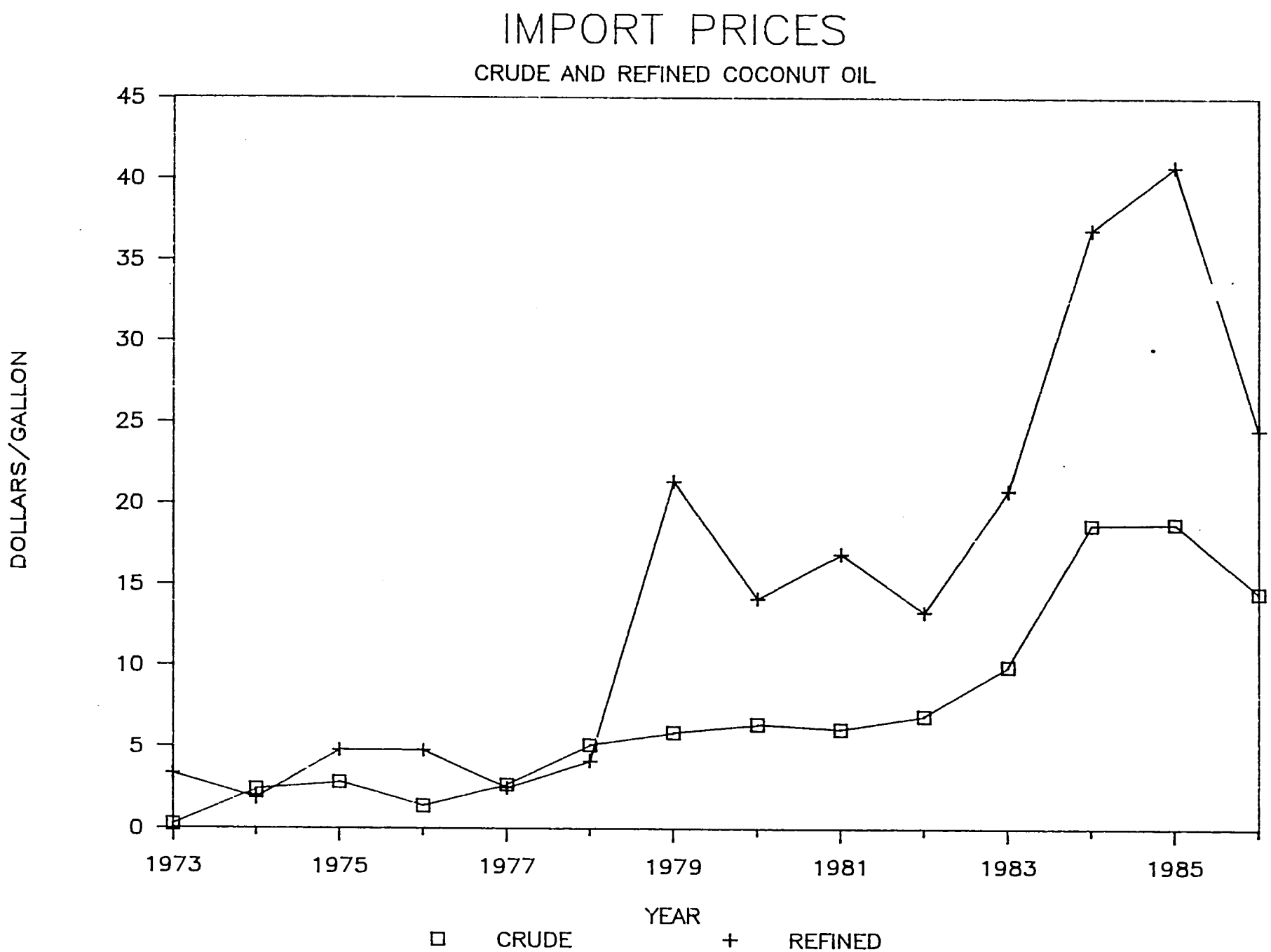

OUTPUT AND USE
PORK
POUNDS
(Thousands)
24
22
20
18
16
14
12
10
8
6
4
2
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
OUTPUT
IMPORTS
DOMESTIC USE

