SUPPLY RESPONSE OF SUGARCANE FARMERS IN THAILAND

by

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A dissertation submitted in partial fulfilment
of the requirements for the degree of Master of
Agricultural Development Economics in
The Australian National University

September, 1977

D E C L A R A T I O N

Except where otherwise indicated, this dissertation is my own work.

Maneerat Pinyopusarerk

September, 1977

ACKNOWLEDGEMENTS

I wish to acknowledge the large intellectual debt that I owe to my supervisor, Dr John W. Freebairn, of the Department of Economics, Research School of Social Sciences, The Australian National University. His criticisms and comments throughout the study have been extremely useful.

I wish also to thank the Australian Government for offering me the Colombo Plan Scholarship which made this study possible.

In the early period of the study, Professor Thomas H. Silcock's advice and suggestions gave me the insight to deal with the problem under study. I am very grateful to him.

To Dr Mark Saad, of the Department of Economics, Research School of Pacific Studies, The Australian National University, whom I owe more than can be expressed here. His suggestions and assistance in the work are extremely appreciated.

I wish also to express my sincere gratitude to Dr Dan Etherington, of the Department of Economics, Research School of Pacific Studies, who not only gave me useful suggestions for the study, but also provided moral support which was most important for the completion of this study.

My sincere thanks also go to Mr Alan McDonald who made himself available whenever I needed his help and guidance. I am very grateful to him.

Last, but not least, I owe a great deal to my family who not only provided a constant source of love and inspiration, but also data necessary for the study.

Maneerat Pinyopusarerk

ABSTRACT

Sugar is one of the major exports of Thailand and sugarcane is the most important raw material used in producing sugar. Time series data for 8 years from 1967/68 to 1974/75 were analysed to estimate a supply response function for sugarcane farmers in 4 regions of Thailand, viz. Central, Eastern, Northern and North-eastern regions. A priori, farmers' decisions on the sugarcane planted area were expected to be influenced by relative expected profitability per rai of sugarcane, the level of rainfall at the sowing period, the influence of the Sugarcane Farmers' Association, the activity of quotaman, the cost of inputs, and Government intervention.

Relative expected profitability per rai is defined as expected price per tonne of sugarcane times its expected yield per rai (i.e. gross return) divided by the product of expected price per tonne of the competing crop and its expected yield per rai. Expected yield was found by regressing yield over time. Farmers' price expectation formations were specified using the Nerlovian Expectation and the Naive models.

Due to unavailability and unreliability of data, many variables were inevitably dropped. The general model was simplified and adjusted. Good fits, therefore, were not obtained. However, it was found from the study that farmers in two regions, viz. Eastern, and North-eastern regions have an inelastic supply response function. It is only farmers in the Northern region which have an elastic supply response function ranging from 2.00 to 5.52 depending on differing expectation models and the use of differing techniques.

Policy recommendations, consequently, were not made because of the inadequacy of the results obtained.

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CHAPTER 1

INTRODUCTION AND SETTING

1.1 The Importance of Agriculture in the Thai Economy

The Thai economy is based on agriculture. Agriculture is the most important source of income and employment for the majority of the Thai people. The percentage share of employment (of people of 15 years of age and over) in agriculture in 1960 was 81.6 per cent[1] but in 1969 it had decreased to 78.3 per cent.[2]

Table 1.1.1 shows the percentage of share of GDP classified by industrial origin from 1963 to 1974.

It can be seen that the share of agriculture dropped from 36.08 per cent in 1963 to 27.86 per cent in 1971. Since then it has increased; however, a trend cannot be readily identified due to the short period under consideration (i.e. only 4 years from 1971 to 1974). Agricultural products constitute the bulk of the merchandise exports of the country. In 1968 and 1969 more than 70 per cent of export revenue was earned through the sale of agricultural products abroad. In 1964, revenue from the rice premium system yielded 12.4 per cent of Government revenue but in 1970 it fell to 2.9 per cent.

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1 1960 Population Census.

2 Labour Force Survey 1969.

TABLE 1.1.1

SHARE OF GDP CLASSIFIED BY INDUSTRIAL ORIGIN

Industrial Origin \ Year	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Agriculture	36.08	33.49	34.85	36.50	32.47	31.51	31.91	28.53	27.86	30.42	33.91	31.93
Mining and Quarrying	1.20	1.67	2.08	1.92	1.90	1.80	1.89	2.03	2.06	1.78	1.34	1.77
Manufacturing	14.18	13.98	14.21	13.72	14.84	14.99	14.69	15.93	17.56	17.28	17.01	17.46
Construction	5.33	5.60	5.58	6.00	6.83	6.97	6.60	6.08	5.09	4.42	3.88	4.03
Electricity	0.63	0.71	0.80	0.88	1.00	1.11	1.19	1.20	1.32	1.38	1.24	1.05
Transport	7.03	7.32	7.09	6.24	6.29	6.24	6.09	6.28	6.50	6.39	5.81	5.75
Wholesale	16.25	18.01	16.51	16.82	17.53	17.29	17.53	19.06	17.74	17.12	18.27	20.04
Banking	2.39	2.56	2.63	2.78	3.17	3.46	3.69	4.14	4.34	4.27	4.09	4.49
Ownership	2.63	2.56	2.44	2.16	2.15	2.07	1.96	2.01	2.13	1.95	1.63	1.53
Public Administration	4.63	4.42	4.26	3.76	3.96	4.25	4.26	4.51	4.63	4.44	3.86	4.04
Services	9.65	9.67	9.55	9.12	9.85	10.30	10.19	10.23	10.76	10.55	8.95	7.90

Source: National Accounting Office, NEDB.

> "As a starting point it can be assumed that Thai agriculture produces the raw materials for the following industries: food, beverages, tobacco, wood, furniture, leather and rubber. These seven identical branches produced around fifty per cent of the total GDP originating from manufacturing in 1968 and 1969. Of course, these industries import some of the raw materials they use. However, this seems to be more than compensated for by the fact that agriculture supplies part of the raw material for the textiles industry. Thus, it appears safe to state that agriculture produces the raw materials for at least fifty per cent of Thailand's industrial production."[3]

Table 1.1.2 shows the findings of the study conducted by the NEDB, the "Rural Manpower Utilization Study", in 1969-1970 in four project areas - Ayuthaya, Chiangmai, Nam Phong and Phu Wieng.

TABLE 1.1.2

CONSUMPTION EXPENDITURES: CASH AND KIND (%)

Project Area	Food		Non-Food		Total	
	Cash	Kind	Cash	Kind	Cash	Kind
Ayuthaya	64	36	99	1	83	17
Chiangmai	43	57	75	25	55	45
Nam Phong	19	81	90	10	47	53
Phu Wieng	12	88	90	10	43	57

Source: Friedrich W. Fahs and Jan Vingerhoets "Rural Manpower, Rural Institutions and Rural Employment in Thailand", Manpower Planning Division, NEDB, Bangkok, 1972.

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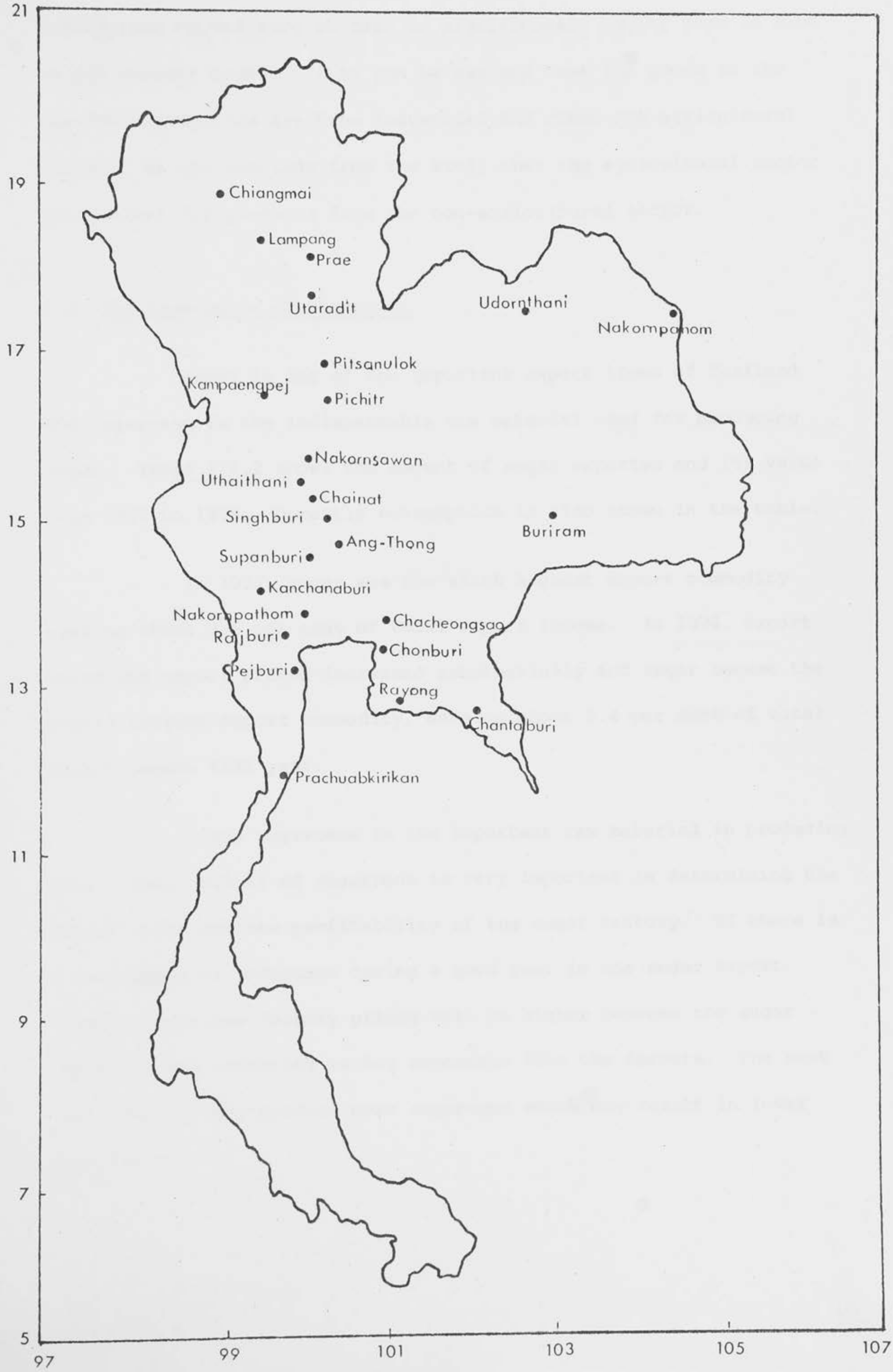
3 Op. cit., p. 3.

MAP 1.2.1

MAP DEPICTING SUGARCANE CENTRES IN THAILAND



It can be observed that in the non-food categories, the consumption expenditure in cash is significantly higher than in kind in all project areas. If it can be assumed that the goods in the non-food categories are from industrial and other non-agricultural sectors, we can conclude from the study that the agricultural sector is a market for products from the non-agricultural sector.

1.2 The Importance of Sugarcane

Sugar is one of the important export items of Thailand and sugarcane is the indispensable raw material used for producing sugar. Table 1.2.2 shows the amount of sugar exported and its value from 1957 to 1975. Domestic consumption is also shown in the table.

In 1972, sugar was the sixth highest export commodity earning about 3.6 per cent of total export income. In 1974, export sales and export prices increased substantially and sugar became the fourth largest export commodity, earning about 8.4 per cent of total export income that year.

Since sugarcane is the important raw material in producing sugar, availability of sugarcane is very important in determining the export value and the profitability of the sugar factory. If there is a low supply of sugarcane during a good year in the sugar export market, sugarcane factory prices will be higher because the sugar factories are competing to buy sugarcane from the farmers. The next year, farmers may produce more sugarcane which may result in lower cane prices.

Table 1.2.3 compares the price of sugarcane and sugar,[4] and the quantity and area of sugarcane produced from 1961-1962 to 1973-1974. It can be seen that the two prices are closely related. When the sugar price falls, the sugarcane price falls and vice versa; this relationship holds except for the two periods, i.e. 1965-1966 and 1972-1973 when the price of sugar rose but the price of sugarcane fell (1965-1966) and in 1972-1973 when the price of sugar fell but the price of sugarcane rose. This is illustrated in Figure 1.2.1.

Sugarcane is grown in all regions except the southern part of Thailand. Thailand has 72 provinces altogether but the sugarcane centres are in the following provinces:

Central Region

1. Kanchanaburi
2. Rajburi
3. Nakornpathom
4. Supanburi
5. Singhburi
6. Ang-Thong
7. Uthaithani
8. Chainat
9. Pejburi
10. Prachuabkirikan

Northern Region

1. Chiangmai
2. Lampang
3. Utaradit
4. Kampaengpej
5. Pitsanulok
6. Pichitr
7. Nakornsawan

Eastern Region

1. Chonburi
2. Rayong
3. Chantaburi
4. Chachoengsao

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4 Sugar price cannot be compared with that of ISA and domestic because sugar sold through ISA is raw sugar whereas sugar sold domestically is white sugar. There are no statistics available on domestic price of raw sugar.

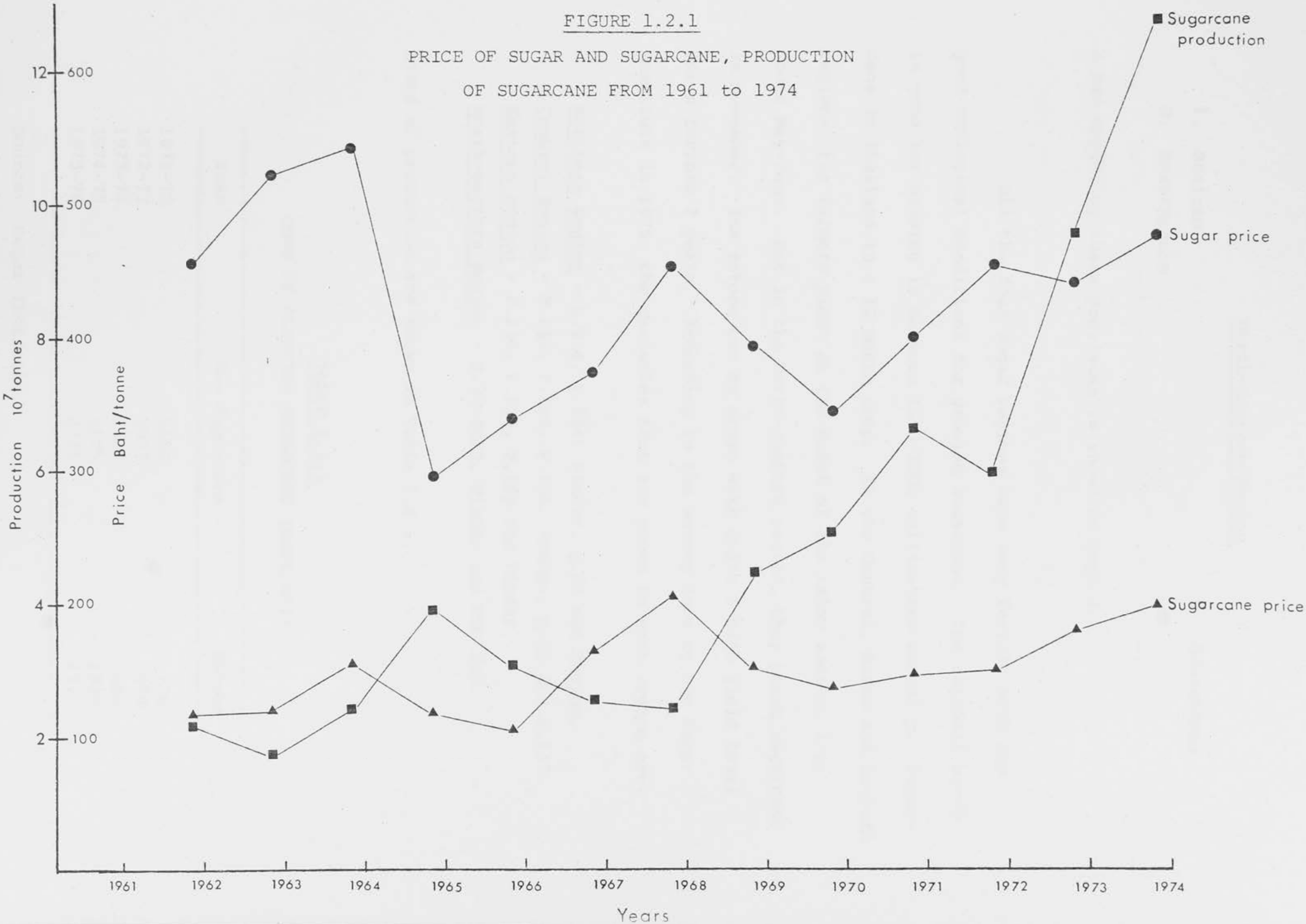

FIGURE 1.2.1

PRICE OF SUGAR AND SUGARCANE, PRODUCTION OF SUGARCANE FROM 1961 to 1974

North-Eastern Region

1. Buriram
2. Nakornpanom
3. Udornthani

A map depicting these provinces is shown on page 4.

All the four sugar regions have very fertile soil and good ecological conditions for growing sugarcane. The rainfall which is good for growing is between 1500-2000 millimetres annually. Sugarcane in Thailand is a 12 month crop. In the Central, North and Eastern regions, the farmers plant at the onset of the rainy season, i.e. about May-June. But in the North-eastern region, they plant sugarcane in November. Its ratoon can be grown with quite a high yield level for a further 2 years. According to the survey done by the Sugar Institute in 1975, the varieties that are grown in each region are:

Northern Region - L.T.4, F.144, Pindar, Q.83 and Trojan.
Central Region - F.140, F.148, F.154, Pindar, Q.83 and F.137.
Eastern Region - F.134, F.153, F.148 and Pindar.
North-eastern Region - H.38-2915, Pindar and NCO.310.

Costs of production are shown in Table 1.2.1.

TABLE 1.2.1

COST OF PLANTING SUGARCANE (BAHT/RAI)

Year	New Sugarcane	Ratoon
1971-72	1162	728
1972-73	1037	659
1973-74	1398	682
1974-75	2105	1330
1975-76	2335	1370

Source: Sugar Institute.

The increase in cost is mainly in the payment of seedlings. The seedling cost in 1975-76 was twice that in 1974-75 and 4 times that in 1971-72. Interest paid by farmers also increased from 50 baht/rai in 1971-72 to 165 baht/rai in 1975-76. Transport cost increased from 34 baht per tonne in 1971-72 to 60 baht per tonne in 1975-76. The labour cost for applying fertilizer also changed markedly from 70 baht per rai in 1971-72 to 250 baht per rai in 1975-76.

TABLE 1.2.2

AMOUNT AND VALUE OF SUGAR EXPORTED

Year	Amount Exported (Tonnes)	Value of Exports (Millions of Baht)	Domestic Consumption (Tonnes)
1957	3,541	6	73,087
1958	82	-	88,626
1959	450	1	96,289
1960	5,723	8	119,475
1961	1,537	3	125,077
1962	43,019	46	81,945
1963	52,823	122	117,854
1964	48,908	211	233,067
1965	85,834	100	184,317
1966	54,858	82	233,726
1967	15,013	37	238,804
1968	52	-	324,459
1969	16,102	47	357,559
1970	56,248	94	364,680
1971	174,571	382	312,302
1972	407,501	1,264	362,316
1973	275,405	1,161	382,298
1974	443,847	3,757	400,000
1975	595,434	5,696	n.n.

Source: Department of Customs.

TABLE 1.2.3

PRICE OF SUGARCANE AND SUGAR,
AREA PLANTED TO SUGARCANE AND PRODUCTION
(1961-62 TO 1973-74)

Year	Area Planted (Rai)*	Production (Tonne)	Sugarcane Price (Baht/tonne)	Retailed Sugar Price (Baht/tonne)
1961-62	441,334	2,195,853	118.22	454
1962-63	344,982	1,694,533	119.80	521
1963-64	452,000	2,387,185	153.98	542
1964-65	532,000	3,912,788	117.87	296
1965-66	523,000	3,044,850	102.87	337
1966-67	361,379	2,534,660	161.18	370
1967-68	447,777	2,379,430	203.65	452
1968-69	646,243	4,399,067	150.97	391
1969-70	738,583	5,102,268	136.22	341
1970-71	861,806	6,585,861	144.90	399
1971-72	872,494	5,925,566	150.45	453
1972-73	1,133,439	9,512,794	179.72	439
1973-74	1,616,304	12,694,491	199.64	473

Source: Sugar Institute.

* 1 hectare = 6.17 rais

TABLE 1.2.4

SHARE OF SUGARCANE, MUNGBEAN, CASSAVA, RICE IN GDP ORIGINATING FROM CROPS (%)

(1962-63 TO 1974-75)

Year	Sugarcane	Mungbean	Cassava	Rice	Others
1962-63	2.87	1.39	2.31	49.35	44.08
1963-64	2.31	1.11	3.07	44.71	48.80
1964-65	1.28	0.97	2.34	50.41	45.00
1965-66	1.35	0.99	2.28	56.11	39.27
1966-67	1.94	1.22	2.05	51.97	42.82
1967-68	2.29	1.12	1.97	49.35	45.27
1968-69	2.27	1.02	2.23	44.87	49.93
1969-70	3.21	1.54	3.55	35.84	55.86
1970-71	3.92	2.06	4.31	38.64	51.07
1971-72	4.34	1.20	4.11	42.68	47.67
1972-73	3.85	1.48	3.16	48.28	43.23
1973-74	5.98	1.12	3.78	45.88	43.24
1974-75	5.92	1.31	3.98	45.18	43.61

Source: National Income Account, NEDB.

Table 1.2.4 shows the sugarcane contribution to GDP along with that of its competing crops from 1962-63 to 1974-75. It can be observed that its contribution increases quite substantially over the decade.

1.3 The Importance of Other Competing Crops

1.3.1 Mungbean

Mungbean is another important economic crop in Thailand. In 1970, the total planted area was 1.5 million rais, and production was 148,500 tonnes. Mungbean exports were 41,036 tonnes at a value of 124 million baht. In 1975, production increased to 270,000 tonnes, of which 53,149 tonnes were exported, the value of which was 266.2 million bahts.

Unlike sugarcane, mungbean can be processed into many products like transparent vermicelli, beansprout and other kinds of desserts. Furthermore, mungbean root can convert nitrogen in the air into fertilizer which helps to maintain fertility in the soil, thus saving the cost of fertilizer.

Nakornsawan province in the central region is the most important province growing mungbean. Mungbean can be grown 3 times a year at the onset of the rainy season, at the end of the rainy season between August and September, and between January and February. It takes only 60-90 days to mature. Therefore, farmers can obtain returns more quickly from mungbean that from sugarcane.

Mungbean's share in the GDP originating from crops is shown in Table 1.2.4. Unlike sugarcane, it shows a relatively constant share.

1.3.2 Cassava

Cassava can be processed into flour, sago and other desserts, glue and alcohol. It can also be processed into animal feeds which are exported, earning foreign exchange. In 1974, the product of cassava which was exported was valued at 3,825 million bahts. Table 1.3.2.1 shows the value and percentage of cassava product exports from 1971 to 1975.

TABLE 1.3.2.1

VALUE OF CASSAVA PRODUCT EXPORTED

Year	Shredded		Pellet		Flour		Total	
	Value	%	Value	%	Value	%	Value	%
1971	2,469	0.20	974,992	79.13	254,608	20.67	1,232,069	100
1972	2,150	0.14	1,307,490	84.60	235,943	15.26	1,545,583	100
1973	25,116	0.99	2,109,872	83.39	395,029	15.62	2,530,017	100
1974	143,580	3.75	2,911,304	76.11	770,272	20.13	3,825,157	100
1975*	118,399	3.25	3,181,916	87.43	339,218	9.32	3,639,533	100

Source: Department of Customs.

* January-October figure.

In 1974/75, Thailand was the sixth largest cassava producer in the world market, producing 3.8 million tonnes. The largest producer in that year was Brazil, followed by Indonesia, Zaire, Nigeria and India.

Table 1.2.4 shows the share of cassava in the GDP originating from crops. This share remained relatively stable from 1963 to 1975.

1.3.3 Maize

Maize is increasingly an important export for Thailand. In 1971, the value of maize exported was 2,280 million bahts thus becoming the third most important export product of Thailand, behind rice and rubber. Maize is expected to become even more important, not only for export, but also for domestic consumption by livestock and humans. In 1975, the export value increased to 5,615 million bahts.

Maize is basically an upland or dryland crop and the good months for planting it in Thailand are May and June of each year (i.e. at the onset of the rainy season) although some areas can be planted during October and November.

Maize centres are in 34 provinces, most of which are in the Central region. The share of maize in the GDP originating from crops includes that of sorghum as they are calculated together.

1.3.4 Rice

Rice has been and will always be an important food crop in Thailand because it is a staple food. Table 1.2.4 shows its share in the GDP originating from crops from 1963 to 1975. Its share has been about one half of the total GDP originating from crops.

Rice can be grown twice a year. There are many varieties that can be grown in Thailand and prices of rice vary accordingly. The majority of rice is grown in the central region where the land is a flat lowland suitable for growing.

Table 1.3.3.1 indicates the share in total export value of the 5 crops that were exported during 1962-1975.

It can be observed that rice has declined in its relative importance. While the share of rice exported declined from 34.00 per cent in 1962 to 11.52 per cent in 1975 that of sugar increased significantly from 1.54 per cent in 1962 to 12.76 per cent in 1975. The share of the other three crops did not vary significantly.

TABLE 1.3.3.1

THE SHARE OF THE FIVE CROPS AND THEIR PRODUCTS IN TOTAL EXPORT VALUE (%)

Year	Rice	Cassava	Mungbean	Maize	Sugar	Others
1962	34.00	4.44	0.65	5.41	1.54	53.96
1963	35.38	4.54	0.61	8.80	1.42	49.25
1964	35.57	5.29	0.68	11.24	1.89	45.33
1965	33.49	5.22	0.78	7.75	1.07	51.69
1966	27.96	4.50	0.56	11.01	0.77	55.20
1967	32.85	5.12	0.48	10.10	0.55	50.90
1968	27.60	5.65	0.56	12.68	0.12	53.39
1969	20.00	5.95	0.92	12.00	0.54	60.59
1970	17.04	8.28	0.89	13.33	2.75	57.71
1971	16.84	7.17	0.78	13.23	2.71	59.27
1972	19.73	6.88	0.64	9.28	6.03	57.44
1973	11.15	7.87	0.65	9.21	4.60	66.52
1974	19.49	7.62	0.53	11.85	8.54	51.97
1975	11.52	9.49	0.49	11.78	12.76	53.96

Source: Agricultural Statistics of Thailand Crop Year 1975/76. Division of Agricultural Economics. Office of the Under-Secretary of State, Ministry of Agriculture and Co-operative, Bangkok, Thailand, No. 54, 1976.

The index number of value of the five crops shows that sugarcane increased markedly after 1967. The second highest increase was for maize, followed by rice, cassava and mungbean respectively.[5]

As for the index number of price of the five crops in the same period (i.e. 1967-1975), maize shows the highest increase, closely followed by sugarcane, and then rice, mungbean and cassava.[6]

As for the index number of production of the five crops, sugarcane increased substantially over the same period, followed by cassava, maize, rice and mungbean.[7]

Table 1.3.3.2 shows changes in areas planted to the five crops from 1962 to 1975.

TABLE 1.3.3.2

CHANGE IN AREA PLANTED TO THE FIVE CROPS
(RAI)

Year	Maize	Rice	Mungbean	Cassava	Sugarcane
1962/63					
1963/64	562	61	320	108	296
1964/65	-837	-357	2	-219	82
1965/66	156	89	121	-19	-131
1966/67	479	5,493	97	177	-105
1967/68	567	-4,842	-20	66	157
1968/69	112	3,561	420	186	202
1969/70	-515	2,227	47	127	-398
1970/71	932	-560	196	210	123
1971/72	1,188	203	-570	-19	3
1972/73	-137	-1,112	361	709	268
1973/74	941	6,339	173	581	483
1974/75	579	-2,381	-164	376	319
1975/76	451	5,713	-271	28	509

Source: Op. cit.

5 Division of Agricultural Economics, Ministry of Agriculture and Co-operative.

6 Op. cit.

7 Op. cit.

1.4 Specific Objectives of the Study

There is little economic research which has been done on the production and supply response of sugarcane in Thailand. The problem under study here is how sugarcane area planted varies with relative gross return (i.e. price times yield) per rai when a changing structure and other economic variables are accounted for over the period 1968-1975. In addition, it is possible that the estimated supply functions may be used in formulating and recommending economic policy if the results obtained are adequate. The central hypothesis of the study is that Thai sugarcane farmers respond positively and rationally to changes in relative gross returns and other economic variables, once the effects of a changing structure and environment[8] are accounted for.

1.5 Outline of the Study

This study will focus attention on sugarcane production in the provinces which comprise the sugarcane growing centre, as listed earlier. Following this introductory chapter, supply studies and supply response models which have been applied to analyses of sugarcane in other countries, as well as supply response models on other crops in Thailand, are reviewed in Chapter 2.

In Chapter 3, the way in which sugarcane price is determined is examined. An understanding of the quota system is necessary

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8 Here "structure and environment" means before and after the establishment of the sugarcane farmers' association; and before and after government intervention.

before a discussion on the price determination process. Other important aspects of sugarcane farmers and contracts other than price are also examined.

Chapter 4 provides a review of some theoretical models of perennial crops supply response. By accumulating information from the previous four chapters, the general model of supply response of sugarcane farmers will be set up.

Chapter 6 considered the availability and limitations of the data, the results of which lead to simplification and adjustment of the model stated in Chapter 5. Section 6 in this chapter reports the results obtained from the regression analyses. A summary of the results is reported.

Finally, in Chapter 7, summary and conclusion will be made.

CHAPTER 2

REVIEW OF LITERATURE

The objective of this chapter is to firstly review some of the literature on supply estimation of sugarcane, and secondly to review that on supply estimation of other crops in Thailand.

2.1 Supply Estimation of Sugarcane

Most of the studies of supply estimation of sugarcane have been carried out in India. R. Krishna[1] developed a model, based on the Nerlovian adjustment model.

$$X_t^* = a + b\,P_{t-1} + c\,Y_{t-1} + g\,Z_{t-1} + h\,W_t + u_t \quad (1)$$

$$X_t - X_{t-1} = \beta(X_t^* - X_{t-1}) \quad (2)$$

where

X_t^* is the standard irrigated acreage that farmers plan to plant in the year t.

X_t is the standard irrigated acreage actually planted to the crop in the harvest year t; "standard irrigated" acreage of the crop means the irrigated acreage plus the un-irrigated acreage multiplied by a standardisation factor.

P is the relative price of the crop, i.e. the post harvest price of the crop deflated by an index of the post-harvest prices of the alternative crops.

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1 Krishna Raj, "Farm Supply Response in India-Pakistan: A Case Study of the Punjab Region", Economic Journal, Vol. 73 (September 1963), pp. 477-487.

Y is the relative yield of the crop, i.e. the yield of the crop deflated by an index of the yields of alternative crops.

Z is the total irrigated area in all crops of the season.

W is the rainfall.

u is the error term.

β is the Nerlovian coefficient of "adjustment".

The estimating equation resulting from the first two equations is:

$$X_t = a_0 + b_2P_{t-1} + b_3Y_{t-1} + b_4Z_{t-1} + b_5W_t + b_6X_{t-1} + v_t \quad (3)$$

where:

$a_0 = a\beta$, $b_2 = b\beta$, $b_3 = c\beta$, $b_4 = g\beta$, $b_5 = h\beta$, $b_6 = (1-\beta)$ and

$v_t = \beta\mu_t$

Krishna's study covered cotton, maize, sugarcane, rice, bajra, jowar, wheat, gram and barley over the period 1914-15 to 1945-46 (31 years).

For sugarcane, the estimating equation was specified as:

$$X_t = a_0 + b_2P_{t-1} + b_3P_{t-2} + b_4X_{t-1} + v_t$$

where:

$a_0 = a\beta$, $b_2 = b\beta$, $b_3 = c\beta$, $b_4 = (1-\beta)$ and $v_t = \beta\mu_t$

He felt that the acreage planted in the crop year t is influenced more by the post-harvest price of year t-2 than the post-harvest price of year t-1, for the preparations for plantings of the year t begin even before the sugar season (December-March) of the immediately preceding harvest is over.

His analysis shows that sugarcane has a positive short-run price elasticity of 0.34. The long-run price elasticity is 0.60. In the determination of acreage, it is found that price alone was the important factor. Table 2.1.1 shows the acreage response function and Table 2.1.2 shows the adjustment coefficient and short and long-run elasticities found by his study.

TABLE 2.1.1

ACREAGE RESPONSE FUNCTION FOR SUGARCANE (KRISHNA'S STUDY)

P_{t-1}	P_{t-2}	Regression Coefficient X_{t-1}	R^2
0.72	1.45	0.44	0.44
(0.49)	(0.38)	(0.20)	

(Figures in parentheses are the standard errors.)

Source: R. Krishna, ibid.

TABLE 2.1.2

ADJUSTMENT COEFFICIENT AND SHORT- AND LONG-RUN ELASTICITIES FOR SUGARCANE (KRISHNA'S STUDY)

Adjustment Coefficient		Price Elasticities of Supply: Short-Run	Long-Run	Serial Correlation
0.56	P_{t-1}	0.17	0.30	No
	P_{t-2}	0.34	0.60	

Source: R. Krishna, ibid.

However, this is a false interpretation of the price elasticity of supply. The reported results reproduced here in Table 2.1.2 make little sense and are open to ambiguous interpretation. A more meaningful interpretation is as follows. The estimated function was as follows:

$$X_t = a_0 + b_2 P_{t-1} + b_3 P_{t-2} + b_4 X_{t-1} + v_t$$

By progressive back substitution we obtain the final form of the equation:

$$X_t = a_0 + b_2 P_{t-1} + (b_3 + b_2 b_4) P_{t-2} + (b_3 + b_2 b_4) b_4 P_{t-2} + \ldots$$

$$= a_0 + \sum_{i=2}^{\infty} b_4 (b_3 + b_2 b_4) P_{t-i} + b_2 P_{t-1}$$

Then the following supply price responses can be derived:

$$\frac{\partial X_t}{\partial P_{t-1}} = b_2 = \text{one year response}$$

$$\frac{\partial X_t}{\partial P_{t-2}} = b_3 + b_2 b_4 = \text{second year response}$$

$$\frac{\partial X_t}{\partial P} = b_3 + \frac{b_3 + b_2 b_4}{1 - b_4} = \text{long-run response}$$

By using this progressive back substitution it is found that the long-run elasticity is approximately 0.90 instead of 0.30 and 0.60 reported by Krishna.

The inclusion of P_{t-1} as a variable in the estimating equation, even though Krishna initially hypothesized that farmers are affected more by the post-harvest price of year t-2, reduces the validity of his findings. Furthermore, the relationship between acreage and prices in the previous two periods involves estimation problems when only one equation is used. Interdependence of prices from one time period to the next may result in multicolinearity between these two price variables and hence reduce the precision of the coefficient estimates. This can be overcome by the estimation of two separate equations regressing acreage firstly on price in period t-1 and then on price in period t-2, or combining the two variables to get a two year moving average. The coefficients for P_{t-1} and P_{t-2} will be different when estimated separately, the result of which is different price elasticities both for the short-run and the long-run. Moreover, Krishna does not explain why the relative yield variable Y_{t-1} was dropped.

M.V. George (1965)[2], a research officer in Kerala University, Trivandrum, carried out a study to examine changes in the price structure and acreage in response to the price of various crops, viz. paddy, sugarcane, coconut, cashew nut, rubber and tapioca in Kerala State over the period 1952-53 to 1961-62 (10 years).

He related the two-year average price of each commodity to two-year average prices of all other commodities as follows:

$$X_i = \frac{(P_{it} + P_{it-1})/2}{\sum_{j}^{m}(P_{jt} + P_{jt-1})/2m - (P_{it} + P_{it-1})/2}$$

2 M.V. George, "Impact of Relative Changes in Prices on the Cropping Pattern of Kerala", Indian Journal of Agricultural Economics, Vol. 20, 1965, pp. 48-51.

where:

X_i = relative price of crop i.

P_{it}, P_{it-1} = prices of crop i in period t and t-1

P_{jt}, P_{jt-1} = prices of competing crops in period t and t-1

m = number of competing crops

George classified crops into two non-competing groups, depending on the nature of land suitable for their cultivation.

He simply compared the index of relative change in price and area. Table 2.1.3 indicates changes in relative prices and acreage under selected crops over the period 1952-53 to 1961-62.

TABLE 2.1.3

CHANGES IN RELATIVE PRICES AND ACREAGE UNDER SELECTED CROPS (1952-53/1961-62 - GEORGE'S STUDY)

	No.	Crop	Index of Relative Change in Price	Index of Relative Change in Area
Group A	1	Paddy	104.97	185.16
	2	Sugarcane	102.54	190.38
	3	Coconut	93.02	114.95
Group B	1	Rubber	145.00	200.00
	2	Cashew nut	129.80	125.00
	3	Tapioca	54.00	52.00

Source: M.G. George, ibid.

The table shows that there is a close correspondence between price and acreage. It was found that there has been a slight shift from food crops to cash crops and that the acreage response to price has been positive for most crops. It is the relative increase in price and not the absolute increase which brings about an increase of acreage under a particular crop (i.e. similar findings to those of Krishna). George recommended a price policy which is designed to stabilise the relative prices of food crops in terms of the other agricultural commodities produced in the State and to maintain this stability by constant vigilance and supervision.

The study did not concern itself with the period in between the two periods, i.e. between 1952-53 and 1960-61. He assumes that average acreage planted in the periods is determined by the average relative price in the same periods, which in fact is over-simplifying reality. With some crops, acreage planted may be determined by the previous year's relative price (i.e. a lagged variable) and not by the contemporary price.

K. Subbarao (1969)[3], a lecturer in Economics in the University of Delhi, carried out a farm supply response study on sugarcane in Andhra Pradesh over the period 1952-53 to 1964-65 (12 years). The hypothesis he was testing was whether there was any significant positive association between changes in relative acreage and output on the one hand and relative prices on the other. He used relative price and relative gross income per acre as a proxy for profitability. He regressed relative area, relative output and relative yield of sugarcane with its relative price. The results are indicated in Table 2.1.4.

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3 K. Subbarao, "Farm Supply Response - A Case Study of Sugarcane in Andhra Pradesh", Indian Journal of Agricultural Economics, Vol. 24, 1969, pp. 84-88.

TABLE 2.1.4

RESULTS OBTAINED FROM SUBBARAO'S STUDY

#	Period of Study and Number of Observations	Equation	R^2
I	1952-53 to 1964-65 (12 observations)	$\frac{A^1 t}{A^2 t} = 41.98 + \underset{(0.274)}{0.612^*} \frac{P^1 t-1}{P^2 t-1}$	0.33
II	1953-54 to 1964-65 (11 observations)	$\frac{A^1 t}{A^2 t} = 74.24 + \underset{\underset{N.S.}{(0.300)}}{0.535} \frac{P^1 t-1}{P^2 t-1} - \underset{\underset{N.S.}{(0.34)}}{0.204} \frac{P^1 t-2}{P^2 t-2}$	0.30
III	1952-53 to 1964-65 (12 observations)	$\frac{A^1 t}{A^2 t} = -12.57 + \underset{(0.247)}{0.513^\dagger} \frac{P^1 t-1}{P^2 t-1} + \underset{(0.316)}{0.622^\dagger} \frac{A^1 t-1}{A^2 t-1}$	0.53
IV	1952-53 to 1964-65 (12 observations)	$\frac{O^1 t}{O^2 t} = 80.72 + \underset{(0.28)}{0.429^\dagger} \frac{P^1 t-1}{P^2 t-1}$	0.20
V	1952-53 to 1964-65 (12 observations)	$\frac{Y^1 t}{Y^2 t} = 86.50 - \underset{\underset{N.S.}{(0.126)}}{0.116} \frac{P^1 t-1}{P^2 t-1}$	0.08
VI	1952-53 to 1964-65 (12 observations)	$\frac{A^1 t}{A^2 t} = -31.38 + \underset{(0.27)}{0.595^*} \frac{P^1 t-1}{P^2 t-1} + \underset{(0.64)}{0.79^\ddagger} \frac{Y^1 t-1}{Y^2 t-1}$	0.43
VII	1952-53 to 1964-65 (12 observations)	$\frac{A^1 t}{A^2 t} = -7.68 + \underset{(0.21)}{0.53^*} \frac{I^1 t-1}{I^2 t-1} + \underset{(0.29)}{0.58^\ddagger} \frac{A^1 t-1}{A^2 t-1}$	0.59
VIII	1952-53 to 1964-65 (12 observations)	$\frac{O^1 t}{O^2 t} = 23.95 + \underset{\underset{N.S.}{(0.66)}}{0.827} \frac{Y^1 t}{Y^2 t}$	0.12
IX	1952-53 to 1964-65 (12 observations)	$\frac{O^1 t}{O^2 t} = 11.71 + \underset{(0.134)}{0.824^*} \frac{A^1 t}{A^2 t}$	0.78
X	1952-53 to 1964-65 (12 observations)	$\frac{P^1 t}{P^2 t} = 172.6 + \underset{(0.213)}{0.407^\dagger} \frac{P^1 t-1}{P^2 t-1} - \underset{(0.210)}{0.96^*} \frac{P^1 t-2}{P^2 t-2}$	0.74

(Column # = Serial No. of the Equation)

Note: $\frac{A^1}{A^2}$, $\frac{P^1}{P^2}$, $\frac{O^1}{O^2}$, $\frac{Y^1}{Y^2}$, indicate, respectively, area, price, output and yield of sugarcane, relatively to its competing crop, rice.

(contd. over)

$\frac{I^1}{I^2}$ indicates the aggregate gross relative income per acre of sugarcane

Subscripts t, t-1, etc., refer to the time period.

* shows that the coefficient is significant at 1 per cent level.

‡ shows that the coefficient is significant at 5 per cent level.

† shows that coefficient is significant at 10 per cent level

N.S. means that the coefficient is not significant.

Source: K. Subbarao, ibid.

The explanation for the variation in relative acreage improved when lagged relative acreage was included (in equation III). Using gross income per acre rather than price as the profitability measure resulted in significantly better explanatory power (e.g. compare equations VI and VII with an R^2 of 0.43 and 0.59 respectively).

The inclusion of P_{t-2} in the estimating equation accounted for the fact that the current year's acreage includes the previous year's ratoon, which therefore should respond to price lagged two years. However, the R^2 is lower, his explanation being that the inclusion of P_{t-2} reduced the number of observations by one.