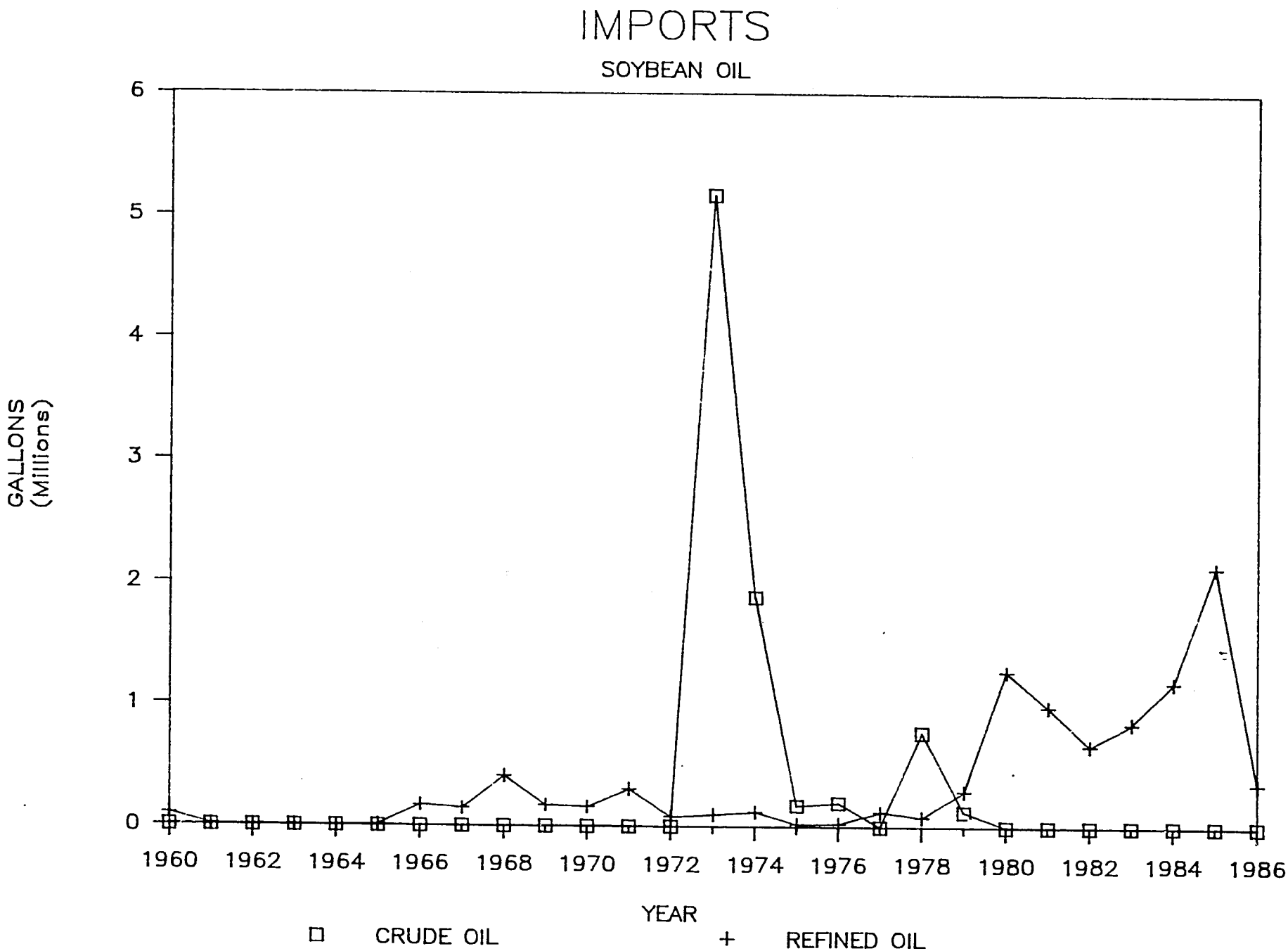

PRICES
PORK
DOLLARS/POUND
0
1
2
3
4
5
6
7
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
YEAR
+ RETAIL