Equation X in the table indicates that the current price is correlated with price in the previous year (P_{t-1}).

From his study, he found that changes in relative acreage under sugarcane in Andhra Pradesh are positively associated with changes in its relative price. However, relative gross return (income) per acre seems to explain better the changes in relative acreage.

Subbarao uses relative acreage instead of absolute acreage, but does not state the reason why he chooses to do so. He also went through a painstaking process of testing the predictive efficiency of various variables such as lagged relative prices, P_{t-1} and P_{t-2} by means of an autoregression. He implicitly assumes that there is no difficulty of adjustment, i.e. the level of acreage desired by farmers is fulfilled (desired acreage equals actual acreage). He applied the Nerlovian Expectation Model, which he did not explicitly spell out, in equations III and VII. This could be either the partial adjustment or the Adaptive Price Expectations Model.

Even though Subbarao could not do anything to solve the ratoon problem, he realized the existence of the problem, resulting in the low value of R^2 obtained in his study, and stated that this can be overcome when there is data on the new planting area and ratoon area every year.

Another study was done by Dayanatha Jha (1970)[4] on the acreage response of sugarcane in the factory area of North Bihar over the period 1912-13 to 1964-65 (52 years). The aim of the study was to investigate the impact of relative price and some non-price variables on sugarcane acreage, and to study changes in the nature and magnitude of the relationship between variables over time. He separated the analysis into three time series to examine changes over time, i.e. from 1912-13 to 1964-65, from 1933-34 to 1964-65, and from 1950-51 to 1964-65. He also regressed from 1912-13 to 1932-33, 1933-34 to 1949-50 and 1950-51 to 1964-65 for a more precise picture of those changes.

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4 Dayanatha Jha, "Acreage Response of Sugarcane in Factory Areas of North Bihar", Indian Journal of Agricultural Economics, Vol. 25, 1970, pp. 79-91.

He adopted the Nerlovian Adjustment Lag Model which is expressed as:

$$A_t^* = a + b_1 P_{t-1} + b_2 Y_{t-1} + b_3 C_t + b_4 W_t + b_5 T_t + b_6 D_t \qquad (1)$$

where:

A_t^* = long-run equilibrium acreage under sugarcane (in thousand acres) in year t.

P_{t-1} = price of sugarcane (and gur) relative to the price of competing crop (wheat) in the preceding period (post-harvest).

Y_{t-1} = yield of sugarcane per acre in the preceding period.

C_t = area under competing crop in period t.

W_t = rainfall during pre-sowing months (October-February) in the period t (in inches).

T_t = time trend

D_t = a dummy variable to pick up the effect of change in the method of estimation of acreage in 1949-50.

Table 2.1.5 indicates the estimated linear acreage response function for sugarcane in different time periods and Table 2.1.6 indicates some additional functions containing significant variables.

Table 2.1.7 shows additional response functions for analysis of changes in relationships over time and Table 2.1.8 indicates estimates of Elasticities obtained for different time periods.

The important finding from this study was that it was not until 1932-33 that prices seem to have a significant positive influence. Before that time period, acreage under other grain crops was the main determinant. Both sugarcane and gur relative prices, exert an identical influence though the former exhibits a trend of being an important explanatory variable only recently. The non-price variables such as lagged yield and pre-sowing rainfall have become significant only recently.

TABLE 2.1.5

ESTIMATED LINEAR ACREAGE RESPONSE FUNCTION FOR SUGARCANE IN DIFFERENT TIME PERIODS

Time Period	Relative Price	Constant	Regression Coefficients							Coefficient of Multiple Deter-mination
			Relative Price in t-1	Cane Yield per Acre in t-1	Cane Acreage in t-1	Wheat Acreage in t	Rainfall (October February) in t	Trend	Dummy	
			P_{t-1}	Y_{t-1}	A_{t-1}	C_t	W_t	T_t	D_t	R^2
1912-13 to 1964-65	Relative gur price	103.5560	50.7662*** (19.0733)	-0.9319 (2.1533)	0.5879*** (0.1225)	-0.2791** (0.1367)	1.6512 (1.7035)	1.8051** (0.7612)	29.4000 (22.5818)	0.8878***
1933-34 to 1964-65		125.6156	81.7155*** (20.8422)	2.5131 (2.3227)	0.3174*** (0.1452)	-0.0427 (0.1500)	3.2487* (1.8300)	-1.8313 (1.1384)	57.0903** (25.2131)	0.6551***
1950-51 to 1964-65		378.5931	209.4967** (87.5043)	5.9281 (3.9711)	0.9757 (0.3927)	-0.0642 (0.2128)	6.1335** (2.5324)	-13.0929* (6.3158)		0.7354**
1933-34 to 1964-65	Relative cane price	128.9455	1066.3629*** (218.8431)	3.5042 (2.0666)	0.2104*** (0.1300)	-0.0729 (0.1353)	3.0359* (1.6409)	-1.6934 (1.0168)	61.2573** (22.9695)	0.7156***
1950-51 to 1964-65		287.7389	2180.6220*** (576.4052)	7.2190* (3.1645)	0.1683*** (0.1916)	0.0137 (0.1679)	5.2982** (1.9488)	-7.5456** (3.0348)		0.8372***

* Significant at 10 per cent
** Significant at 5 per cent
*** Significant at 1 per cent

The null hypothesis for the coefficient of lagged acreage is that it is equal to one. Note: Figures in parentheses are standard errors.

Source: Dayanatha Jha, *ibid*.

TABLE 2.1.6

SOME ADDITIONAL RESPONSE FUNCTIONS CONTAINING SIGNIFICANT VARIABLES

Time Period	Relative Price	Constant	Regression Coefficients							Coefficient of Multiple Deter-mination
			Relative Price in t-1	Cane Yield per Acre in t-1	Cane Acreage in t-1	Wheat Acreage in t	Rainfall (October February) in t	Trend	Dummy	
			P_{t-1}	Y_{t-1}	A_{t-1}	C_t	W_t	T_t	D_t	R^2
1912-13 to 1964-65	Relative gur price	97.8180	46.6940** (18.2029)		0.5566*** (0.1122)	-0.2605* (0.1338)		2.0643*** (0.7066)	23.2193 (21.2435)	0.8854***
1933-34 to 1964-65		107.3094	88.7272*** (19.7954)		0.4083*** (0.1216)		3.7692** (1.7041)	-1.9420* (1.1125)	53.1753** (19.1468)	0.6340***
1950-51 to 1964-65		221.7091	162.0804* (84.3345)		0.8960 (0.3984)		6.0880** (2.5811)	-7.6661 (5.3824)		0.6517**
1933-34 to 1964-65	Relative cane price	101.2725	1072.8925*** (215.3773)	3.7868* (1.9700)	0.2083*** (0.1281)		2.8555* (1.5827)	-1.7615* (0.9945)	53.2354*** (17.2163)	0.7121***
1950-51 to 1964-65		293.0399	2175.5995*** (540.6698)	7.1659** (2.9213)	0.1708*** (0.1786)		5.3155** (1.8270)	-7.5067** (2.8272)		0.8370***

* Significant at 10 per cent
** Significant at 5 per cent
*** Significant at 1 per cent

The null hypothesis for the coefficient of lagged acreage is that it is equal to one. Note: Figures in parentheses are standard errors.

TABLE 2.1.7

ADDITIONAL RESPONSE FUNCTIONS FOR ANALYSIS OF CHANGES IN RELATIONSHIPS OVER TIME

Time Period	Relative Price	Constant	Regression Coefficients: Relative Price in t-1	Cane Yield per Acre in t-1	Cane Acreage in t-1	Wheat Acreage in t	Rainfall (October February) in t	Trend	Coefficient of Multiple Deter-mination	Short run Elasticity with Respect to Price
			P_{t-1}	Y_{t-1}	A_{t-1}	C_t	W_t	T_t	R^2	
1912-13 to 1932-33	Relative gur price	273.0684	-1.9282 (17.9722)	-4.7433 (3.8717)	0.0098*** (0.2748)	-0.3181** (0.1338)	-1.3629 (1.3479)	2.1646*** (0.5684)	0.7171***	Negative
1933-34 to 1949-50		161.6906	74.4834*** (20.5427)	1.3313 (4.3393)	0.0673*** (0.1562)	0.1310 (0.1122)	-1.0449 (2.4386)	-2.0496 (1.4618)	0.7207**	0.2607
1950-51 to 1964-65		378.5931	209.4967** (87.5043)	5.9281 (3.9711)	0.9757 (0.3927)	-0.0642 (0.2128)	6.1335** (2.5324)	-13.0929* (6.3158)	0.7354**	0.6390
1933-34 to 1949-50	Relative cane price	180.3223	763.0454** (253.7703)	1.0917 (4.7623)	0.0923*** (0.1726)	0.0925 (0.1212)	-0.8418 (2.7453)	-2.3721 (1.6103)	0.6630**	0.2765
1950-51 to 1964-65		287.7389	2180.6220*** (576.4052)	7.2190* (3.1645)	0.1683*** (0.1916)	0.0137 (0.1679)	5.2982** (1.9488)	-7.5456** (3.0348)	0.8372***	0.6585
Test of significance of difference between coefficients for different time periods: 't' values										
Gur 13-33 Vs. 34-50			2.7971***	1.0445	0.1819	2.5722**	0.1142	2.6869**		
Gur 13-33 Vs. 51-65			2.3666**	1.9241*	2.0152*	1.0099	2.6131**	2.4061**		
Gur 34-50 Vs. 51-65			1.7338*	0.7395	4.2036***	0.8576	3.0763***	1.9682*		
Cane 34-50 Vs. 51-65			2.2720**	1.0671	0.2981	0.3990	1.8177	1.5230		

* Significant at 10 per cent ** Significant at 5 per cent *** Significant at 1 per cent
The null hypothesis for the coefficient of lagged acreage is that it is equal to one. Note: Figures in parentheses are standard errors.

Source: For Tables 2.1.6 and 2.1.7 - Dayanatha Jha, ibid.

TABLE 2.1.8

ESTIMATES OF ELASTICITIES OBTAINED FOR DIFFERENT TIME PERIODS

Time Period and Price Variable Used	Elasticity with Respect to Price		Elasticity with Respect to		Coefficient of Adjustment
	Short Run	Long Run	Yield	Rainfall	
Relative gur price					
1912-13 to 1964-65	0.2257***	0.5477	-0.0464	0.0343	0.4121
1933-34 to 1964-65	0.2710***	0.3970	0.0998	0.0559*	0.6826
1950-51 to 1964-65	0.6390**	18.6297	0.2324	0.0963*	0.0243
Relative sugarcane price					
1933-34 to 1964-65	0.3508***	0.4443	0.1391*	0.0522*	0.7896
1950-51 to 1964-65	0.6585***	0.7917	0.2830*	0.0832*	0.8317

* Significant at 10 per cent
** Significant at 5 per cent
*** Significant at 1 per cent
@ Calculated as $(1-r)^n = 0.05$, where r is the coefficient of adjustment and n is the number of years required to enable 95 per cent of change in price to materialise.

Source: Dayanatha Jha, ibid.

The short-run elasticities over the period 1933-34 to 1964-65 do not differ significantly from those estimated by Krishna. But others do exhibit significant differences. "A high coefficient of adjustment implies in Nerlovian terms, a general lack of rigidities which inhibit attainment of equilibrium output."[5] This means that there is little institutional limitation on the response of sugarcane farmers to changes in the relative sugarcane price.

This study found a long-run inelastic supply of sugarcane, the reason for which seems to be the limited land resources and high premium placed on growing food crops which have priority in acreage until the food requirement of the population is reached.

Note that his study assumes partial adjustment and naive price expectations. Jha treats sugarcane as the annual crop and thus fails to consider the ratoon as an important determinant on farmers' decisions. However, he does carry out a very extensive study, including many explanatory variables and many years of observations. Although not stated, the data was presumably fairly accurate.

The inclusion of wheat acreage as an explanatory variable was justified only because of the priority that the Government gave to growing wheat. A large number of observations allowed this extensive study.

M.C. Madhavan[6] (1972) carried out a study on acreage response of Indian farmers in Tamil Nadu and made an acreage response

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5 Dayanatha Jha, ibid., p. 89.

6 M.C. Madhavan, "Acreage Response of Indian Farmers: A Case Study of Tamil Nadu", Indian Journal of Agricultural Economics, Vol. 27, 1972, pp. 67-84.

analysis with respect to relative price, yield per acre and rainfall for four major cereal crops, viz. rice, sorghum, Ragi and Cumbu; and for four major commercial crops, viz. sugarcane, groundnut, cotton and gingelly.

His model began by identifying a production function which led to the desired demand function for the cultivation of the crop under study, expressed as:

$$\log \hat{X}_i = a + a_1 \log \frac{\hat{P}_i}{\hat{P}_j} + a_2 \log \hat{E}_i + a_3 \log \hat{E}_j + a_4 \log \hat{X}_j + \hat{u}_i \quad (1)$$

where:

$\hat{X}_i$ = desired acreage of crop i

$\frac{\hat{P}_i}{\hat{P}_j}$ = ratio of expected price of crop i with respect to crop j

$\hat{E}_i$ = planned yield per acre of crop i

$\hat{E}_j$ = planned yield per acre of crop j

$\hat{X}_j$ = desired acreage of crop j

He added the coefficient of adjustment such that:

$$\frac{X_{it}}{X_{it-1}} = \left[\frac{\hat{X}_{it}}{X_{it-1}}\right]^{\beta} \quad (2)$$

Before he decided to use a one-year lag, Madhavan ran tests on a one-year lag, a two-year lag, a two-year moving average, and a three-year moving average. The one with the one-year lag yielded the highest R^2 value. Therefore, assuming a one-year lag, substituting equation (2) into equation (1) and solving it for X_{it}, we have:

$$\log X_{it} = b_0 + b_1 \log \frac{P_{it-1}}{P_{jt-1}} + b_2 \log E_{it-1} + b_3 \log E_{jt-1} + b_4 \log X_{jt-1}$$

$$+ b_5 \log X_{it-1} + v_{it} \qquad (3)$$

where:

$b_0 = a_0\beta$, $b_2 = a_2\beta$, $b_3 = a_3\beta$, $b_4 = a_4\beta$, $b_5 = (1-\beta)$ and $v_{it} = \beta u_{it}$

where:

$\frac{P_{it-1}}{P_{jt-1}}$ = relative price of crop i with respect to crop j, lagged one year

E_{it-1} = yield per acre of crop i, lagged one year

E_{jt-1} = yield per acre of crop j, lagged one year

X_{jt-1} = acreage of competing crop, lagged one year

X_{it-1} = acreage of crop i, lagged one year

The weather variable is incorporated into the equation only when it is deemed important in farmers' decision-making. It is assumed that the farmers' decision-making process consists of two stages. In the first stage, with the knowledge of the variables specified in equation (3), he would make his tentative decision towards the end of May as to what crop or crops to cultivate in the next season to get maximum net income. The weather variable should then be relevant to the second stage when weather will be an important factor influencing his final decision.

Equation (3) is a log-linear function, which differs from other models. Another difference is in the denomination of the price variable. Other models noted above used the weighted average of the prices of all competing crops as the denominator, while in this model the lagged relative price variable refers to only one competing crop. A further difference is that Madhavan did not use relative yield. However, he realizes that his model could be reduced to have a yield ratio if he assumes the substitution parameters of crops i and j to be equal. Unsupported by any reason he stated that, ceteris paribus, an expected increase in yield per acre of a dependent crop (or an expected decrease in the yield per acre of a competing crop) would make the production of the dependent crop desirable. Thus, he expected the coefficient of yield elasticity b_2 to have a positive sign, and the coefficient of cross yield elasticities b_3 to have a negative sign. This, in my opinion, is not necessarily true. For, in some cases where farmers have a certain level of production in mind and where they expect a higher yield, they may reduce the acreage planted to the crop, and vice versa. However, this argument is invalid if farmers are profit maximisers. Also, if this is the case, we would expect the coefficient on both P_i and P_j to be positive. The point is one of a consistent approach to relative price and yield as they affect relative profits.

Table 2.1.9 indicates regression coefficients. It can be seen from the table that the coefficient of E_{jt-1} (i.e. yield of competing crop) does not have the expected megative sign. However it is felt that with the exception of the groundnut coefficient the rice and the Ragi coefficients will not be statistically significant. By not imposing a homogeneity constraint on the yield variables, he loses one degree of freedom.

TABLE 2.1.9

REGRESSION COEFFICIENTS

Crop	Competing Crop	P_{t-1}	E_{it-1}	E_{jt-1}	X_{jt-1}	W_t	X_{it-1}	R^2	$\bar{R}$
Sugarcane	Rice	0.62	0.44	1.32	1.48	-0.35	-	0.88	0.85
		(0.18)	(0.88)	(0.73)	(1.23)	(0.20)			
	Ragi	0.52	1.70	0.58	1.14	-0.20	0.57	0.58	0.43
		(0.34)	(1.30)	(1.04)	(2.25)	(0.40)	(0.34)		
	Groundnut	0.63	1.27	1.86	0.57	-0.35	0.17	0.85	0.75
		(0.25)	(0.80)	(0.60)	(0.53)	(0.23)	(0.27)		

Source: M.C. Madhavan, *ibid*.

Table 2.1.10 indicates estimated short run and long run acreage elasticities of sugarcane. In the table the coefficient of adjustment (B), when rice is the competing crop, should be 1.00 instead of 0.94. It seems that sugarcane responds more to the relative rice price than to the price of Ragi or groundnut (because its β is equal to 1). The high price response and quick adjustment could be attributed to the general behaviour of the large land owners who produce mainly for the market; these groups of farmers are better equipped with market information and their better education enables the adaptation of new techniques and new technology in growing sugarcane.

Madhavan's study contradicts itself because the inclusion of competing crop acreage (e.g. rice) is justified only when priority is given to grow rice first. However, his explanation of why the cross yield coefficient is positive is in contrast with this fact. He explained that the positive relationship between sugarcane acreage and cross yield is due to the cropping pattern associated with sugarcane cultivation. At the time of making a choice between sugarcane and, say, rice, they are competing crops. But once the choice is made to cultivate sugarcane in the first year, rice becomes a complementary crop.

Furthermore, Madhavan's model involves a simultaneous equation bias. This means that OLS parameter estimates are biased.

Most of the studies reviewed here assume a naive price expectation, even though some experimented with several price formulations. They applied the Nerlovian Adjustment Model without trying to consider that it is suitable for an annual crop but not

TABLE 2.1.10

ESTIMATED SHORT- AND LONG-RUN ACREAGE ELASTICITIES OF SUGARCANE

Crop	Competing Crop	Short-Run Elasticities of Acreage with Respect to					Coefficient of Adjustment	Long-Run Elasticities of Acreage with Respect to				
		P_{t-1}	E_{it-1}	E_{jt-1}	X_{jt-1}	W_t	B	P_{t-1}	E_{it-1}	E_{jt-1}	X_{jt-1}	
Commercial Group												
Sugarcane	Rice	0.62	0.44	1.32	1.48	-0.35	0.94	0.66	0.47	1.40	1.57	-0.37
	Ragi	0.52	1.70	0.58	1.14	-0.20	0.43	1.21	3.95	1.35	2.65	-0.47
	Groundnut	0.63	1.27	1.86	0.57	-0.35	0.83	0.76	1.53	2.24	0.69	-0.42

Source: M.C. Madhavan, *ibid*.

for a ratoon crop such as sugarcane. In other words, they do not present any theoretical background for a ratoon crop. A good econometric model should represent reality as closely as possible but obviously they ignored this important consideration. As a result, the coefficients estimated and therefore elasticities may be subject to specification errors. Policy recommendation based on these results may be detrimental to the economy. Therefore, a careful analysis should be made before deciding to use these results as a guide to policy recommendation and policy implementation.

2.2 Application to Thailand

Very few empirical studies have been done on agricultural supply functions in Thailand. Two major studies are:

(1) "Supply Response in Underdeveloped Agriculture: A Case Study of Four Major Annual Crops in Thailand, 1937-1963", by Behrman, J.R., 1968. North-Holland Publishing Company.

(2) Chaiwat Konjing, "Demand and Supply of Rice in Thailand", Staff Paper No. 3, Department of Agricultural Economics, Faculty of Economics and Business Administration, Kasetsart University, December 1970.

Behrman's model is the Expectations-Adjustment Model.

(a) $A_t^d = a_{11} + a_{12}P_t^e + a_{13}Y^e + a_{14}P_t + a_{15}Y_t + a_{16}N_t + a_{17}M_t + u_{1't'}$

(b) $A_t = a_{21} + A_{t-1} + a_{22}(A_t^d - A_{t-1}) + N_{2't'}$

(c) $P_t^e = a_{31} + P_{t-1}^e + a_{32}(P_t + a_{33}D_{t-1} - P_{t-1}^e) + u_{3't'}$

(d) $Y_t^e = a_{41} + a_{43}t + a_{44}t^2$

where

A_t^d = the desired area planted to the crop of concern

A_t = the actual area planted to the crop of concern

P_t^e = the expected normal farmers' price of the crop of concern relative to alternative crops

P_t = the actual farmers' price of the crop of concern relative to alternative crops

D_t = a dummy variable representing the transportation charges which alter the Bangkok-Up-Country price differential

Y_t^e = the expected yield of the crop

Y_t = the actual yield

N_t = the farm population in the geographical area under study

M_t = the annual malaria death rate per 100,000 occupants in the area, per se.

t = a time trend

u_{it} = a disturbance term for the i^{th} relationship.

In estimating equation (a), he defined two new variables. These are:

sP_t = the standard deviation of the relative price of the crop over the last three preceding production periods

sY_t = the standard deviation of actual yields of the crop over the last three preceding production periods

The variables sP, sY are proxies for the farmers' subjective assessment of the uncertainty element in future prices and yields, i.e. replace P_t^e and Y_t^e in equation (a) above by sP and sY respectively. The coefficients of these two determinants were assumed on a priori grounds to be negative. But the values of the short-run elasticities of supply with respect to sP_t and sY_t do not support the hypothesis of a preference for avoiding risks.

Table 2.2.1 indicates coefficients of multiple correlation and supply elasticities for rice in Thailand.

TABLE 2.2.1

COEFFICIENTS OF MULTIPLE CORRELATION AND SUPPLY ELASTICITIES FOR RICE IN THAILAND, 1937-63

	Range	Median	Mean[1]
I. Coefficient of multiple correlation	0.03 to 0.96	0.73	0.70
II. Estimated short-run elasticity[2] of area planted in rice at point of means for 1940-63 with respect to:[3]			
1. Expected relative price of rice (P_t^*)	0.00 to 1.81	0.20	0.25
2. Expected relative yield of rice (Y_t^*)	0.00 to 1.94	0.00	0.21
3. Standard deviation in price over last 3 years (SP_t)	0.00 to -1.68	0.00	-0.10
4. Standard deviation in yield over last 3 years (SY_t)	0.00 to -0.31	0.00	-0.03
5. Population residing in agricultural households (N_t)	0.00 to 8.31	0.59	0.76

Notes: 1 Each of the 50 provinces was given an equal weight in calculating the mean value.

2 The short-run is defined to be one crop-year.

3 The difference in the two time periods, 1937-63 and 1940-63 is due to the inclusion of SP_t and SY_t which were measured over three years.

Source: J.R. Behrman, "Supply Response in Undeveloped Agriculture: A Case Study of Four Major Annual Crops in Thailand, 1937-1963", North-Holland Publishing Company.

TABLE 2.2.2

COEFFICIENTS OF MULTIPLE CORRELATION AND SUPPLY ELASTICITIES FOR CASSAVA, MAIZE AND KENAF IN THAILAND, 1950-63

	Range	Median	Mean
I. Coefficient of Multiple Correlation			
Cassava	0.23 to 0.90	0.57	0.57
Maize	0.73 to 0.96	0.84	0.84
Kenaf	0.73 to 0.99	0.86	0.85
II. Estimated Short-Run Elasticity of Area Planted (at Point of Means) with Respect to:			
1. Expected relative price (P_t^*)			
Cassava	0.00 to 1.09	0.55	0.55
Maize	0.00 to 4.47	0.14	1.03
Kenaf	0.88 to 5.50	2.51	2.70
2. Expected relative yield (Y_t^*)			
Cassava	0.00 to 0.60	0.30	0.30
Maize	1.36 to 7.73	3.06	3.56
Kenaf	0.00 to 3.71	0.00	1.05
3. Standard deviation in price over last 3 years (SP_t)			
Cassava	-0.46 to -0.50	-0.48	-0.48
Maize	0.00 to -1.69	-0.26	-0.44
Kenaf	0.00 to -3.63	-0.19	-0.70
4. Standard deviation in yield over last 3 years (SY_t)			
Cassava	0.00 to -0.09	-0.05	-0.05
Maize	0.00 to -0.35	0.00	-0.07
Kenaf	0.00 to -1.28	-0.33	-0.46
5. Annual malaria death rate per 100,000 inhabitants (M_t)			
Cassava	0.00 to 0.00	0.00	0.00
Maize	0.00 to -12.27	0.00	-1.67
Kenaf	0.00 to -1.39	-0.28	-0.46

Source: J.R. Behrman, "Supply Response in Undeveloped Agriculture; A Case Study of Four Major Annual Crops in Thailand, 1937-1963", North-Holland Publishing Company.

Table 2.2.2 indicates coefficients of multiple correlation and supply elasticities for cassava, maize and kenaf in Thailand.

On the whole, maize, cassava and kenaf have higher multiple correlation coefficients than those obtained for rice. The short-run price elasticities of the three upland crops are also higher, especially in the case of kenaf. However, the three upland crops exhibit more risk aversion than rice.

Chaiwat used ordinary least squares to estimate the supply of rice. The period under study was from 1952 to 1966. His supply function was:

$$\log Y_{3t} = a_{11} + b_{11} \log Y_{2t-1} + b_{13} \log X_{3t} + b_{13} \log X_{5t-1} + u_{1t}$$

where

Y_3 = annual production of rice (on paddy basis) in kilograms per capita

Y_2 = annual wholesale price of paddy (no. 1) in baht/tonne deflated by the wholesale price index (1958 = 100)

X_3 = trend, 1952 = 1, 1953 = 2, etc.

X_5 = annual harvested rice area (rai) per capita

u_{1t} = disturbance term

The R^2 obtained was fairly low (0.12). The coefficients were all statistically insignificant. This can be, among other things, due to unreliability of the data which can lead to a dependence between the error term and the explanatory variable(s) thus violating the underlying assumptions of the O.L.S. method. A further complication is that of the possible collinearity between pairs of the explanatory variables resulting in multicollinearity.[7]

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7 Chu, K., "Principles of Econometrics", International Textbook Company, 1968, pp. 102-122.

CHAPTER 3

SOME IMPORTANT ASPECTS OF SUGARCANE AND THE DETERMINANTS OF SUGARCANE PRICE

Before the establishment of the sugarcane farmers' association, the sugarcane price was determined solely by sugar factories in the regions. The sugar factories usually have many tricks to depress the cane price paid to farmers. For example, before the production season starts the factories would try to get all of the sugar stocks out for sale to depress the sugar price. In doing so, they can tell farmers that they cannot afford to pay a higher price for sugarcane. Since the establishment of the sugarcane growers' association in 1965 it has been a two-way bargaining process. In 1976 the Government stepped in to set the price at 300 bahts per tonne of sugarcane because both parties could not agree upon a price. This chapter, therefore, will touch on certain aspects of cane farmers, the cane farmers' association, sugar factories, and price determination.

3.1 Cane Farmers

Table 3.1.1 indicates the number of farmers and average rai per farmers in the four regions in 1973/74 and 1975/76.

Table 3.1.2 indicates the distribution of farms by size (%), belonging to the sugarcane farmers' association in the Central Region. Out of 6,000 members of the association, 12 per cent hold less than 25 rai and 23 per cent of the members have 25-100 rai. The majority of farmers, i.e. 47 per cent, use 100-500 rai to grow sugarcane. Only 18 per cent of the 6,000 members have greater than 500 rai. The majority of sugarcane farmers in the region belong to the sugarcane farmers' association.[1]

TABLE 3.1.1

NUMBER OF SUGARCANE FARMERS AND NUMBER OF RAI PER FARM (AVERAGE) IN 1973/74 AND 1975/76

Year	Central Region		Eastern Region		Northern Region		North-Eastern Region	
	No. of Farmers	Average Rai per Rarm	No. of Farmers	Average Rai per Farm	No. of Farmers	Average Rai per Farm	No. of Farmers	Average Rai per Farm
1973/74	18,673	55.14	1,831	192.30	12,126	11.86	2,893	31.38
1975/76	23,920	59.10	3,151	144.43	17,012	18.00	4,800	36.06

Source: Sugar Institute, Ministry of Industry.

TABLE 3.1.2

SIZE OF MEMBER FARMS OF THE CANE GROWERS' ASSOCIATION IN THE CENTRAL REGION (1976)*

Size	Percentage of Farmers
Less than 25 rai	12
25-100 rai	23
100-500 rai	47
Greater than 500 rai	18
Total:	100

*Source: The Sugarcane Farmers' Association of the Seventh Part.

1 There are very few farmers who do not belong to any association especially those who sell cane straight to the Government factories in Supanburi province. Also, those farmers who borrow money from the Bank for Agriculture and Agricultural Co-operatives (BAAC) do not belong to the Sugarcane Farmers' Association.

3.2 Quota System

The sugar factories refuse to buy less than a certain minimum requirement of sugarcane and this leads to the existence of the quota system. If the managers make separate transaction contracts with all of the small farmers, then the greater will be the number of contractors, and the higher the book-keeping and contract making costs. Furthermore, the arrangement of the queue for sugarcane delivery will be very difficult with so many small contracted farmers. The minimum requirement of sugarcane for a quota is not necessarily the same for each factory. Sugar mills with larger production capacity would set a higher level on the minimum requirement than the smaller ones. Normally, in the Central Region, the minimum requirement is 2,000 tonnes.[2]

Quotamen, usually rich sugarcane farmers, act as middlemen gathering sugarcane from smaller farmers for their contracted sugar mill manager. The farmers are charged 10 bahts per tonne as the contract commission from their cane money. Besides the service mentioned above, the quotamen also provide other services like loans to their contracted farmers for planting sugarcane, for precautionary spending, and so on at a 20 per cent rate of interest (or greater). Other services like selling fertilizer, herbicide and rice, etc. on credit are also given by quotamen. Tractors for ploughing and trucks for

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2 Knowing the average farm size and yield per rai (approximately 8 tonnes per rai), we can calculate how many farmers a quotaman needs to contract to meet the minimum requirement of 2000 tonnes. If the quotaman deals with farmers with 100 rai of sugarcane, he will have a transaction with only 2 to 3 farmers.

transportation of sugarcane to the factories are also provided on credit. The quotamen also obtain labourers for the contracted farmers.

Each individual quotaman does not contract the entire amount of sugarcane under his control with only one sugar mill. This is to minimize the risk of a shut down of his contracted mills for repairs and also when faced with an unexpected increase in the demand on his processing facilities resulting from different rates of arrival known as the queueing behaviour.

Small farmers claim that they are being exploited by quotamen. When they join in under any quotaman's quota, they bear some risk of transaction. By "risk of transaction", it is meant that farmers dealing with any quotamen, with no literal contracts between them, claim that they are not sure of the amount they can actually sell through the quotaman. The only contract between them is in borrowing money. Because the majority of the quotamen are large-scaled sugarcane farmers themselves, in the year of good cropping they cheat the farmers under their quota by not bringing all of the sugarcane from their farms to sugar mills. The quotaman's own cane will be transported first to the mill and then he will transport the small farmers' sugarcane later. The amount may be just enough to cover the debt created from borrowing money from the quotamen. Farmers claim also that they are being cheated in the weighing of sugarcane because they do not follow it to the sugar mills at the time when the quotamen bring their cane to be sold at the sugar mills. Farmers, then, have to accept whatever the quotamen say about the quality and the weights of their sugarcane. Moreover, the quotaman receives the cane money from the sugar mills manager twice a month during the production season, while paying the whole amount of sugarcane money to the farmers at the end of each sugar production season. This gives the quotamen time and opportunity to invest the money. However, there is no strong evidence about this malpractice.

The BAAC together with the Sugar Institute established a Credit Project in Kanchanaburi in 1970, charging farmers a 12 per cent rate of interest. This enabled farmers to reduce their production cost. Furthermore, small farmers can sell their products to a sugar mill through the quota of BAAC, thus bearing a smaller risk of transaction than under any quotamen. It is required that small farmers group together under a farmer who acts as the head of the group and who takes responsibility to pay back the loans and interest. The BAAC also provides an opportunity for them to get tractors for ploughing their farms and trucks for transporting their cane to the sugar mill. But this project has not been progressing very well because it only benefits the middle-class farmers who have lands or property required by the bank to be used as collateral in borrowing money from the bank. Besides, the BAAC does not provide loans for consumption, etc. But farmers can borrow money from quotamen for purposes other than planting sugarcane. Therefore, most of the farmers in Kanchanaburi province still remain under the quotaman's control.

Table 3.2.1 shows the number of sugarcane farmers who borrowed money from the BAAC in Kanchanaburi.

TABLE 3.2.1

NUMBER OF SUGARCANE FARMERS WHO BORROWED MONEY FROM THE BAAC IN KANCHANABURI

Year	Total Sugarcane Farmers[1]	No. of Clients of BAAC[2]	Percentage
1970	5,041	56	1.11
1971	4,111	150	3.65
1972	6,010	234	3.89
1973	6,576	585	8.90

Source: 1 Sugar Institute, Ministry of Industry.
2 BAAC, Ministry of Finance.

Even though the quotaman plays a very important role, he does not directly influence the decision-making of the farmers. The farmers themselves have a choice about which crops, and how much of each crop to plant.

Quotamen activities do, however, seem to influence returns to sugarcane farmers. The potential effects of institutional changes on returns from sugar production and hence also of supply response behaviour should be built into the model specification.

3.3 Determinants of Sugarcane Price

Before the establishment of the sugarcane farmers' association, price was determined by purchasers. The sellers were price-takers and had no bargaining power over the price because the sugar factories were the sole buyers of the sugarcane and also because the nature of sugarcane means that it can easily lose its sucrose content thus losing some of its quality, resulting in a lower price to the farmers.

The price set by the factories was, therefore, low depending on how low the price of sugar was just before the beginning of the production season. The price of sugar was usually low before the production season due to the various tricks employed by the factories to depress the sugar price as has already been mentioned.

Later, when the sugarcane farmers' associations were established in Kanchanaburi (Central Region) in 1964 and in Chonburi (Eastern Region) in 1969, the price was determined by the bargaining process between sugar factories and the cane association. In 1976, the Government stepped in to control the sugarcane price at 300 baht per tonne.

The following section will deal in some detail with some aspects of the sugarcane farmers' association, sugar factories and the Government, which together determine the sugarcane price.

3.3.1 <u>Sugarcane Farmers' Association</u>

The first association was established in 1964. Its main objective was to bargain over the price of sugarcane. Later, the objectives were extended to the improvement of transport facilities and public facilities. It also provides some welfare assistance to members.

The sugarcane farmers' association can bargain for a sugarcane price against the sugar mills because they have control over the sugarcane supply. Table 3.3.1.1 indicates the price of sugarcane from 1961/62 to 1974/75 in each region.

TABLE 3.3.1.1

YEARLY AVERAGE SUGARCANE PRICE (AT FACTORY LEVEL) IN EACH REGION FROM 1961/62 TO 1974/75

Year	Region			
	North	Central[1]	Eastern[2]	North-Eastern
1961/62	120.68	126.43	125.78	100.00
1962/63	121.44	126.78	128.12	102.84
1963/64	116.49	155.80	169.69	154.24
1964/65	118.67	125.51	124.72	112.92
Average	119.32	133.63	137.08	117.50
1965/66	92.87	105.63	100.82	96.41
1966/67	114.68	169.68	158.65	128.16
1967/68	118.01	204.89	223.63	158.68
1968/69	126.59	157.01	150.63	122.10
Average	113.04	159.30	158.43	126.34
1969/70	130.37	135.09	140.92	123.97
1970/71	126.32	145.87	146.30	130.09
1971/72	131.91	149.75	156.95	133.04
1972/73	155.08	182.36	182.98	138.76
1973/74	177.79	203.61	200.79	168.74
1974/75	292.39	300.65	300.70	276.32
Average	168.98	186.22	188.14	161.82

1 Sugarcane farmers' association established in 1964.

2 Sugarcane farmers' association established in 1969.

Source: Sugar Institute, Ministry of Industry.

There is no sugarcane farmers' association in the Northern, nor in the North-Eastern Regions. It can be clearly observed that the sugarcane price in the two regions is lower than the Central and Eastern Regions. By comparing the two average prices of Central and Northern Regions from 1961/62 to 1964/65 and 1965/66 to 1968/69 (which is the period after the establishment of the sugarcane farmers' association in the Central Region), the difference in the average price between the two regions during the first period was 14.31 baht per tonne while that of the second period was 46.62 baht per tonne. After the establishment of the sugarcane farmers' association in 1965, the four year average price (1965/66 to 1968/69) increased 19.21 per cent from the previous four years (1961/62 to 1964/65). For the Eastern Region, after 1969 when the association was established, the average price increase over the six year period was 18.75 per cent. However, the rate of increase in price in the Northern and North-Eastern Regions was higher than the Central and Eastern Regions when comparing the two periods between 1965/66 to 1968/69 and 1969/70 to 1974/75 (i.e. 49 per cent for the Northern Region and 28 per cent for the North-Eastern Region).

Nevertheless, when looking at the absolute price level, prices in the Central and the Eastern Regions have always been higher than in the Northern and the North-Eastern Regions. This is true even before the establishment of the sugarcane farmers' association. This may be because of more oligopsonistic power exerted by sugar factories in the latter two regions. This will be dealt with in more detail later in Section 3.3.2.

To be a member of the association sugarcane farmers pay a subscription fee of 2 baht per tonne of sugarcane sold to the factory. Under the association regulations, some portion of the 2 baht will be spent on the association administration, and a portion will be spent to improve the public utilities used by the general sugarcane farmers, e.g. to improve roads to facilitate sugarcane transportation, for scholarships for poor but intelligent children of the sugarcane farmers and for building hospitals in the sugarcane districts.

However, these associations were formed by quotamen, not by the general sugarcane farmers. The wealthy quotamen are on the operating committee and most of the members are quotamen. It is generally believed that quotamen benefit from the operation of the association. Bargaining for a higher price is of more benefit to quotamen than to the farmers because the quotamen have much more cane of their own than each farmer. The higher the price the association can bargain for, the more benefit it gets. Everyone in the district can enjoy a better transportation from constructing the roads, but the quotamen can get more benefits because this enables them to reduce the sugarcane transportation cost.

One of the objectives of the association is to create unity among sugarcane farmers which has not been well achieved. Whenever there is a conflict between sugarcane farmers and quotamen, the association will try to achieve a compromise but in the end, quotamen gain instead of farmers rightfully receiving the benefit. For example, in the production year 1973/74, the sugar mills increased the sugarcane price by 20 baht per tonne. This amount should have been paid to the farmers because quotamen already receive a commission of 10 baht per tonne. However, the association settled on a compromise to share the additional price between quotamen and their contracted farmers. This example is just one of the conflicts between quotamen and farmers which still occur every now and then.

Furthermore, the associations do not provide agricultural knowledge to their members. Nor do they provide cheap credit or the supply of fertilizer and insecticides. This may be because these services will obstruct the quotamen's profit and benefits.

3.3.2 Sugar Factories

The plantation white sugar mills were first established in Thailand in the 1860s. Before that sugarcane was used as an important material in making muscovado. Therefore, when the sugar mills first purchased cane from farmers, they had to compete with the cottage muscovado mill owners. The sugar mills advanced money to sugarcane farmers who agreed to make a forward contract with them. This money was called "sugarcane promotion money" which, in a way, was a loan to farmers who had no capital to spend on growing sugarcane. This sugarcane promotion money is still used but is given to each farmer in different amounts at a fixed rate depending on the weight of cane to be transacted, e.g. at the rate of 10 baht per tonne. A farmer who contracted to supply 1,000 tonnes of sugarcane receives 10,000 baht while those who contracted 2,000 tonnes receive 20,000 baht.

With many small farmers, the transaction cost is high, e.g. the cost of book-keeping and difficulties in arranging the queue of sugarcane delivery. To eliminate these problems, they set up a minimum sugarcane requirement, which varies from factory to factory. Thus the importance of quotamen. Contract bonuses are used as an incentive by the sugar mill to ensure that the quotamen will try to deliver the contracted amount. Those farmers who could not supply sugarcane to them at the contracted amount would not only not receive this money, but would also have deducted from their sugarcane money an amount to cover the shortage of sugarcane in tonnes. However, in the case of crop failure or burnt sugarcane, the factories cannot impose this penalty upon the contracted farmers.

Before the establishment of the sugarcane farmers' association, sugar factories were the only authority measuring the weights of sugarcane sold by the farmers. Farmers complained that this enabled the factories to cheat them. However, the establishment of the association gave this measuring service to the farmers. The weight measured by both authorities has to be the same or must have only a marginal difference.

The managers of sugar factories and sugarcane farmers make forward transaction contracts with each other in June. The farmers have just planted their sugarcane at that time, so that the amount of sugarcane supply for the coming production season is not yet known exactly. The sugar production season in Thailand starts in November of every year, so that there is a five months gap between the time the forward transaction contracts are made and the time of starting the new sugar production season. During this time, the sugar market situation in the world market can change. The manager would bear the risk of this uncertainty if prices had been fixed previously.

In order to avoid this risk, the sugar mill managers have to set the sugarcane price at the time the new sugar production season starts. At that time, both the sugar market and the sugarcane market conditions will be known more exactly.

However, the farmers would not want to know the sugarcane price too late. It was decided, then, to bargain for the price one month prior to the starting of the new production season.

In 1975/76 the number of sugar factories in each region was:

Central Region	:	20
Eastern Region	:	9
Northern Region	:	8
North-Eastern Region	:	4

By making a comparison of price data in Table 3.3.1.1, I have observed that the larger the number of factories, the higher the price of cane paid to the farmers (as in the case of the Central and Eastern Regions). The smaller the number of factories, the lower the price of cane (as in the case of the North-Eastern Region). In the North-Eastern Region many small farmers produce sugarcane but there are very few factories to sell to. The factories have a relatively large control over the farmers. But in the Central Region, where there are more factories, cane farmers and quotamen have the opportunity to make a contract with many alternative factories and hence oligopsonistic power is less in the Central and Eastern Regions. As for the Northern Region, where there are eight sugar factories, prices are not markedly different from those in the Eastern Region.