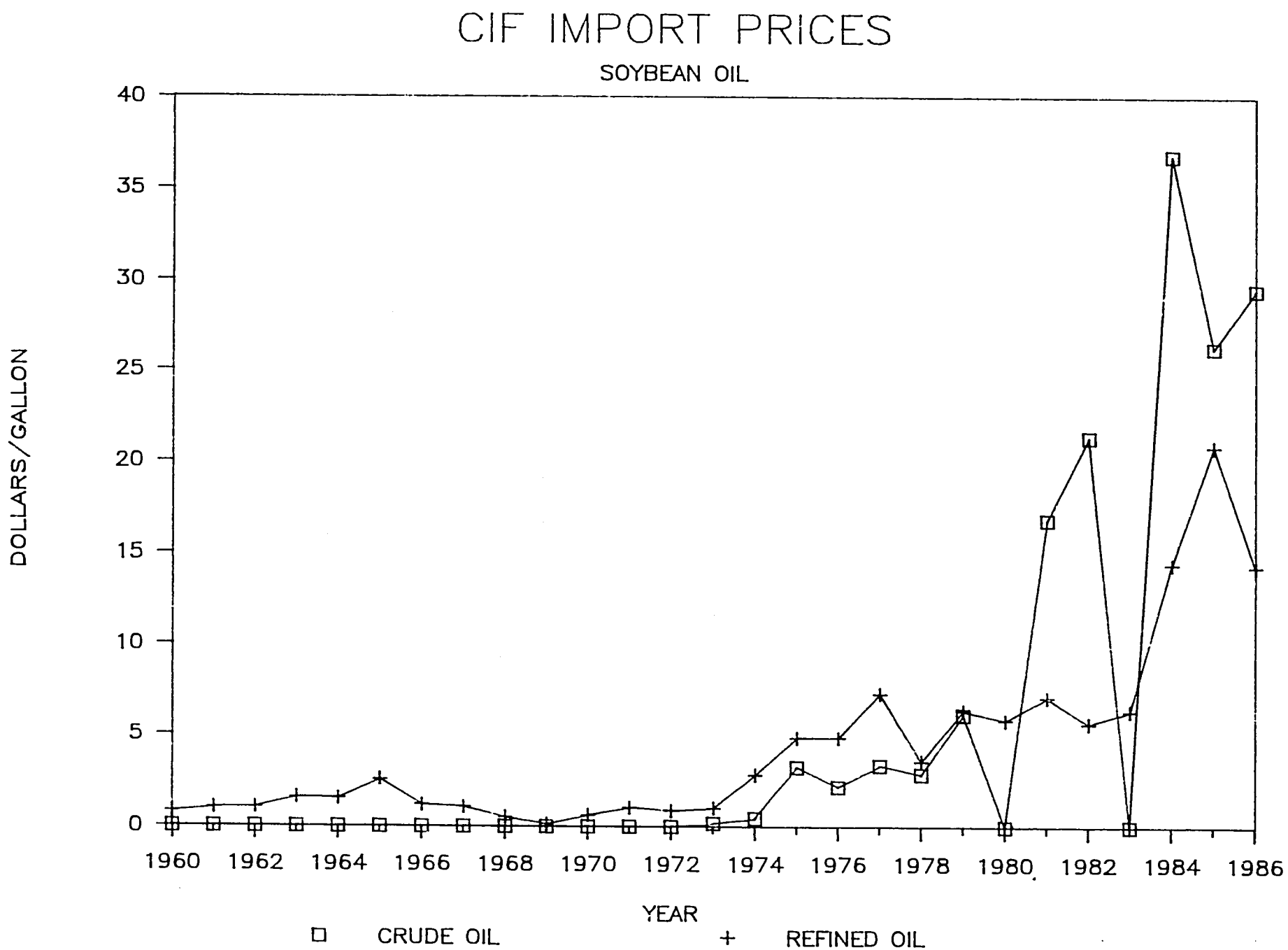
IMPORTS

CRUDE AND REFINED COCONUT OIL



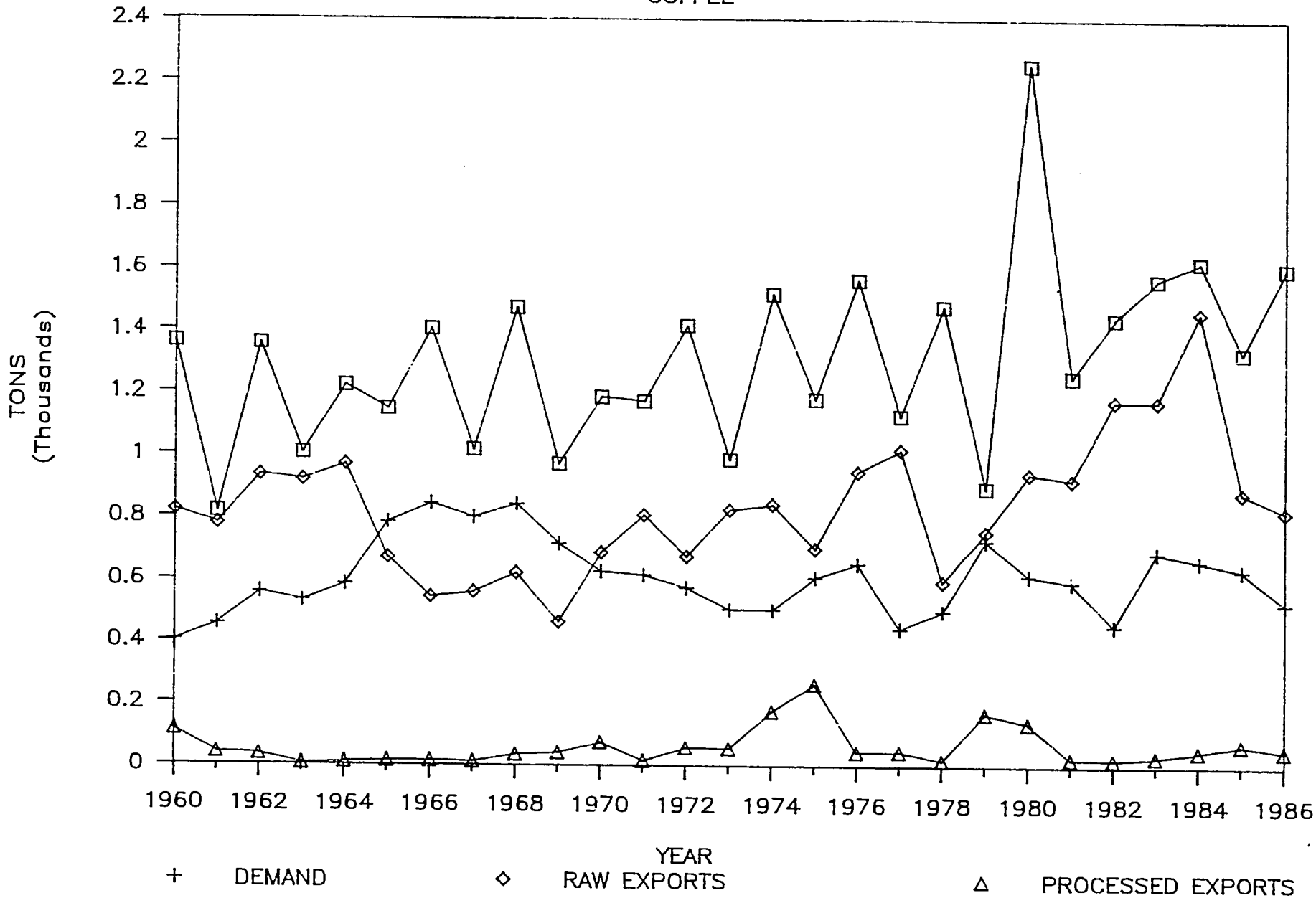

IMPORT PRICES
CRUDE AND REFINED COCONUT OIL
DOLLARS/GALLON
45
40
35
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
YEAR
CRUDE
REFINED