The marginal difference in price may be due to the existence of sugarcane farmers' associations in the Eastern Region.[3]

Furthermore, the rate of growth in the number of factories in the Northern Region is lower than that in the Eastern Region as can be observed from the fact that the first modern sugar factory was established in the Northern Region in 1938, long before those in the Eastern Region. However, the number of factories in the Northern Region was one less than the Eastern Region in 1975/76. This, therefore, implies that in the Northern Region before 1975/76, as there were fewer sugar factories, oligopsonistic power may have been in existence. This may explain the differences in price between the two regions.

Moreover, factory capacity is greater in the Eastern Region than in the Northern Region. The factories in the Eastern Region require more sugarcane thus bidding the price up. The quantity of sugarcane processed annually in the Eastern Region has always been greater than in the Northern Region. For example, in 1974/75 production season the quantity of sugarcane processed in the Eastern Region was 3,340,490 tonnes, while that in the Northern Region was 1,615,061 tonnes.

Another reason may be that the labour cost is lower in the North and the North-Eastern Regions than in the other two regions because more labourers are available. This is especially true for

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3 Inability to know the details on type of soil and its fertility make it impossible to investigate whether the difference in price is due to the quality difference.

the North-Eastern Region because quotamen in the Central and Eastern Regions, where there are shortages of labour, obtain labour from the North-Eastern Region for farmers in the Central and Eastern Regions for a certain commission. With more labour available in the North and the North-Eastern Regions, the cost of production is reduced, the consequence of which may be the apparent lower price. Furthermore, in the North-Eastern Region some sugar factories also have their own sugarcane farms which, even though they might not be able to produce all the sugarcane required, might be another factor which reduces the sugarcane price.

The factories operate only between November and June. They stop operating before the onset of the rain because sugarcane in the rainy season has a very low sugar content but a very high weight. Farmers, therefore, have to cut and deliver their sugarcane to the factories before the rainy season arrives.

3.3.3 Government

The Thai Government controlled the sugarcane price of every region in Thailand during the years 1961 to 1965 to aid the sugar factories and to stimulate the export of sugar. This is an integral part of the "Sugar Industry Aid Fund" Scheme. The Government stopped controlling the sugarcane price in 1965 when the sugar market was very bad and the Government had to abolish the Sugar Industry Aid Fund because the money to support the fund ran out. Since then price has been negotiated between the sugarcane farmers' association and the sugar factories. But during the production season 1974/75, a satisfactory negotiation was not made. The Government therefore had to step in and decide on 300 baht per tonne. This controlled price is still in effect. However, some factories still pay less than 300 baht per tonne because of their oligopsonistic power and because of quotamen activities. Some factories pay more than 300 baht per tonne because of the application of the C.C.S. system (Commercial Cane Sugar) which measures the sugar content and the price is set accordingly. Only a few factories are using this method.

Besides controlling the sugarcane price, the Government has control over three important areas: the distribution of sugar within the country, the calculation of the domestic requirement for sugar, and the domestic sugar price. In December 1974, the Cabinet created the Sugar Production Control and Distribution Centre. Its function is to administer domestic sugar sales by producers and to watch over and regulate producer stocks.

The Centre's main activity is to calculate the quantity of sugar which should be released into the domestic market at any time and to issue each sugar company with a weekly release figure. The basic quantity for each company is 1/52 of its annual production quota for white sugar, minus 20 per cent for stocks. This quantity can be varied as demand changes. Sugar companies are permitted to release white sugar to domestic buyers until their weekly release quota is reached.

As an additional mechanism to control domestic distribution, the sugar companies may sell white sugar only when the buyer has a release certificate issued by the Sugar Centre. The release certificates generally are supplied only to wholesalers or to major consumers.

The Centre has encountered operational difficulties as a result of the refusal of some producers, including the Government sugar factories, to co-operate with its program. The Government is having trouble convincing the dissidents to co-operate, which is destroying any confidence that might have existed in the Centre's attempts to regulate distribution. The future of the Sugar Centre is not certain at present.

As for the calculation of the Domestic Requirement, the Thai Government policy is to give first priority for sugar supplies to the domestic market, leaving the residual amount available for export. Before the start of each milling season, the Government calculates expected domestic demand for the year, adds an amount for stocks, then subtracts this sum from total expected production for the season, determining the amount available for export.

As well as guaranteeing adequate supplies of white sugar to the domestic market, the Thai Government controls domestic sugar prices. The controlled wholesale price of white sugar in March 1975 was 4.00 baht per kilogram and the retail price was 4.50 baht per kilogram.

These controlled prices are set by the Centre on behalf of the Cabinet. Theoretically speaking, these prices should be determined with a view to the maintenance of adequate sugar supplies in the domestic market. In practice, however, retail prices usually lie above these controlled levels.

The production and price controls applied to white sugar have led to irregularities in distribution. The most obvious is extensive smuggling which has reduced supplies to the domestic market and helped raise retail prices above their controlled levels. Another irregular practice is a "buy back" system which involves the sugar producers releasing their prescribed quantities of white sugar to wholesalers, then buying it back in order to inflate their white sugar stocks and therefore the millers are able to produce an equally greater quantity of raw sugar for export.

In summary, the present price determination is made as a result of price bargaining between representatives of all sugarcane farmers'associations and the representatives of all private sugar mills in the same area. Government officers from the Ministry of Industry act as arbitrators. However, if they cannot agree upon the final sugarcane price, the Government officers will try to reach a compromise. If the officers do not succeed in doing so, they make a final decision on the price as a last resort (as happened in 1974/75).

As for the North and North-Eastern Regions, where there are no sugarcane farmers' associations, the sugar factories still play a very dominant role in deciding the price of sugarcane although their importance is diminishing due to intervention by the Government. While writing this thesis, the establishment of a sugarcane farmers' association in the Northern Region is under way. Even though the price is set by the Government at 300 baht per tonne, sugar factories in these two regions actually pay less than that amount.

The sugarcane price determination contract will be made in the conference room of the Ministry of Industry about October or November. It consists of four important parts:

(1) Sugarcane Price Determination. This contains the items that have to be deducted from the agreed sugarcane price, e.g. the subscription paid to the sugarcane farmers' association. Contract guarantee money (or contract bonus) is also deducted from the sugarcane money in order to pay quotamen after that production period is over (in certain provinces only).

(2) Agreements on the sugarcane money payments. Sugar mills in every region make two payments a month. The dates of payment are indicated in the contract. The money is paid 50 per cent in cash and the remainder in post-dated cheques.

(3) The Agreement on the quality of transacted sugarcane which will affect the price. This agreement is intended to prevent conflicts between the sellers and the mills on the quality judgement of transacted sugarcane and the sugarcane price deduction.

(4) The Agreement between sugar mills and the Ministry of Industry on the quantity of raw sugar to be produced by each factory in order to ensure sufficient production for domestic consumption of white sugar.

3.4 Farm Price

Sugarcane farmers do not actually receive the full amount paid by the sugar factories. Certain deductions are made, e.g. subscription fee of the sugarcane farmers' association, quotamen commission, interest on loans borrowed from quotamen, labour costs, etc. Table 3.4.1 indicates the farm price of sugarcane in the four regions from 1967 to 1976.

TABLE 3.4.1

FARM PRICE OF SUGARCANE FROM
1967 TO 1974 (BAHT/TONNE)

Year	Region		
	North	North-East	Eastern and Central
1967	93.41	80.89	153.55
1968	95.13	96.54	-
1969	99.92	112.55	115.64
1970	111.23	102.41	111.80
1971	105.84	100.16	144.76
1972	100.28	105.00	138.06
1973	94.90	115.12	192.25
1974	193.00	155.00	193.00

Source: Division of Agricultural Economics, Ministry of Agriculture and Cooperative.

The Eastern Region is combined with the Central Region. The reason for this will be discussed in detail in Chapter 6 in the data and adjustment section.

3.5 Other Contracts

Besides the price determination contracts, the sugarcane forward transaction contract is also important. This contract is written by each sugar mill and is composed of three parts:

(1) Agreement on Transacted Cane which consists of an agreement on the quantity and quality of transacted sugarcane. The sugar factories have two methods of enforcing the quantity contracted. They are:

(a) Preventive Control Method. The managers investigate the seller thoroughly before making the contract with him. They look into the seller's record on his ability to supply sugarcane for the mill in the past production year. Other aspects are also examined, e.g. the quality of sugarcane supplied by the seller, etc.

(b) Penalty Control Method. The mill either cuts down next production year's contract quota or imposes the contract guarantee money which is determined at a fixed rate per tonne on the amount of sugarcane the seller cannot deliver.

In practice, the quantity delivered can fluctuate by 20 per cent around the contracted amount.

The standard quality of sugarcane is 10 C.C.S[4] and if it is below that level, the price will be lower. Other conditions

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4 C.C.S means Commercial Cane Sugar which is the system of payment by quality of the sucrose content.

affecting price are maturity, dryness or freshness and the presence of other mixtures such as soil or leaves. Burnt sugarcane is only accepted at a lower price while sugarcane cut with too much of the top part is not acceptable.

(2) Agreement on Sugarcane Promotion Money. This states that the sellers who accept the loans must spend all the borrowed money on planting sugarcane otherwise the loans will be stopped. Conditions for the loan are also stated, e.g. collateral, date of payments of loans, etc.

(3) A further Agreement is that on the delivery date of the sugarcane to sugar factories which also states how many trucks per day or per interval of time are allowed depending on the contracted amount. Another important agreement concerns the obligation on the sugar factories to purchase all the contracted amount unless there are unforeseen circumstances like machine breakdowns, strikes, floods, fire, etc.

CHAPTER 4

SUPPLY RESPONSE FUNCTION: A THEORETICAL SURVEY OF SUPPLY RESPONSE FOR PERENNIAL CROPS

Sugarcane is, of course, not an annual crop but a short-term perennial crop, whose life in Thailand is three years, beyond which time the yield drops dramatically. Consequently, two ratoon crops are grown in most regions. However, three ratoon crops are common in Kampaengphet which is in the Northern Region where soils and rainfall are particularly suited to cane production. The second ratoon crop usually gives the highest sugar content. Therefore, once a farmer decides to grow sugarcane, he is - generally speaking - committed to it for three years. The supply estimate studies reviewed in Chapter 2 treated sugarcane as an annual crop. Their results, therefore, may not be accurate. This section thus reviews the general supply models for perennial crops.

Bateman's Model[1]

Bateman studied the supply response of cocoa farmers in Ghana. He expresses acreage planted (X_t) as a function of the average expected future real producer price of cocoa ($\bar{P}_t$) and the average expected future real producer price of the competing crop, i.e. coffee ($\bar{C}_t$). That is,

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1 M.J. Bateman, "Aggregate and Regional Supply Functions for Ghanian Cocoa", Journal of Farm Economics, May, 1965.

$$X_t = a_0 + a_1\bar{P}_t + a_2\bar{C}_t + u_t$$

and

$$\bar{P}_t = \frac{\sum_{i=0}^{n} P^*_{t+i}/(1+\gamma)^i}{n+1}$$

$$\bar{C}_t = \frac{\sum_{i=0}^{n} C^*_{t+i}/(1+\gamma)^i}{n+1}$$

where:

P^*_{t+i} = the expected real producer price of cocoa in year t+i

C^*_{t+i} = the expected real producer price of coffee in year t+i

γ = the farmer's subjective rate of discount

n = the life span of the perennial crop

The Nerlovian price expectation model is assumed, i.e.:

$$\bar{P}_t - \bar{P}_{t-1} = \beta(P_t - \bar{P}_{t-1}) \qquad \text{where } 0 \leq \beta < 1$$

$$\bar{C}_t - \bar{C}_{t-1} = \gamma(C_t - \bar{C}_{t-1}) \qquad \text{where } 0 \leq \gamma < 1$$

and P_t and C_t are actual prices of cocoa and coffee respectively in year t.

By assuming β and γ to have the same value, the following is obtained:

$$X_t = a_0\beta + a_1\beta P_t + a_2\beta C_t + (1-\beta)\ X_{t-1} + v_t$$

where $v_t = u_t - (1-\beta)\ u_t - 1$

This model assumes that yield and cost do not change significantly during the period under consideration, i.e. price fluctuates more than costs and yields.

Thus the major determinant of expected profits is the expected price stream. If the farmer expects future prices to be higher than past prices, expected profits will increase and the incentive to invest will induce more planting. On the other hand, if the farmer expects lower future prices and that the average price level will be low relative to past prices, gross investment in this product will fall.

However, the model does not consider the removal from the stock of trees and thus could overstate the net change in stock.

The Ady Model[2]

Ady adds the existing stock of trees in the previous year as another important determinant of the area planted. That is:

$$X_t = a_0 + a_1 P_t^* - a_2 A_{t-1}$$

where

P_t^* = the expected price of cocoa in the year t

A_{t-1} = the acreage under cocoa in the year t-1

X_t = the difference between A_t and A_{t-1}

A further difference is in the formulation of price expectation which is:

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2 P. Ady, "Trend in Cocoa Production", Bulletin of the Oxford University Institute of Economics and Statistics, December, 1949.

$$P_t^* = P_{t-1} + \beta(W_{t-1} - P_{t-1}) \qquad 0 \leq \beta < 1$$

where W and P are the world prices of cocoa and coffee respectively. Instead of using domestic prices, he uses world prices. Thus, the model becomes:

$$X_t = a_0 + a_1 (1-\beta)P_{t-1} + a_1\beta W_{t-1} - a_2 A_{t-1} + u_t$$

Behrman Model[3]

The model is an improvement on the previous two models in that is uses farmer's intended acreage instead of the actual acreage planted because the latter may not reflect the constraint imposed by institutional and technological factors on the farmer's decision.

The model is such that:

$$X_t^* = a_{10} + a_{11} P_t^* + a_{13} C_t^* + u_{1t} \qquad (1)$$

where

X_t^* = the desired acreage in cocoa trees in year t

P_t^* = expected price of cocoa

C_t^* = expected price of coffee

He applies Nerlovian adjustment and expectation hypotheses. Thus:

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3 J.R. Behrman, "Monopolistic Cocoa Pricing", American Journal of Agricultural Economics, August, 1968.

$$X_t - X_{t-1} = a_{20} + \partial(X_t^* - X_{t-1}) + u_{2t} \qquad (2)$$

$$P_t^* - P_{t-1}^* = a_{30} + \beta(P_{t-1}^* - P_{t-1}) + u_{3t} \qquad (3)$$

$$C_t^* - C_{t-1}^* = a_{40} + \beta(C_{t-1}^* - C_{t-1}) + u_{4t} \qquad (4)$$

He assumes that β in (3) and (4) have the same value. By combining (1), (2), (3) and (4) he obtains:

$$X_t = b_0 + b_1 X_{t-1} - b_2 X_{t-2} - b_3 P_{t-1} - b_4 C_{t-1} + v_0$$

where:

$b_0 = a_o\partial - a_{20}\beta$

$a_0 = -a_{10}\beta + a_{11} a_{30} + a_{12} a_{40}$

$b_1 = (2 - \partial + \beta)$

$b_2 = (1 - \partial)(1 + \beta)$

$b_3 = a_{11} \partial \beta$

$b_4 = a_{12} \partial \beta$

$v_0 = \beta u_0 + u_{2t} - (1 + \beta) u_{2t-1}$

$u_0 = u_{1t} - (1 + \beta) u_{1t-1} + a_{11} u_{3t} + a_{12} u_{4t}$

Even though the model reflects the constraints imposed by institutional and technological factors, it creates serious estimation problems in that it is not possible to separate the influence of the price expectation coefficients (β) and the output adjustment coefficient (∂). Frequently the inclusion of both X_{t-1} and X_{t-2} as explanatory variables introduces severe multicollinearity problems.

The French and Matthews Model[4]

Besides being the model which explicitly recognises the constraints imposed on the farmer in adjusting his stock of trees, it also formulates the framework within which new plantings and acreage adjustments are determined. The model explains not only the planting but also the removal and replacement of plants. It considers explicitly the lags between input and output and the effect of population of bearing plants of production. Perfect competition and similar production functions among farmers are assumed in this model.

The model involves five major components:

(I) A pair of functions that explain the quantity of production and bearing acreage desired by growers:

$$Q_t^* = Q_{t-1}^e + b_{11} (\Pi_t^e - \Pi_t^*) + b_{12} (\Pi_{At}^e - \Pi_{At}^*) + u_{1t} \quad (1)$$

where:

Q_t^* = desired production for year t

Q_{t-1}^e = $Y_{t-1}^e A_{t-1}$ = expected average production with acreage at the actual level of t-1

Π_t^e = expected long-run profitability per unit for the commodity of concern with production of Q_{t-1}^e

Π_t^* = normal long-run (equilibrium) profitability per unit of product for the commodity of concern

Π_{At}^e = conditional expected profitability per unit of product for the alternative land use

Π_{At}^* = normal long-run profitability per unit of product for the alternative land use

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4 B.C. French and Matthews, J.L., "A Supply Response Model for Perennial Crops", American Journal of Agricultural Economics, August, 1971.

u_{1t} = a disturbance term

Since the desired acreage is used as the dependent variable, equation (1) is transformed into:

$$A^*_t = \frac{Y^e_{t-1}}{Y^e_t} A_{t-1} + \frac{b_{11}}{Y^e_t} (\Pi^e_t - \Pi^*_t) + \frac{b_{12}}{Y^e_t} (\Pi^e_{At} - \Pi^*_{At}) + \frac{u_{1t}}{Y^e_t} \quad (2)$$

where $b_{11} > 0$; $b_{12} = k < 0$, and Π^e_t and Π^e_{At} are determined independently.

Simplification of equation (2) leads to:

$$A^*_t = A_{t-1} + b_{21}(\Pi^e_t - \Pi^*_t) + b_{22}(\Pi^e_{At} - \Pi^*_{At}) + b_{23}\Delta Y^e_t + u_{2t} \quad (3)$$

where $\Delta Y^e_t = Y^e_t - Y^e_{t-1}$

If yield expectations remain constant equations (2) and (3) are identical and if it is assumed further that $\Pi^e_t = \Pi^*_t$ and $\Pi^e_{At} = \Pi^*_{At}$, then $A^*_t = A_{t-1} + u_{2t}$.

(II) A new planting function defined by the adjustments that would shift acreage toward the desired level. Thus, given A^*_t, we have:

$$N^*_t = A^*_{t+k} - A_{t-1} + R^e_{kt} - N_{kt-1} \quad (4)$$

$$N_t \leq 0$$

where

N^*_t = acreage of new plantings desired by growers in year t

k = the gestation period in years

R^{e}_{kt} = the total amount of acreage expected to be removed during the next k years including year t

$N_{kt-1} = \sum_{i=1}^{k} N_{t-i}$ = the total acreage planted after year t - k - 1

(III) A removal equation to explain the acreage removed each year. R^{e}_{kt} in equation (4) is composed of two parts. The first is the acreage of non-bearing and young and middle-aged bearing plants which have to be removed because of disease or damage by insects. The second is the acreage of older plants which are to be removed because of rapidly declining productive capacity. The former is assumed to be proportional to the amount of bearing and non-bearing acreage. The latter is likely to be highly correlated with the acreage of plants which are older than the age at which productivity starts to decline significantly (A^{o}). Then:

$$\begin{aligned} R^{e}_{kt} &= b_{31} A^{o}_{t-1} + b_{32} (N_{kt-1} + A_{t-1} - A^{o}_{t-1}) + u_{3t} \\ &= b_{31} A^{o}_{t-1} + b_{32} N_{kt-1} + b_{32} A_{t-1} + u_{3t} \end{aligned} \qquad (5)$$

where $0 \leq b_{31} < 1$ and b_{32} is a very small proportion.

(IV) Relationships between unobservable expectation variables and observable variables. Firstly, they believe that actual plantings (N_t) may differ from desired plantings (N^{*}_{t}) because of institutional or technological rigidities and managerial mistakes. By assuming that there is no residual effect of unobtained past desired planting, the relationship is:

$$N_t = \alpha N_t^* + e_t \qquad 0 < \alpha < 1 \tag{6}$$

Therefore, by combining equations (4), (5) and (6), one obtains:

$$N_t = b_{51}\ (\Pi_t^e - \Pi_t^*) + b_{52}(\Pi_{At}^e - \Pi_{At}^*) + b_{53}\Delta Y_t^e + b_{54}A_{t-1}^o + b_{55}N_{kt-1}$$

$$+ b_{56}\ A_{t-1} + u_{5t} \tag{7}$$

where:

$b_{51} = \alpha b_{21}$

$b_{52} = \alpha b_{22}$

$b_{53} = \alpha b_{23}$

$b_{54} = \alpha b_{33}$

$b_{55} = \alpha (b_{32-1})$

$b_{56} = \alpha b_{32}$

$u_{5t} = \alpha (u_{2t} + u_{3t}) + e_t$

Secondly, actual acreage removed (R_t) is believed to be determined by at least three factors - namely:

(a) Institutional and physical factors such as urban expansion, a heavy freeze, or flood;

(b) Short-run profit expectations for the next year. If it is expected that, for the coming year, it is going to be high then some removals might be deferred, and vice versa; and

(c) Random factors which cause deviation between producer intentions and actions like a sudden shortage of fertilizer.

Thus:

$$R_t = b_{60} + b_{61}\ A_t^o + b_{62}\ A_t^o\ (\Pi_t^s - \Pi_t^*) + b_{62}\ A_t^o\ (\Pi_{At}^s - \Pi_{At}^*)$$

$$+ b_{64}\ Z_t + b_{65}\ A_t + u_{6t} \tag{8}$$

where:

R_t = acreage removed at the end of year t

A_t^o = acreage over the age when productivity starts to decline sharply

Π_t^s = short-run profit expectation per unit of product held in year t for year t+1

Π_{At}^s = short-run profit expectations per unit of product held in year t for the alternative land use in year t+1

Π_t^*, Π_{At}^* = long-run normal profitability per unit of product and per unit of alternative crop in year t respectively

Z_t = variable to reflect institutional or physical factors

A_t = bearing acreage in year t

u_{6t} = disturbance term

The following function which shows the total change in bearing acreage from the year t-1 to the year t is presented as:

$$A_t - A_{t-1} = (1 - b_{32})\, N_{t-k} - R_{t-1} + v_{1t} \tag{9}$$

when v_{1t} accounts for minor random variations such as disease losses. Substituting equations (1) and (8) into (9), we obtain:

$$\begin{aligned} A_t - A_{t-1} = {} & b_{70} + b_{71}\,(\Pi_{t-k}^e - \Pi_{t-k}^*) + b_{72}\,(\Pi_{At-k}^e - \Pi_{At-k}^*) \\ & + b_{73}\Delta Y_{t-k}^e + b_{74}\,A_{t-k-1}^o + b_{75}\,A_{t-1}^o + b_{76}\,A_{t-1}^0\,(\Pi_{t-1}^s - \Pi^*_{t-1}) \\ & + b_{77}\,(\Pi_{At-1}^s - \Pi_{At-1}^*) + b_{78}\,Z_{t-1} + b_{79}\,N_{kt-k-1} \\ & + b_{710}\,A_{t-k-1} + b_{711}\,A_{t-1} + u_{7t} \end{aligned} \tag{10}$$

where:

$b_{70} = -b_{60}$

$b_{71} = (1-b_{32})\ b_{51}$

$b_{72} = (1-b_{32})\ b_{52}$

$b_{73} = (1-b_{32})\ b_{53}$

$b_{74} = (1-b_{32})\ b_{54}$

$b_{75} = -b_{61}$

$b_{76} = -b_{62}$

$b_{77} = -b_{63}$

$b_{78} = -b_{64}$

$b_{79} = (1-b_{32})\ b_{55}$

$b_{710} = (1-b_{32})\ b_{56}$

$b_{711} = -b_{65}$

$u_{7t} = (1-b_{32})\ u_{5t-k} + u_{6t-1} + v_{1t}$

Equation (10) indicates that the change in bearing acreage of a perennial crop from year t-1 to year t is determined by unit profit and yield expectations held in year t-k (where k is gestation period), by the acreage of "old age" plants in year t-k-1 and t-1 (multiplied by old age acreage in t-1), by institutional factors or physical factors, by the amount of non-bearing acreage as of t-k-1, by the total bearing acreage in t-1 and t-k-1, and by a random disturbance.

Yet equation (10) still constitutes seven expectation variables and the hypothesis relating the expectations to observable variables are given below.

(a) For yield:

$$\Delta Y_t^e = f(Y_{nt-1}, Y_{nt-2}) \ldots, v_{2t} \tag{11}$$

when Y_n refers to yields of plants at a mature bearing age.

(b) For normal long-run profitability:

$$\Pi^*_t = b_{80} + b_{81} C_t + u_{8t} \quad (12)$$

$$\Pi^*_{At} = b_{90} + b_{91} C_{At} + u_{9t} \quad (13)$$

where C is average cost. As this model assumes perfect competition, long-run equilibrium profit is therefore zero, i.e. the difference between price (P) and average cost (C) is zero.

(c) For expected profitability:

$$\Pi^e_t = h(\Pi_{t-1}, \Pi_{t-2}) \ldots, L_t, v_{3t}) \quad (14)$$

$$\Pi^e_{At} = h_A(\Pi_{At-1}, \Pi_{At-2}, \ldots, v_{4t}) \quad (15)$$

where L_t is a variable representing institutional factors.

(d) For short-run profit expectations:

Π^S_t and Π^S_{At} can be determined in a similar manner as Π^e_t and Π^e_{At}. Thus, by substituting these functions into equation (10) we obtain an estimating equation in observable variables.

(V) An equation that explains variation in the values of average yields, viz.:

$$Y_t = \sum_{i=k}^{H} a_i A_{it} + b_{71} T + v_{5t} \quad (16)$$

where:

A_{it} = the acreage of the i^{th} age in year t

k = the initial bearing age

H = a reasonable maximum age of the plant

T = time

v_{5t} = a disturbance term

The importance of this model is that it reflects the nature of perennial crops, i.e. it explains not only the planting process but also the removal and replacement of plants.

<u>The Desired Stock Model</u>

Instead of using desired acreage as the dependent variable, the desired stock of trees is used. The model is:

$$T_t^* = c_0 + c_1\bar{P}_t + c_2\bar{C} + u_t$$

where

T_t^* = desired stock of trees in year t

$\bar{P}_t$ = expected price

$\bar{C}_t$ = expected price of the competing crop(s)

Applying the Nerlovian adjustment and expectation hypothesis, the final equation becomes something like the Behrman Model mentioned earlier, viz equation (1), except that stocks of trees is used instead of acreage.

The Liquidity Model

This model treats farmer's income as an important determinant of new plantings. This is particularly true in developing countries where farmers' incomes are very low. However, in the case of sugarcane farmers, loans can be arranged from the quotaman with certain rates of interest. With the Bateman Model, adding the farmer's income in the previous year, i.e. Y_{t-1}, gives:

$$X_t = a_0 + a_1 P^*_t + a_2 C^*_t + a_3 Y_{t-1} + u_t \qquad (1)$$

Even though the price expectation is large, if the income situation is not in a favourable condition the investment in that crop will be smaller.

If the price expectation (Nerlovian) hypothesis is assumed then equation (1) becomes:

$$X_t = a_0\beta + a_1\beta P_t + a_2\beta C_t + a_3\beta Y_{t-1} + v_t$$

where $v_t = u_t - (1-\beta)\, u_{t-1}$.

Finally, it should be mentioned here that all models presented above assume symmetry of response to price changes.

CHAPTER 5

THEORETICAL SUPPLY RESPONSE MODEL OF SUGARCANE

5.1 Introduction

Of the six theoretical models of perennial crop mentioned in Chapter 4, I feel that the French and Matthews Model reflects the true nature of the perennial crop more adequately than the other models. However, the model is far too sophisticated and too complicated to be applied to sugarcane for the following reasons:

(1) Sugarcane is cut down after three years of planting, and thus the removals decision can be treated as given by plantings three years earlier.

(2) Sugarcane planted in that year can be harvested in the same year. Therefore, there is no gestation period.

(3) Consequently, the concept of bearing/non-bearing acreage cannot be applied here.

(4) The acreage removed is always the acreage planted in year t-3 or more generally, that acreage planted three years earlier, except in Kampaengphet in the Northern Region. There may be some acreage removed because the plants are destroyed by flood, drought or fire but there are no data available on these damaged plants.

5.2 A Priori Factors Affecting Supply of Sugarcane

The information on sugarcane, and other competing crops commented upon in the first three chapters enables us to hypothesize a priori that nine factors influence the supply of sugarcane. They are as follows:

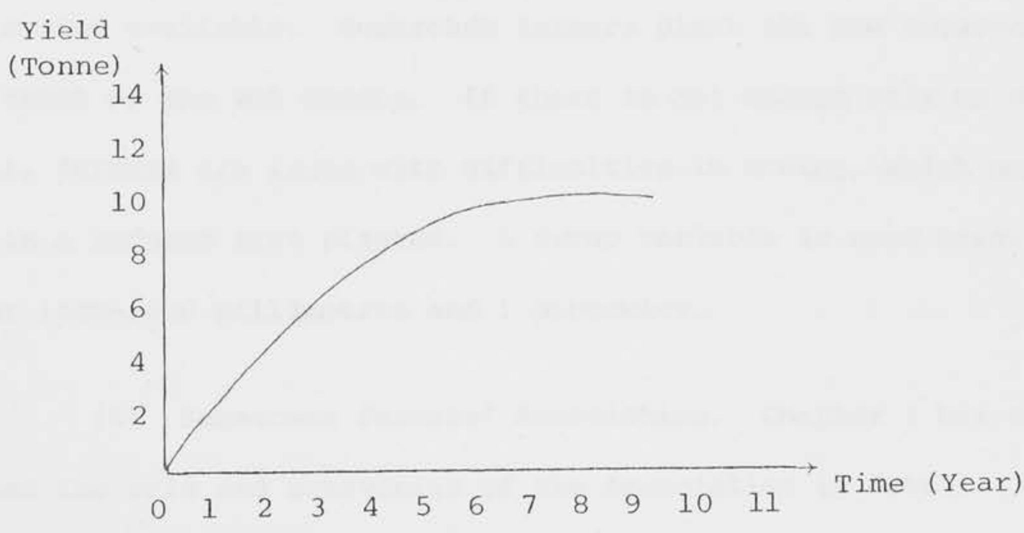
(1) Output price. Farmers' decisions on the production of sugarcane and other competing crops are influenced by the respective prices that they expect to prevail after the harvest. Expected price of sugarcane is usually compared with the expected price of the most profitable competing crop in any one year. Competing crops differ from region to region. Since sugarcane is an upland crop, other upland crops, i.e. cassava, maize and mungbean are the main competing crops. However, rice is a special case in the Central Region because some provinces in the Central Region (mainly Supanburi province) used to be rice-growing areas. Later, when sugarcane growing was found to be more profitable, farmers switched to sugarcane. Therefore, in the Central Region it is decided that rice, maize and cassava are the three important competing crops. In the Eastern Region, competing crops are maize, mungbean, and cassava while for the Northern and North-Eastern Regions, they are cassava and mungbean.

(2) Stock of sugarcane. Stocks of sugarcane affect the farmers' decisions on new plantings in year t. In reality a farmer decides on the total area that he desires to have under sugarcane, given a certain expected price, and adjusts the new planting in year t to the stock of planted sugarcane so as to acquire the desired total area planted to sugarcane.

(3) Yield rate. Yield per rai expected at the time of harvest is also one of the important factors for farmers to decide on the production of sugarcane and competing crops. Yield per rai of sugarcane differs from variety to variety. The variety grown in each region is usually the same although that grown in the North-Eastern Region differs from the other regions due to lack of water. Expected yield rate when regressed with time is usually of a semi-log type as is shown in Figure 5.1. With improved technology, yield is expected to increase over time, but the rate of increase is expected to decrease through time.[1]

FIGURE 5.1

YIELD CHANGE OVER TIME



(4) Cost of inputs. Farmers' decisions on the production of sugarcane and other competing crops will be influenced by their expectation of the cost of purchasing inputs per rai of each crop. The

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1 See Appendix D for regression analysis.

quantity of inputs used determines the cost of inputs. A higher cost usually means lower profits to the farmers. The expected relative cost of purchased inputs per rai of sugarcane and competing crops will therefore affect sugarcane production.

(5) Weather. Production of any crop is affected by the level of rainfall, humidity and temperature. The level of rainfall especially affects the production of sugarcane and its sugar content (sucrose). Too much rain dilutes the sucrose content and may kill the plant. If the purchasing system is by sucrose content, the price received by the farmers will be lower. On the other hand, if the rainfall is too low, the sugarcane will be dry as well as affecting the sucrose content and the weight. Rainfall is also one of the main determinants of the area planted, especially since there is no irrigation system available. Sugarcane farmers plant the new sugarcane at the onset of the wet season. If there is not enough rain to soften the soil, farmers are faced with difficulties in sowing, which may result in a reduced area planted. A dummy variable is used here. Zero for 1500-2000 millimetres and 1 otherwise.

(6) Sugarcane Farmers' Association. Chapter 3 has already discussed the role and activities of the Association in detail. It is believed that the Association is one of the factors which enables higher sugarcane prices (at factory level). With the bargaining power of the Association, farmers expect to get higher prices, thus the introduction of an effective Sugarcane Farmers' Association may affect production and the sugarcane planted area. An attempt should therefore be made to see whether the existence of a Sugarcane Farmers' Association

does have any effect on farmers' decisions on the sugarcane planted area. Dummy variable will be used. Zero for non-existence and 1 otherwise.

(7) Government intervention. The Thai Government controlled the sugarcane price in every region of Thailand during the years 1961 to 1965. In the Eastern Region, the price was 125 baht per tonne. In the Central Region, the price was 115 baht per tonne. The price in the North and North-Eastern Regions was slightly lower. The criteria used by the Government to impose these prices is not known.

The reason for controlling price in that period was that the Government had created a "Sugar Industry Aid Fund" to subsidise the sugar mills in order to stimulate exports.

In 1975, the Government introduced guaranteed minimum sugarcane prices (at factory level) for all regions at 300 baht per tonne. Actually, the Government had no intention of interfering with the price-setting process but agreement could not be reached between the Sugarcane Farmers' Association and the sugar factories, even after the second meeting. Hence, the Government had to step in. At present, this guaranteed minimum price is still in effect.

Again, dummy variable will be used. Zero for no policy and 1 otherwise.

(8) Activity of Quotaman. It has been explained in Chapter 3 how the quota system can affect the sugarcane price received by the farmers. From the farmers' returns are deducted the transport

cost, payments due to the quotaman, e.g. the interest rate on loans borrowed from the quotaman, commission, and so on. Dummy variable is used to represent aggressiveness of quotaman. Zero when farmer expects that quotaman's activity is aggressive and 1 otherwise.

(9) Area of sugarcane removed in year t. The area removed is always less than or equal to the area planted to sugarcane three years earlier (year t-3). With the assumption that there are no damaged plants due to flood, fire, drought or insects, area removed is always the area planted in year t-3. This is because all the second ratoon is removed. The economic rationale behind this is that the discounted future returns from the three year old crop are lower than the discounted future returns from replacement plantings. This can be largely attributed to the significant drop in yield and sucrose content after the second ratoon crop and the consequent decrease in returns. Although fertilizer can be used to try and lessen the yield decrease, it would appear that the costs involved are greater than the costs of replacing the crop.

5.3 The General Model

The initial model developed here is based upon the hypothesis that the actual area planted is actually the desired area planted. Farmers have no difficulties in adjusting the number of rai to their desired level. The above information can be expressed as a functional relationship as follows:

$$NP_t = f(S, \bar{P}_s, \bar{P}_c, \bar{C}, \bar{Y}_s, \bar{Y}_c, R, G, O, W, Q)$$

where:

NP_t = new planting in year t

S = stock of sugarcane, i.e. new planting in year t-1 and t-2

$\bar{P}_s$ = expected price of sugarcane in year t

$\bar{P}_c$ = expected price of competing crops in year t

$\bar{C}$ = expected cost of input

$\bar{Y}_s$ = expected yield of sugarcane in year t

$\bar{Y}_c$ = expected yield of competing crops in year t

R = area under sugarcane removed in year t, which under the assumption of no damaged plants, is the area planted in year t-3

G = Government intervention

O = existence of Sugarcane Farmers' Association

W = weather condition

Q = quotaman's activity

The estimated equation is therefore as follows:

$$NP_t = a + b_1\bar{P}_s + b_2\bar{P}_c + b_3\bar{C} + b_4\bar{Y}_s + b_5\bar{Y}_c + b_6G + b_7O$$

$$+ b_8W + b_9R_t + b_{10}a + u_t$$

The above equation will be estimated using linear and log linear equation forms. For the linear form, a coefficient reflects the absolute change in dependent variable resulting from a unit change in the independent variable. For log linear form, log value of both dependent and independent variables is used for estimation. Hence the coefficient can be interpreted as percentage change in dependent variable which results from a 1 per cent change in independent variable, i.e. the coefficient can be directly interpreted as an elasticity estimate. For the linear equation a mean elasticity estimate can be divided by multiplying the coefficient by the ratio of

$$\frac{\text{mean independent variable}}{\text{mean dependent variable}}.$$

Standard error of estimate will be great if one uses the form which does not yield the best fit to the available data. Standard statistical tests (R^2, F-test, etc.) will be used to consider which of the estimated forms provides the best fit.

It is expected that the new planting area would be positively associated with changes in its expected own price but negatively associated with changes in the expected price of competing crops, and changes in the expected cost of sugarcane production. The coefficients of $\bar{Y}_s$ and $\bar{Y}_e$ may be of a negative or positive sign, depending on the level of production of the crops per se that the farmer expects. If the farmer has a fixed level of production in mind, the expected yield increase may not lead to an increase in new planting area. If the farmer expects sugarcane yield to decrease, he may increase the new planting area to maintain that fixed level of production. On the other hand, if the farmer does not have a fixed level of production in mind, expected yield increase may lead to increase in the new planting area.

The coefficient of the Government variable is expected to be positive. This means that changes in Government policy have a positive effect on farmers' decisions. The new planting area is responding positively to change in Government policy. A zero coefficient means that new planting is not influenced by changes in Government policy. Worse still is a negative coefficient which indicates that Government policy has detrimental effects. The Government, in order to make an effective policy, should look into the cause of the non-responsiveness of the farmers.

The coefficient of quotaman variable is expected to be of a negative sign. Any change in quotamen's activities influences farmers' decisions on new planting area. Quotamen's commissions, interest paid of loans, and other payments to quotamen all affect income earned by farmers. The more aggressive the quotaman, the lower the expected farm income - the result of which is low incentives to plant more sugarcane, and vice versa.

The coefficient of weather condition variable is expected to be positive. It indicates that favourable moisture conditions during planting time encourage a little more area to be put under sugarcane. This is especially true when irrigation facilities are not available.

The coefficient of removed area variable is expected to be positive. Given favourable price conditions, the more areas that have to be removed, the more new planting areas, and vice versa.

The coefficient of Sugarcane Farmers' Association is expected to be positive. With the expected increase in price due to the existence of the Association and its bargaining power, farmers increase new planting area.

CHAPTER 6

EMPIRICAL/ESTIMABLE MODEL

6.1 Data

6.1.1 The Limitation and Adjustment

Unfortunately, major limitations with respect to both availability and accuracy of the data necessitate the exclusion of certain variables. Consequently some adjustments of the data and the model are inevitable.

(a) Planted area data. For sugarcane the area newly planted in any one year is not known. This presents a very serious problem for the proposed model, since new plantings in year t constitute the dependent variable and plantings in year t-1, t-2 and t-3 years appear as independent variables. To try and overcome this problem a simplification of the model, based on total area data, will be used as outlined shortly. The Sugar Institute collects data yearly (specific date and time is not known). There is no missing data on the planted area of sugarcane. For maize, the data is obtained from the Division of Agricultural Economics, Ministry of Agriculture and Cooperatives. The Eastern Region presents some problems because data for 1969 to 1971 are missing, the reason for which is not known. Possibly it was because data was not collected or because there was no maize planted during the period. The author assumes the second reason. For mungbean, the data on planted area in 1970 is missing for all regions. It has been assumed that no mungbean was planted in 1970. For cassava and rice, no such problem was encountered.

(b) Annual average yield. Yield data is obtained by dividing total production of each crop by its area planted in that year. With improved technology, and better varieties of crops, it is expected that, with fairly constant and favourable weather conditions together with good fertility, the yield will be improved through time (except for cassava, where fertilizer has never been applied to the soil. This is particularly true in the case of Thailand). Yield is regressed against time from 1968 to 1975. Predicted yield is used in the study as a measure of expected yield instead of the actual yield.

(c) Price data. Price information presents several problems. Ideally, farm prices should be used in the study but for sugarcane this data is not available. The factory price and farm price of sugarcane were compared and it was found that there is no reliability in the farm price. For example, farm prices in the Northern Region in 1972/73 were 100.28 baht per tonne but in 1973/74 they were 94.90 baht per tonne, a decrease in price while farm prices in the other regions were increasing. Factory price from 1972/73 to 1973/74 showed an increase from 155.08 baht per tonne to 177.79 baht per tonne, which contrasts with the decrease in farm price. Moreover, there are missing data and the farm prices for the Eastern Region were not recorded. Hence, factory price is used as a proxy by assuming that quotamen, whose activities account for the difference in price, try to keep their proportion of income stable from year to year. The cassava price also presents problems. Data are missing or unreliable. For example, in 1973 the cassava price in the Northern Region was 0.04 baht per kilogram, in North-Eastern Region 0.27 baht per kilogram, while for the Central and Southern Regions it was 5.92 baht per kilogram and 1.85 baht per kilogram respectively. It was decided to use the whole kingdom farm price of cassava for all four regions under study. As for maize and mungbean, the only problem is missing data. It was decided, therefore, to find the missing data by comparing the regional farm price with the whole-kingdom farm price, observing the per cent increase or decrease in the whole-kingdom farm price of the year in question over the previous year and adjusting the missing regional farm price accordingly.

For the Eastern Region as a whole, several difficulties were encountered. According to the Sugar Institute, sugarcane growing areas are divided into four regions - the Central, Eastern, Northern and North-Eastern Regions. But officially, all Thai statistics are recorded for the Central, Northern, North-Eastern, and Southern Regions. The Eastern Region, according to the classification of the Sugar Institute, is, in fact, part of the Central Region as classified by official statistics. The price of sugarcane is specified according to the Sugar Institute. Prices of other competing crops are recorded according to the normal Thai statistics. Farm price of sugarcane is collected by the Division of Agricultural Economics, Ministry of Agriculture and Cooperatives and not by the Sugar Institute which is the reason why farm prices in the Eastern Region are not recorded. Therefore, the price of competing crops in the Eastern Region used in the study is, in fact, the price in the Central Region.

(d) Cost data. It is not possible to get annual data on the cost of production for sugarcane and competing crops for the eight years under study. For some of the crops like mungbean, cost data is available for only one year. Thus it is impossible to include this factor in the model to be estimated.