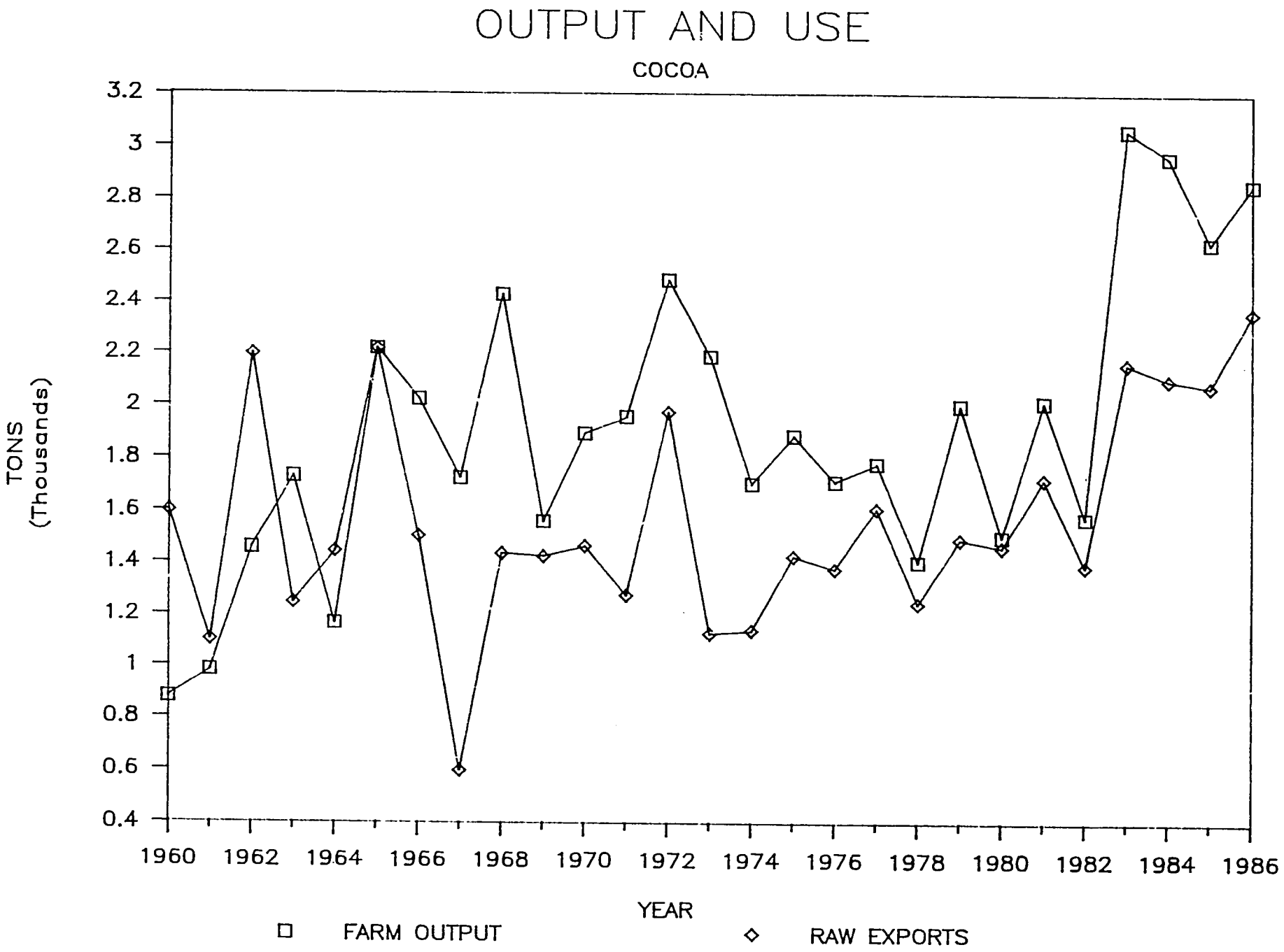

IMPORTS
SOYBEAN OIL
GALLONS
(Millions)
6
5
4
3
2
1
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
CRUDE OIL
REFINED OIL


CIF IMPORT PRICES
SOYBEAN OIL
DOLLARS/GALLON
40
35
30
25
20
15
10
5
0
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
CRUDE OIL
REFINED OIL

OUTPUT AND USE

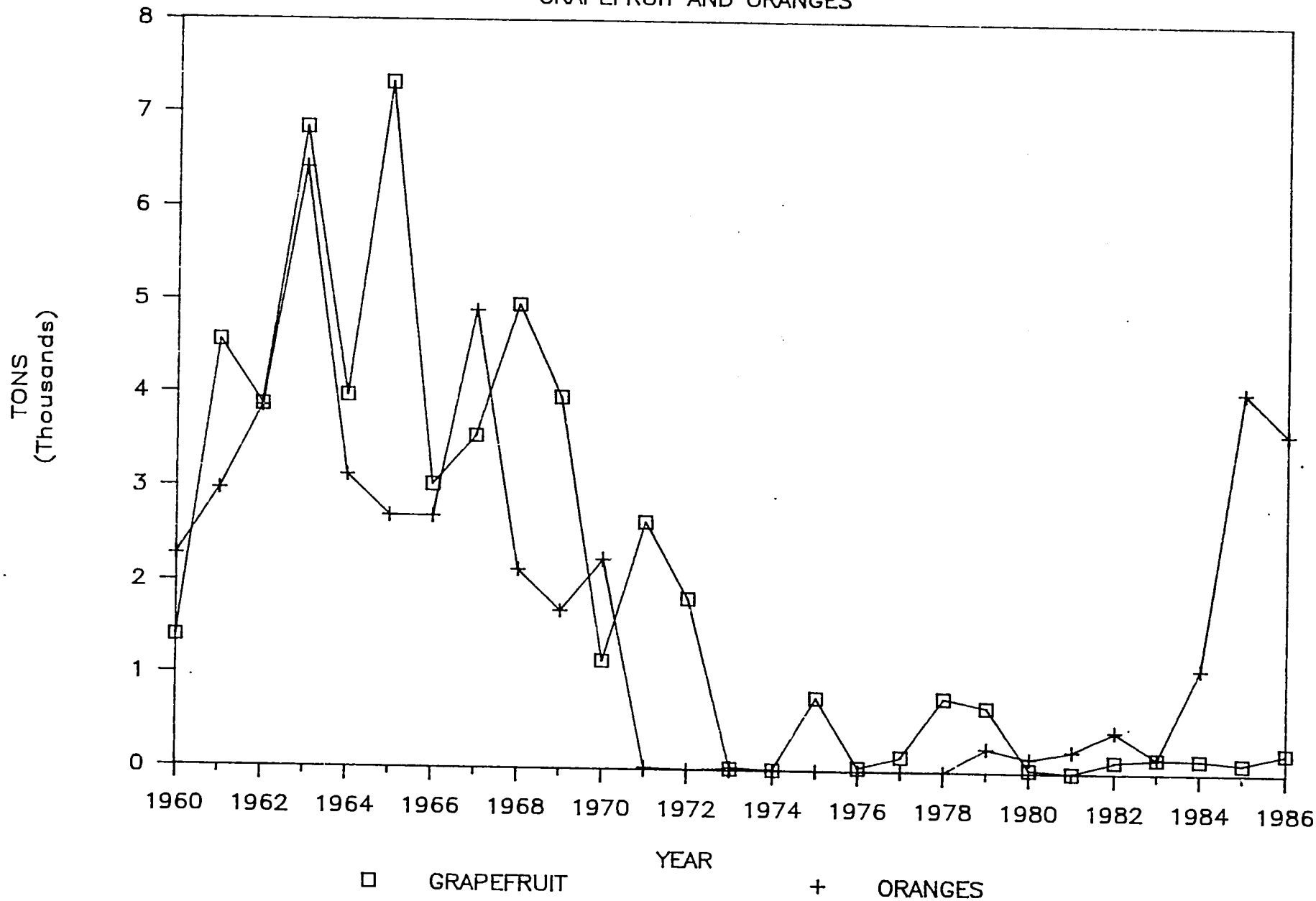