(e) Rainfall data. The data on rainfall is on a yearly basis and a record is usually not kept in the provinces that grow sugarcane. If the data is used it will not represent the true decision-making process of the sugarcane farmers. Furthermore, the study has a very low number of observations. Inclusion of another variable means a loss of a further degree of freedom. For the abovementioned reasons, it was decided not to include the weather variable in the model.

(f) Sugarcane Farmers' Association. This variable is dropped because the available data on farm price is from 1968 to 1975, the period throughout which the Association existed. Thus, the inclusion of this variable into the model is unnecessary.

(g) Government intervention. As mentioned before, the available data on farm price is from 1968 to 1975. Therefore, it was decided not to include this variable in the model. But it should be borne in mind that the speculation by farmers on the Government policy on sugarcane price may play a very important role in their decisions.

(h) Activity of quotamen. Data on payments to quotamen are impossible to collect. Thus, it was decided not to include it as another independent variable.

6.1.2 Period of Study

Even though the sugarcane price (at regional factory level) can be obtained from 1961 to 1975, competing crops price (regional farm price) can only be obtained from 1968 to 1975 which is only eight years. An attempt was made to use the wholesale price of competing crops to get 14 observations, but the result obtained was much poorer than using the regional farm price for competing crops of the eight year period.

6.1.3 Reliability of Data

The regional farm prices for competing crops and area planted to competing crops in the sugarcane centre are primary data obtained from the Division of Agricultural Economics, Ministry of Agriculture and Cooperatives. These data are not published. The published data are those of the whole kingdom farm price and the total area under particular crops. The author does not know of the adjustments that are made to the primary data before they are averaged out to obtain the whole-kingdom farm price and the total area planted. Little is known about the precision of the data published, let alone the unpublished primary data. The yield rate of any crop is obtained by dividing the total production of one crop by its total area planted. Again, the primary data are used.

Sugarcane data are collected by the Sugar Institute. This information is presumably more reliable than that collected by the Agricultural Economics Division whose functions are wider than the Sugar Institute which specializes in the sugarcane and sugar field.

The method of data collection and survey for all crops under study is not known. In the absence of information on these matters, the precision and reliability of the data are very suspect and, therefore, this must be borne in mind when interpreting the estimated supply functions.

6.2 Simplification of the Model

From the discussion in Section 6.1, the general model presented in Chapter 5 needs to be simplified.

Since sugarcane is a ratoon crop, once a crop is planted it will remain planted for three harvests (assuming that farmers do not remove the crop prior to the second ratoon season); the area planted in total to sugarcane in any one year will be the sum of plantings in years t, t-1, and t-2, i.e.:

$$A_t = NP_t + NP_{t-1} + NP_{t-2} \quad (1)$$

where

A_t = total area planted in period t

NP_t, NP_{t-1}, NP_{t-2} = new planting in periods t, t-1 and t-2 respectively.

Similarly:

$$A_{t-1} = NP_{t-1} + NP_{t-2} + NP_{t-3} \quad (2)$$

Subtracting (2) from (1), we obtain:

$$\Delta A_t = NP_t - NP_{t-3} \quad (3)$$

where $\Delta A_t = A_t - A_{t-1}$

NP is composed of replacement of the sugarcane planted in period t-3 and the net change in planted area ΔA_t (which may be positive or negative).

The change in area in any year will be the net result of two opposite forces - the removal of the crop planted three years ago and the newly planted crop this year. If the change in area is negative then the new planted area is not sufficient to offset the area lost by removal of the three-year-old crop. This may be due to several reasons:

(1) Poor gross returns and non-price conditions in the present period, e.g. Government policy on restriction of land to be planted with sugarcane.

(2) Very favourable gross returns and other non-price conditions in the period three years ago (and hence abnormally high plantings in that period).

(3) A combination of both.

Similarly, if the change in area is positive then the loss in area from crop removal is more than offset by new planted areas in the current period. Again, a very relevant influence here may be the gross returns and the non-price conditions prevailing in one or other, or both of the two time periods. The above information together with the information in Section 4.1 suggests that NP_t and NP_{t-3} may be determined by gross returns, weather conditions, cost of inputs, existence of sugarcane farmers' associations, activity of quotamen and Government intervention in the two periods. As mentioned earlier in Section 4.1, i.e. the impossibility to include the latter five variables in the model, means that the only main determinant left is gross returns which therefore will be used as a proxy for profitability. Thus the possible model is:

$$\Delta A_t = f(R_t - R_{t-3}) \quad (4)$$

which means that the total change in planted area in period t is determined by the change in profit between the two periods. If no cost information is included then there is an implicit assumption that production costs remain consistent over time.

Consideration must also be given to the prices of alternative crops. The sugarcane farmer is likely to be concerned with the profitability of sugarcane relative to the profitability of other best alternative competing crops. Hence:

$$\Delta A_t = f(\Pi_t - \Pi_{t-3}) \quad (5)$$

where Π_t is relative profitability of sugarcane in period t; and Π_{t-3} is relative profitability of sugarcane in period t-3.

Gross returns used as a measure of profitability measure is defined here as price times yield per rai. This results in a significantly better explanatory model than using price alone. However, in using gross returns we assume a 10 per cent increase in yield has the same effect on acreage as a 10 per cent increase in price. Furthermore, because it is in relative terms, the model faces a zero degree homogeneity constant with respect to the effects of relative prices and yields. That is, a 10 per cent increase in prices of both crops leaves area planted unchanged.

Some form of price expectation is actually used in the estimating model because farmers form expectations of prices for the current year which in turn determines the amount of area planted. Hence equation (5) becomes:

$$\Delta A_{st} = f(\Pi^e_t - \Pi^e_{t-3}) \qquad (6)$$

where:

$\Pi^e_t = \dfrac{P^e_{st} \times Y^e_{st}}{P^e_{ct} \times Y^e_{ct}}$ = expected relative profitability of sugarcane to competing crop in year t

$\Pi^e_{t-3} = \dfrac{P^e_{st-3} \times Y^e_{st-3}}{P^e_{ct-3} \times Y^e_{ct-3}}$ = expected relative profitability of sugarcane to competing crop in year t-3

$Y^e_{it} = f(T)$ = expected yield of the i^{th} crop in year t

T = time trend from 1968 to 1975

6.3 Search for Specification of Farmers' Expectation of Price

The expectation of price formed by farmers is different when different expectation models are applied. These may be the naive model or the distributed lag models which will be discussed briefly below:

(1) The naive model. The more general form is that the expected price in period t is determined by the previous year price:

$$P^e_t = P_{t-1}$$

Again, the expected price can be the mean price of the previous two, three or four years.

However, this is a gross over-simplification (in the case of the OLS) of the complex phenomenon of price expectation formation. Parameters obtained from the models, as a result, may be unrealistic and lower than those obtained from other models.[1]

(2) Distributed lag model. This model implies that expected price in a year is the weighted sum of all past prices prior to that year. That is:

$$P_t^e = \sum_{i=1}^{\infty} W_i P_{t-i} \quad \text{where} \quad \sum_{i=1}^{\infty} W_i = 1 \quad \text{and} \quad W_i > 0$$

W_i can be estimated directly by least squares if the number of relevant values over which the distributed lag extends is small and the successive past observations are not collinear. Otherwise some restrictive assumption about the pattern of weights is necessary, giving rise to different estimating methods, some of which are summarized here:

(a) The arithmetic lag structure suggested by Fisher (1935). This is a structure of weights where the weights of successive observations decline in an arithmetic progression as one goes back in time.

$$P_t^e = \frac{2}{n(n+1)} \sum_{i=0}^{n-i} (n-i) P_{t-i}$$

1 M. Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities", Journal of Farm Economics, Vol. 38, pp. 496-509.

where n is the number of years over which the distributed lag extends. By iterating n, different values of P^e_t can be obtained and when substituted in the model, the one which gives the best fit of the model can then be chosen to estimate the supply response.[2]

(b) The geometric lag structure. Koyck's general distributed lag function is:

$$A_t = a + \alpha_1 P_{t-1} + \alpha_2 P_{t-2} + \alpha_3 P_{t-3} + \ldots + u_t \quad (1)$$

But the close intercorrelation of successive values of prices (P) leads to problems of multicollinearity. Thus, he suggests that the weights of successive observations decline in a geometric progression as one goes back in time because it is normally expected that the more remote values would tend to have a smaller influence than the more recent ones. If the coefficient of the k^{th} lag is the first one in such a geometrically declining series, we have:

$$\alpha_{k+j} = \Theta^j \alpha_k \qquad 0 \leq \Theta < 1 \qquad j \geq 0 \quad (2)$$

Substituting (2) in (1) gives:

$$A_t = a + \alpha_1 P_{t-1} + \ldots + \alpha_k P_{t-k} + \alpha_k \Theta P_{t-(k+1)} + \alpha_k \Theta^2 P_{t-(k+2)}$$

$$+ \ldots + u_t \quad (3)$$

Equation (3) simply states that after the first k lags the coefficients of P decline in geometric progression, each one being Θ times its predecessor where Θ is zero or positive but less than one.

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2 A regression was run using the arithmetic lag structure but R^2 obtained was very low. It is as low as 0.0009.

The Koyck model postulates the existence of a distributed lag. Nerlove, however, accounts for its existence in the adaptive price expectations model, i.e.:

$$P_t^* - P_{t-1}^* = \beta(P_{t-1} - P_{t-1}^*) \qquad 0 \leq \beta < 1$$

where β is the coefficient of expectation.

The model assumes that all past prices must be considered but in practice prices in the very distant past can be ignored as β is zero or positive but less than 1. The exact point at which such past prices can be ignored depends on the size of β. The bigger the size of β, the more the farmer depends on his previous expectations and therefore the larger the number of past prices that must be included.

The number of past prices that should be included in order that the error be less or equal to some small positive value, e, can be calculated from the following formula:

$$|1 - (1-\beta)^{n-1}| \leq e$$

where n is the number of past prices.

The Nerlovian model can be extended to include other independent variables.

The Koyck and the Nerlovian models introduce problems of serial correlation, even though they reduce the multicollinearity problem.

(c) Assume no structure. Timbergen suggests that the lagged prices should be added successively in the estimation of the model until the signs of the coefficients become erratic and cease to make sense, i.e. there is a change in sign or magnitude of the coefficients. The typical distributed lag supply function is thus:

$$A_t = a + \sum_{i=1}^{\infty} b_i P_{t-i} + u_t$$

However, the model is applicable only when the successive observations of the lagged variables are not intercorrelated. This is especially true with price data. The model will yield unstable estimates of the parameters and the variance of the estimates is high. Furthermore, stopping the addition of successive lagged prices for estimation when the signs become erratic is an a priori bias because it does not mean that the lagged variable has no influence when the coefficients become erratic.

It was decided, in the analysis of the supply response of sugarcane farmers in Thailand, to try the Nerlovian geometric lag, Fisher arithmetic lag, and naive model where the price expectation is formed from a one year lagged, a two year average price, and a two year lagged price.

6.4 Adjustment of the Simplified Model

If we assume that, no matter what level of NP, i.e. new planting is desired, the farmer is more concerned with the total area planted to sugarcane and that he has no difficulties in adjusting it to the desired level; that is, it is assumed that per unit return of NP_t is independent of NP_{t-3}, then:

$$A^*_{st} = A_{st} = f \text{ (current expected profitability) where } A^*_{st}$$

is the desired area planted to sugarcane and A_{st} is the actual area planted to sugarcane.

Hence, the simplified model is adjusted to:

$$A_{st} = f(\Pi^e_t)$$

$$\Pi^e_t = \frac{P^e_{st} \times Y^e_{st}}{P^e_{ct} \times Y^e_{ct}}$$

$$Y^e_{it} = f(T)$$

where:

A_{st}	=	total area planted to sugarcane
Π^e_t	=	expected relative profitability of sugarcane to competing crop in year t
Y^e_{it}	=	expected yield of the i^{th} crop in year t
T	=	time trend from 1968 to 1975
P^e_{st}, P^e_{ct}	=	expected price of sugarcane and competing crop in year t

6.5 Specification of the Model

Assuming that the variables in the general model in Section 6.3 have a linear relationship in their real value and adding an error term, the statistical supply model for sugarcane can be written as:

$$A_{st} = \alpha_0 + \alpha_1 \Pi_t^e + u_t$$

$$Y_{it}^e = \log T + e_t$$

$$\Pi_t^e = \frac{P_{st}^e \times Y_{st}^e}{P_{ct}^e \times Y_{ct}^e}$$

where:

A_{st} = total area planted to sugarcane in year t

Π_t^e = expected relative profitability of sugarcane to competing crop per rai in year t

Y_{it}^e = expected yield of the i^{th} crop

T = time trend from 1968 to 1975

P_{st}^e, P_{ct}^e = expected price of sugarcane and competing crops respectively

u_t, e_t = error terms

6.6 Specified Form of Expectation and Choice of Lag Structure

Whatever estimating techniques and form of expectation used, inaccurate results are expected when data used in the study is unreliable, other data is unavailable, and when there are only a few observations. Therefore, it was decided to use only a few of the expectation models. The naive model of price expectation (1 year lag, 2 year average price, 2 year lag, and current price) and the Nerlovian price expectations were tried. The estimation models are:

(1) The naive model:

(A) $$A_{st} = \alpha_0 + \alpha_1 \left(\frac{P_{st-1} \times Y^e_{st}}{P_{ct-1} \times Y^e_{ct}}\right) + e_t$$

where $\frac{P_{st-1}}{P_{ct-1}}$ is relative price lagged one year.

(B) $$A_{st} = \alpha_0 + \alpha_1 \left(\frac{\bar{P}_{st} \times Y^e_{st}}{\bar{P}_{ct} \times Y^e_{ct}}\right) + e_t$$

where $\bar{P}_{st}$ and $\bar{P}_{ct}$ are the previous 2 year average prices of sugarcane and competing crops respectively.

(C) $$A_{st} = \alpha_0 + \alpha_1 \left(\frac{P_{st-2} \times Y^e_{st}}{P_{ct-2} \times Y^e_{st}}\right) + e_t$$

where $\frac{P_{st-2}}{P_{ct-2}}$ is relative price lagged two years.

(D) $$A_{st} = \alpha_0 + \alpha_1 \left(\frac{P_{st} \times Y^e_{st}}{P_{ct} \times Y^e_{ct}}\right) + e_t$$

where P_{st} and P_{ct} are the current prices of sugarcane and competing crops respectively.

Even though the price of sugarcane is determined after the sugarcane has been grown, i.e. the sowing season is in May or June (at the onset of the rainy season) and the price is determined later through a bargaining process in November prior to the sugar production, it may be assumed that the sugarcane farmers' association has a target price set in mind. The association usually sets the negotiated price higher than the target one so that after the bargaining takes place the association achieves more or less the target price. However, as the executive members of the association are quotamen and sugarcane farmers themselves, the expected current price may be known beforehand. Prices for the competing crops do not have to go through the bargaining process, and they are available throughout the current year. Since it is assumed that prices of competing crops play an important role in farmers' decision-making, their current levels therefore may have an impact on farmers' decisions. This is the reason for using current prices.

(2) Nerlovian price expectations:

$$A_{st} = a + b\,\Pi_t^e + u_t \qquad (1)$$

where:

A_{st} = total area planted to sugarcane in period t

Π_t^e = relative expected gross returns of sugarcane in period t

u_t = error term

$$\Pi_t^e - \Pi_{t-1}^e = \beta(\Pi_{t-1} - \Pi_{t-1}^e) \qquad (2)$$

and β is the coefficient of expectation.

The above equation states that for each period the farmer revises the change in the gross returns ratio he expects to occur in the coming period in proportion to the mistake he made in predicting price this period.

From equation (1) the expected profitability variable in period t can be written as:

$$\Pi_t^e = \frac{-a}{b} + \frac{1}{b} A_{st} - \frac{1}{b} u_t \qquad (3)$$

Similarly,

$$\Pi_{t-1}^e = \frac{-a}{b} + \frac{1}{b} A_{st-1} - \frac{1}{b} u_{t-1} \qquad (4)$$

Hence, equation (2) can be written as:

$$\Pi_t^e = \beta(\Pi_{t-1}) + (1-\beta)\, \Pi_{t-1}^e \qquad (5)$$

Substituting Π_{t-1}^e from (4) in (5), we obtain:

$$\Pi_t^e = \beta\, \Pi_{t-1} + (1-\beta)\, [\frac{-a}{b} + \frac{1}{b} A_{st-1} - \frac{1}{b} u_{t-1}] \qquad (6)$$

Substituting Π_t^e from (6) into (1), gives:

$$A_{st} = a\beta + b\beta\, (\Pi_{t-1}) + (1-\beta)\, A_{st-1} + u_t - (1-\beta)\, u_{t-1}$$

and the final equation becomes:

$$A_{st} = a_0 + b_0\, \Pi_{t-1} + c_0\, A_{st-1} + v_t$$

where $a_0 = a\beta$, $b_0 = b\beta$, $c_0 = (1-\beta)$ and $v_t = u_t - (1-\beta)\, u_{t-1}$

where:

A_{st} = area planted to sugarcane in year t

Π_{t-1} = relative gross returns in year t-1

A_{st-1} = lagged area planted to sugarcane in year t-1

v_t = error term

6.7 Results and Discussion

The results obtained from the various regression relationships using O.L.S. method are given below.

(A) Simple Linear Regression

(1) Naive Model (price lagged one year)

(i) Central Region:

$$A_{st} = 1657340.94 - \underset{(114853.695)}{185704.459}\ \Pi_t^e$$

R^2 = 0.34 D.F. = 6 S.E.E. = 284571.734

D-W Test = 0.99295

(ii) Eastern Region:

$$A_{st} = 131871.038 + \underset{(45934.0611)}{108881.3150}\ \Pi_t^e$$

R^2 = 0.53 D.F. = 6 S.E.E. = 52243.8111

D-W Test = 0.96421

(iii) Northern Region:

$$A_{st} = -253610.782 + \underset{(62662.7294)}{206240.1990}\ \Pi_t^e$$

R^2 = 0.67 D.F. = 6 S.E.E. = 46157.72470

D-W Test = 1.02539

(iv) North-Eastern Region:

$$A_{st} = 19010.97150 + \underset{(56059.88340)}{76535.03880}\ \Pi_t^e$$

$R^2 = 0.27$ D.F. = 6 S.E.E. = 30321.23890

D-W Test = 0.34741

(2) Naive Model (2 year average price)

(i) Central Region:

$$A_{st} = 2781365.2 - \underset{(123765.904)}{406108.786}\ \Pi_t^e$$

$R^2 = 0.73$ D.F. = 5 S.E.E. = 177058.79300

D-W Test = 0.36443

(ii) Eastern Region:

$$A_{st} = 95442.71120 + \underset{(82468.57080)}{154229.54300}\ \Pi_t^e$$

$R^2 = 0.47$ D.F. = 5 S.E.E. = 59849.87580

D-W Test = 0.64032

(iii) Northern Region:

$$A_{st} = -414893.142 + \underset{(111456.32600)}{313588.22000}\ \Pi_t^e$$

$R^2 = 0.66$ D.F. = 5 S.E.E. = 49638.74940

D-W Test = 1.24048

(iv) North-Eastern Region:

$$A_{st} = 45808.28770 + \underset{(118537.69300)}{46728.39560}\ \Pi_t^e$$

$R^2 = 0.04$ D.F. = 5 S.E.E. = 38389.25710

D-W Test = 0.44494

(3) Naive Model (2 year lagged price)

(i) Central Region:

$$A_{st} = 144361.45 - \underset{(132827.808)}{130124.367}\ \Pi^e_t$$

$R^2 = 0.19$ D.F. = 5 S.E.E. = 305514.06100

D-W Test = 0.65088

(ii) Eastern Region:

$$A_{st} = 236182.703 + \underset{(126247.56500)}{40757.57110}\ \Pi^e_t$$

$R^2 = 0.03$ D.F. = 5 S.E.E. = 80892.08692

D-W Test = 0.37393

(iii) Northern Region:

$$A_{st} = -212181.794 + \underset{(165887.54900)}{196379.50100}\ \Pi^e_t$$

$R^2 = 0.26$ D.F. = 5 S.E.E. = 73728.25950

D-W Test = 0.89353

(iv) North-Eastern Region:

$$A_{st} = 119790.065 - \underset{(84666.07410)}{60312.59330}\ \Pi^e_t$$

$R^2 = 0.11$ D.F. = 5 S.E.E. = 36859.73610

D-W Test = 0.91978

(4) Naive Model (current price)

(i) Central Region:

$$A_{st} = 986813.605 - \underset{(143035.98200)}{68947.60860}\ \Pi^e_t$$

$R^2 = 0.04$ D.F. = 7 S.E.E. = 361612.38300

D-W Test = 0.25167

(ii) Eastern Region:

$$A_{st} = 164547.97800 + \underset{(19052.43250)}{59533.57230}\ \Pi^e_t$$

$R^2 = 0.62$ D.F. = 7 S.E.E. = 50669.75530

D-W Test = 1.18890

(iii) Northern Region:

$$A_{st} = -88222.25650 + \underset{(11138.42750)}{87724.93720}\ \Pi^e_t$$

$R^2 = 0.91$ D.F. = 7 S.E.E. = 22470.38

D-W Test = 1.81738

(iv) North-Eastern Region:

$$A_{st} = 19537.74200 + \underset{(13806.01730)}{59305.76740}\ \Pi^e_t$$

$R^2 = 0.75$ D.F. = 7 S.E.E. = 16937.00680

D-W Test = 1.00053

(5) Nerlovian Expectation Model

(i) Central Region:

$$A_{st} = 458104.342 - \underset{(33884.73420)}{62492.22120}\ \Pi_{t-1} + \underset{(0.12422)}{1.02024}\ A_{st-1}$$