COFFEE

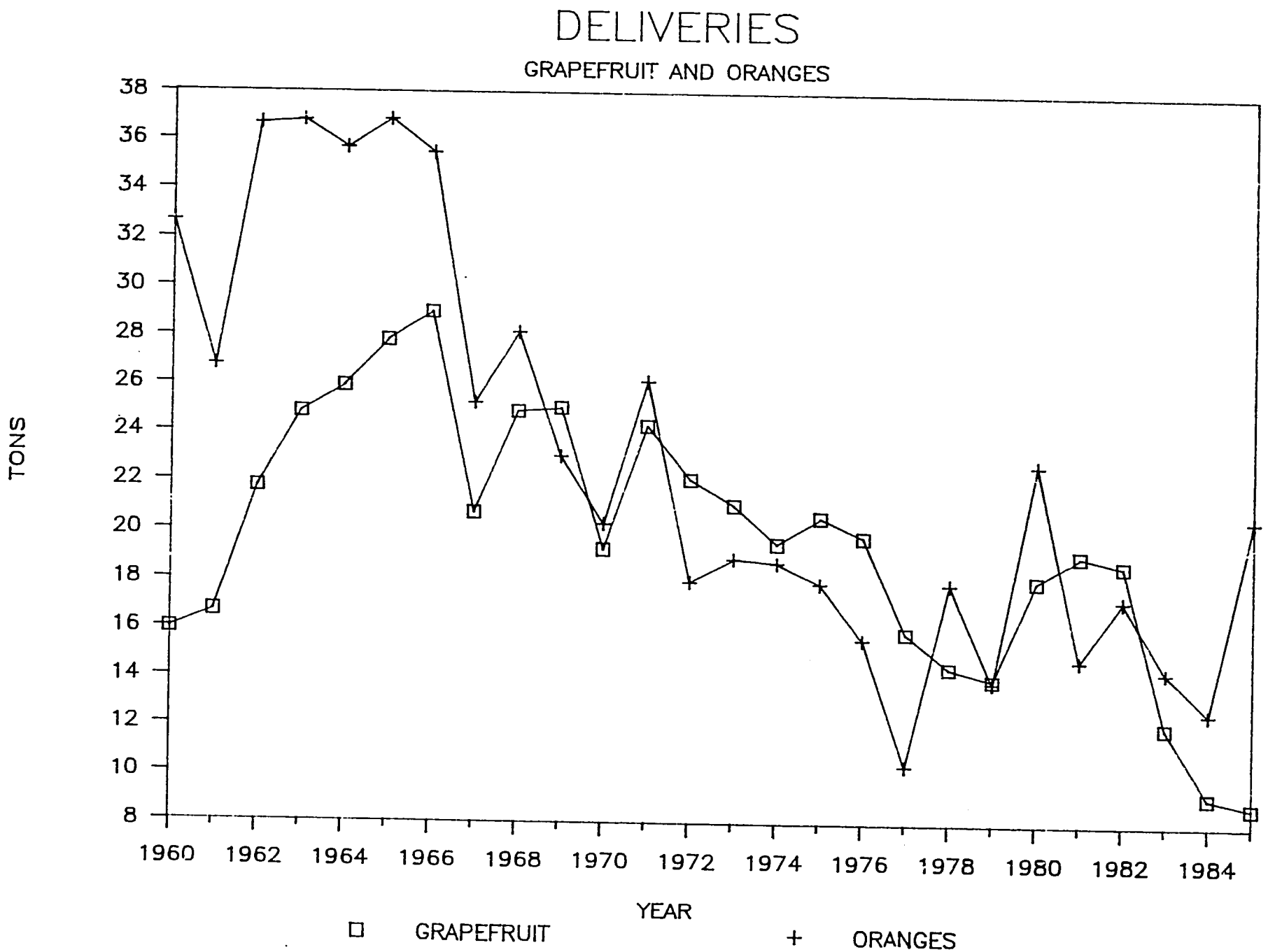
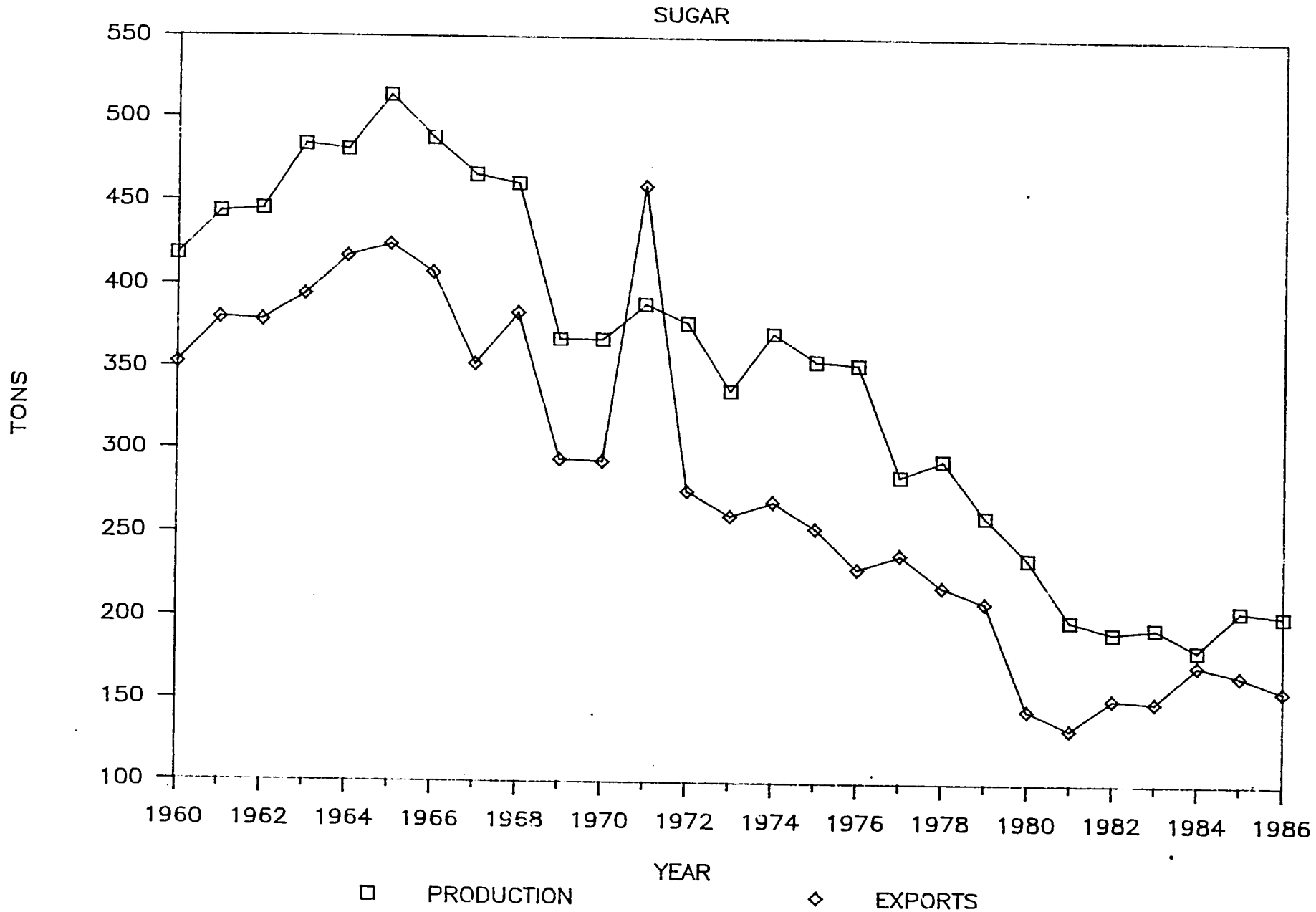



OUTPUT AND USE
COCOA
TONS
(Thousands)
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR
FARM OUTPUT
RAW EXPORTS

EXPORTS

GRAPEFRUIT AND ORANGES




DELIVERIES
GRAPEFRUIT AND ORANGES
TONS
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
YEAR
GRAPEFRUIT
ORANGES

OUTPUT AND USE