$R^2 = 0.96$ D.F. = 6 S.E.E. = 75278.72810

D-W Test = 2.69438

(ii) Eastern Region:

$$A_{st} = 36307.85810 + \underset{(45242.73210)}{60421.56080}\, \Pi_{t-1} + \underset{(0.34560)}{0.65411}\, A_{st-1}$$

$R^2 = 0.75$ D.F. = 6 S.E.E. = 42424.79900

D-W Test = 1.62853

(iii) Northern Region:

$$A_{st} = -45675.55990 + \underset{(86813.21940)}{24933.26920}\, \Pi_{t-1} + \underset{(0.64064)}{1.57307}\, A_{st-1}$$

$R^2 = 0.87$ D.F. = 6 S.E.E. = 32590.63070

D-W Test = 2.13702

(iv) North-Eastern Region:

$$A_{st} = -47203.74960 + \underset{(38742.03980)}{37220.63520}\, \Pi_{t-1} + \underset{(0.54020)}{1.52914}\, A_{st-1}$$

$R^2 = 0.76$ D.F. = 6 S.E.E. = 19561.74760

D-W Test = 1.33559

(B) Log Linear Regression

(1) Naive Model (price lagged one year)

(i) Central Region:

$$A_{st} = 6.94906 - \underset{(0.94188)}{1.62045}\, \Pi_t^e$$

$R^2 = 0.37$ D.F. = 6 S.E.E. = 0.18050

D-W Test = 0.92289

(ii) Eastern Region:

$$A_{st} = 5.38041 + \underset{(0.23368)}{0.49306}\ \Pi_t^e$$

$R^2 = 0.47$ D.F. = 6 S.E.E. = 0.08273

D-W Test = 1.05149

(iii) Northern Region:

$$A_{st} = 0.12067 + \underset{(1.12773)}{3.29675}\ \Pi_t^e$$

$R^2 = 0.63$ D.F. = 6 S.E.E. = 0.12426

D-W Test = 1.17126

(iv) North-Eastern Region:

$$A_{st} = 4.9421 + \underset{(0.50518)}{0.62292}\ \Pi_t^e$$

$R^2 = 0.23$ D.F. = 6 S.E.E. = 0.15546

D-W Test = 0.42164

(2) Naive Model (two year average price)

(i) Central Region:

$$A_{st} = 7.56738 - \underset{(0.92614)}{2.47652}\ \Pi_t^e$$

$R^2 = 0.64$ D.F. = 5 S.E.E. = 0.12018

D-W Test = 0.35844

(ii) Eastern Region:

$$A_{st} = 5.39060 + \underset{(0.36269)}{0.67707}\ \Pi_t^e$$

$R^2 = 0.47$ D.F. = 5 S.E.E. = 0.08974

D-W Test = 0.63533

(iii) Northern Region:

$$A_{st} = 3.86792 + \underset{(1.79565)}{4.78771}\ \Pi_t^e$$

$R^2 = 0.64$ D.F. = 5 S.E.E. = 0.21739

D-W Test = 1.39111

(iv) North-Eastern Region:

$$A_{st} = 4.91799 + \underset{(1.00154)}{0.34011}\ \Pi_t^e$$

$R^2 = 0.03$ D.F. = 5 S.E.E. = 0.19380

D-W Test = 0.44033

(3) Naive Model (price lagged 2 years)

(i) Central Region:

$$A_{st} = 6.56759 - \underset{(1.02343)}{1.00338}\ \Pi_t^e$$

$R^2 = 0.19$ D.F. = 5 S.E.E. = 0.18017

D-W Test = 0.67692

(ii) Eastern Region:

$$A_{st} = 5.42811 + \underset{(0.49250)}{0.22389}\ \Pi_t^e$$

$R^2 = 0.05$ D.F. = 5 S.E.E. = 0.11970

D-W Test = 0.39256

(iii) Northern Region:

$$A_{st} = 4.26659 + \underset{(2.21980)}{3.14097}\ \Pi_t^e$$

$R^2 = 0.33$ D.F. = 5 S.E.E. = 0.29575

D-W Test = 0.91190

(iv) North-Eastern Region:

$$A_{st} = 4.76973 - \underset{(0.73057)}{0.52652}\ \Pi^e_t$$

$R^2 = 0.11$ D.F. = 5 S.E.E. = 0.18493

D-W Test = 0.92102

(4) Naive Model (current price)

(i) Central Region:

$$A_{st} = 6.37855 - \underset{(1.36348)}{0.90025}\ \Pi^e_t$$

$R^2 = 0.07$ D.F. = 7 S.E.E. = 0.26863

D-W Test = 0.22950

(ii) Eastern Region:

$$A_{st} = 5.34228 + \underset{(0.17327)}{0.37716}\ \Pi^e_t$$

$R^2 = 0.44$ D.F. = 7 S.E.E. = 0.09985

D-W Test = 1.05501

(iii) Northern Region:

$$A_{st} = 4.26867 + \underset{(0.32979)}{1.99749}\ \Pi^e_t$$

$R^2 = 0.86$ D.F. = 7 S.E.E. = 0.12624

D-W Test = 1.62322

(iv) North-Eastern Region:

$$A_{st} = 4.88813 + \underset{(0.22996)}{0.63666}\ \Pi^e_t$$

$R^2 = 0.56$ D.F. = 7 S.E.E. = 0.11617

D-W Test = 1.04679

(5) Nerlovian Expectation Model

(i) Central Region:

$$A_{st} = 1.74842 - \underset{(0.24326)}{0.52961}\, \Pi_{t-1} + \underset{(0.08116)}{0.77817}\, A_{st-1}$$

$R^2 = 0.97$ D.F. = 6 S.E.E. = 0.04123

D-W Test = 2.43981

(ii) Eastern Region:

$$A_{st} = 2.57864 + \underset{(0.20675)}{0.34718}\, \Pi_{t-1} + \underset{(0.28155)}{6.52378}\, A_{st-1}$$

$R^2 = 0.72$ D.F. = 6 S.E.E. = 0.06772

D-W Test = 1.89356

(iii) Northern Region:

$$A_{st} = -0.91354 + \underset{(1.53533)}{0.43077}\, \Pi_{t-1} + \underset{(0.53790)}{1.20045}\, A_{st-1}$$

$R^2 = 0.75$ D.F. = 6 S.E.E. = 0.15987

D-W Test = 2.14850

(iv) North-Eastern Region:

$$A_{st} = 0.01453 + \underset{(0.41351)}{0.35605}\, \Pi_{t-1} + \underset{(0.49450)}{1.02193}\, A_{st-1}$$

$R^2 = 0.63$ D.F. = 6 S.E.E. = 0.12089

D-W Test = 1.20242

Looking at the coefficients obtained from different models, with two year lagged price as the expected price, more of the coefficients obtained are significantly different from zero. Using the two year average price, only the Northern Region has the coefficient of Π_t^e significantly different from zero at 2.5 per cent significance level. For price lagged one year, Eastern and Northern Regions have coefficients of Π_t^e significantly different from zero at 5 per cent and 1 per cent significance level respectively (at 5 per cent and 2.5 per cent significance level respectively for log linear regression). Using the current price, Eastern, Northern and North-Eastern Regions have coefficients of Π_t^e significantly different from zero at 1 per cent, 0.05 per cent and 0.5 per cent significance level respectively (at 5 per cent, 0.05 per cent and 2.5 per cent significance level respectively for log linear regression). For the Nerlovian Expectation Model, the coefficient of Π_{t-1} is insignificant for all regions (both linear and log linear regression), Northern and North-Eastern Regions at 0.05 per cent, 2.5 per cent and 2.5 per cent significance level respectively (0.05 per cent, 5 per cent and 5 per cent respectively for log linear regression). However, the coefficients of A_{st-1} are mostly greater than 1 which yields a negative coefficient of expectation (β) except for the Eastern Region (both linear and log linear regression) and Central Region (log linear regression only).

Therefore, using the Nerlovian Expectation Model, the Naive Model with price lagged one year, and the current price (in terms of acceptable sign and statistically significant coefficient) seems to work for the Eastern Region. Using the Naive Model with price lagged one year, the 2 year average price and the current price seem to work for the Northern Region. As for the Central Region, the only model that works is the Nerlovian Expectation Model with the coefficient A_{st-1} significantly different from zero at 0.05 per cent confidence level.

For the North-Eastern Region, it is the Naive Model with current price which works and the coefficient of Π_t^e is significantly different from zero at 0.5 per cent confidence level for linear regression and at 2.5 per cent confidence level for log linear regression. The R^2 obtained from the Nerlovian Expectation Model seems to be generally higher. The second highest is that obtained from the Naive Model with current price. When comparing R^2 between the Eastern and Northern Regions, it is the latter region which has the higher R^2. Also, the standard error of estimates for the latter region is lower.

All of the four regions can be grouped together, by assuming that sugarcane farmers, no matter what region they are in, have the same response function. By doing so, it enables one to obtain a larger number of observations. The results are as follows:

(A) Simple Linear Regression

(1) Nerlovian Expectation Model

$$A_{st} = -6104.57883 + \underset{(7982.86695)}{11952.33850}\ \Pi_{t-1} + \underset{(0.06391)}{1.16187}\ A_{st-1}$$

$R^2 = 0.96$ D.F. = 27 S.E.E. = 58089.89190

D-W Test = 1.47

(2) Naive Model (price lagged one year)

$$A_{st} = 32723.85390 + \underset{(21850.25950)}{109176.79700}\ \Pi_t^e$$

$R^2 = 0.49$ D.F. = 27 S.E.E. = 214791.37700

D-W Test = 1.71

(3) Naive Model (current price)

$$A_{st} = 929.53381 + \underset{(19041.66230)}{105134.63600}\ \Pi^e_t$$

$R^2 = 0.50$ D.F. = 31 S.E.E. = 202285.17300

D-W Test = 1.88

(B) Log Linear Regression

(1) Nerlovian Expectation Model

$$A_{st} = 0.34792 + \underset{(0.07778)}{0.14068}\ \Pi_{t-1} + \underset{(0.05825)}{0.94359}\ A_{st-1}$$

$R^2 = 0.96$ D.F. = 27 S.E.E. = 0.10150

D-W Test = 1.24

(2) Naive Model (price lagged one year)

$$A_{st} = 5.00360 + \underset{(0.19361)}{0.97590}\ \Pi^e_t$$

$R^2 = 0.49$ D.F. = 27 S.E.E. = 0.33744

D-W Test = 2.17

(3) Naive Model (current price)

$$A_{st} = 4.93041 + \underset{(0.17551)}{0.96616}\ \Pi^e_t$$

$R^2 = 0.50$ D.F. = 31 S.E.E. = 0.33007

D-W Test = 2.39

For the Nerlovian Expectation Model, a log linear regression gives a better result than the simple linear regression one. Using log linear regression, the coefficients of Π_{t-1} are significantly different from zero at 5 per cent significance level. The coefficient of A_{st-1} is significantly different from zero at 0.05 per cent significance level and the coefficient of expectation (β) is found to be 0.06. Using simple linear regression, the coefficient of Π_{t-1} is insignificant but that of A_{st-1} is significantly different from zero at 0.05 per cent significance level but β is negative.

For the Naive Model with a one year lagged price, R^2 obtained are much lower than those obtained by the Nerlovian Expectation Model. However, the coefficient of Π_t^e is significantly different from zero at 0.05 per cent significance level. For the Naive Model with current price, R^2 obtained is nearly the same as that obtained by using one year lagged price. The coefficient of Π_t^e is also significantly different from zero at the same significance level as that obtained by using one year lagged price.

The Nerlovian Expectation Model gives a higher R^2 and lower standard error of estimate than other models. Simple linear regression technique does not seem to work here due to the negative β value obtained. With the log linear regression technique, it yields high R^2, β is positive although very small which means that price for as long as, say 20 years, still has an effect on the farmer's expectation and the farmer tends to look at the more recent prices and bases his price expectation on them.

6.8 Elasticity of Response

For simple linear regression, the short-run elasticities of the sugarcane planting area with respect to relative gross returns are calculated using the formula:

$$\varepsilon = \frac{dA_{st}}{d\Pi_t} \quad \frac{\bar{\Pi}_t}{\bar{A}_{st}}$$

where:

ε = elasticity of area of sugarcane with respect to relative gross returns

$\frac{dA_{st}}{d\Pi_t}$ = first order derivative of A_{st} with respect to relative gross returns which is equal to the coefficient of (i.e. slope b)

$\bar{\Pi}_t$ and $\bar{A}_{st}$ = mean of the sample values of Π_t and A_{st} respectively

For the Nerlovian Expectation Model, long-run elasticity can be calculated from the following formula:

$$\eta = \frac{\varepsilon}{\beta}$$

where:

η = long-run elasticity

ε = short-run elasticity

β = coefficient of expectation

These coefficients which are not significantly different from zero at an acceptable level of significance (i.e. 5 per cent significance level) are assumed to be zero and elasticities were not estimated for them. The elasticities estimated are shown in Table 6.8.1.

TABLE 6.8.1

ELASTICITIES COEFFICIENTS OF SUGARCANE WITH RESPECT TO RELATIVE GROSS RETURNS

Model	Region	Simple Linear Regression		Log Linear Regression	
		Short Run[1]	Long Run[2]	Short Run[1]	Long Run[2]
Nerlovian	Eastern	0.29 (2.18)	0.83	n.c.	-
	Whole Kingdom	n.c.	-	0.14 (0.08)	2.33
Naive (One Year Lagged Price)	Eastern	0.05 (2.21)	-	0.49 (0.23)	-
	Northern	4.05 (1.27)	-	3.30 (1.13)	-
	Whole Kingdom	0.88 (0.17)	-	0.98 (0.19)	-
Naive (Two Year Average Price)	Northern	5.52 (1.96)	-	4.79 (1.80)	-
Naive (Current Price)	Eastern	0.38 (0.12)	-	0.38 (0.17)	-
	Northern	2.14 (0.27)	-	2.00 (0.33)	-
	North-Eastern	0.73 (0.17)	-	0.64 (0.23)	-
	Whole Kingdom	1.00 (0.07)	-	1.00 (0.18)	-

1 Short-run elasticities with respect to relative gross returns.
2 Long-run elasticities with respect to relative gross returns.
n.c. Not calculated because coefficients are either insignificant or have a wrong sign.
Figures in brackets are standard error of elasticities estimate = standard error of coefficient of relative gross returns × mean of relative gross returns/mean of area planted to sugarcane.

Short-run elasticities with respect to relative gross returns range from 0.05 in the Eastern region when one year lagged price is used as the expected price, to 5.52 in the Northern Region when two year average price is used as the expected price. All regions except the Northern Region have elasticity values less than 1. As for the whole kingdom, the elasticities obtained range from 0.14 when the Nerlovian Expectation Model is applied, to 1.00 when current price is applied. For the majority of the regions (except the Northern Region) where elasticities are less than 1, this means that a 1 per cent increase in relative gross returns brings forth less than 1 per cent increase in area planted to sugarcane and a 1 per cent decrease in relative gross returns brings forth less than a 1 per cent decrease in area planted to sugarcane. Farmers in the Northern Region seem to respond more to changes in relative gross return in view of the higher elasticities obtained no matter which model or technique is used.[3]

The poor results obtained from this study are due to limitation in the number of observations as can be observed when four regions are grouped together - the majority of coefficients become significant at the same significance level. Furthermore, there are many explanatory variables that are left out. The rain-fall at the sowing period, the influence of the Sugarcane Farmers' Association, and the others which have been mentioned in Section 5.2 in Chapter 5. Unreliability of these data and measurement errors

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3 Regression with relative area as dependent variable was also tried but the results obtained were very poor from statistics and economics standpoints.

may be the reason for low R^2 obtained for most of the regions no matter which model is postulated or technique is used. Several competing crops of sugarcane have been left out. For example, in Kanchanaburi (a province in Central Region), another important competing crop is tobacco. Soy beans are also becoming an important competing crop. Even within the same region, competing crops differ from province to province. There are more competing crops in the Central Region, which alone covers 69 per cent of the total sugarcane planted area, than in the other regions. This may be the reason why all of the proposed models did not work in the case of the Central Region. There are several other reasons that may explain the poor results obtained from the study. Unreliability of data may be one of the reasons. There is so much doubt about the quality of the data collected by the statistical officers because one does not know what is going on behind the scenes between the officers and factory owners or between the officers and quotamen.

In addition, the model estimated is a simplified one, depending on certain assumptions. This simplified model is not so different from the other models reviewed in Chapter 2, except that certain assumptions underlying their models have not been explicitly spelled out. The estimated model from the simplified model may be one of the reasons why the result is poor. Had we had a longer time series, we could have applied the simplified model proposed in Section 6.2, i.e.:

$$\Delta A_{st} = f(\Pi^e_t - \Pi^e_{t-3})$$

where:

ΔA_{st} = change in area planted to sugarcane in period t

Π^e_t, Π^e_{t-3} = relative gross returns (expected) in periods t and t-3 respectively

The results obtained would have been even better, more valuable and more adequate, had one had data on other variables, for example cost of inputs, new planting data, removal data, etc. so that the general model proposed in Chapter 5 could have been applied, i.e.:

$$NP_t = f(S, \bar{P}_s, \bar{P}_c, \bar{C}, \bar{Y}_s, \bar{Y}_c, R, G, O, W, Q)$$

where:

NP_t = new planting in year t

S = stock of sugarcane, i.e. new planting in years t-1 and t-2

$\bar{P}_s$ = expected prices of sugarcane in year t

$\bar{P}_c$ = expected price of competing crop in year t

$\bar{C}$ = expected cost of input

$\bar{Y}_s$ = expected yield of sugarcane in year t

$\bar{Y}_c$ = expected yield of competing crops in year t

R = area under sugarcane removed in year to which, under the assumption of no damaged plants, is the area planted in year t-3

G = Government intervention

O = existence of Sugarcane Farmers' Association

W = weather conditions

Q = quotaman's activity

It is hoped to be able to undertake such a study in the future when a longer time series relating to these variables mentioned earlier becomes available.

CHAPTER 7

SUMMARY AND CONCLUSION

Although empirical supply response studies are a useful tool in the formulation of economic policies, the author is not aware of such studies having been attempted for sugarcane in Thailand. As a starting point, this study reviews the supply response studies relating to this crop in India and comments upon their results in Chapter 2. The main shortcoming of these studies seem to be their failure to explicitly treat sugarment as a perennial crop. Consequently, an examination of the main theoretical models of supply response for such crops was undertaken in Chapter 4. This was followed in Chapter 5 by postulating a general model for sugarcane in Thailand. However, data limitations necessitated the simplification of this model. The simplified and adjusted model together with the results obtained are presented in Chapter 6.

Time series data for eight years from 1968 to 1975 were used to estimate a supply response function for sugarcane. Gross returns (price times yield) is used as a proxy, i.e. a measure of profitability. Both the naive and the Nerlovian Models are used to form price expectations. Predicted yield is used instead of actual yield. The results obtained were fairly poor due to the limited number of observations and the unreliability of the available data. Use of other expectation models was not attempted as it was felt that, in view of such data limitations, no matter what techniques or models were used the empirical results would not be very satisfactory.

The elasticity of supply of sugarcane with respect to relative gross returns was calculated only for those coefficients which were significantly different from zero at a significance level of 5 per cent or less and when the coefficient was of the expected sign (i.e. positive according to economic theory). Elasticity for the Central Region was, therefore, not estimated. It was found that farmers in the Eastern and North-Eastern Regions have short-run elasticities of less than 1 which means that a 1 per cent change in relative gross returns brings forth less than a 1 per cent change in area planted to sugarcane. When farmers expect low relative gross returns (i.e. price of sugarcane is low relative to price of competing crops) they will reduce the area planted to sugarcane; the released area will be put to the available competing crop deemed to be more profitable. However, the relative change in the area released to the competing crop will be less than in the Northern Region where supply response is more elastic (estimated values range from 2.14 to 5.52 and 2.00 to 4.79 with Simple Linear Regression and Long Linear Regression respectively depending on expectation model used).

Results and hence conclusions must be considered preliminary at this stage. When more detailed data can be collected the full model developed in this study can then be estimated and, hopefully, more meaningful results can be obtained.

APPENDIX A

AREA, PRICE AND YIELD OF SUGARCANE IN THE FOUR REGIONS

Year	Central Region			Eastern Region			Northern Region			North-Eastern Region		
	Area (Rai)	Price[1] (Baht/ Tonne)	Yield[2] (Tonne)	Area (Rai)	Price[1] (Baht/ Tonne)	Yield[2] (Tonne)	Area (Rai)	Price[1] (Baht/ Tonne)	Yield[2] (Tonne)	Area (Rai)	Price (Baht/ Tonne)	Yield[2] (Tonne)
1967/68	202,032	204.89	6.98	163,181	223.63	6.79	35,064	118.01	4.71	47,500	158.68	4.37
1968/69	315,207	157.01	7.18	235,076	150.63	6.96	32,739	126.59	5.03	63,221	122.10	4.55
1969/70	393,181	135.09	7.38	244,599	140.92	7.13	37,764	130.37	5.36	63,039	123.97	4.74
1970/71	545,025	145.87	7.57	223,529	146.30	7.31	44,285	126.32	5.69	48,967	130.09	4.92
1971/72	573,371	149.75	7.77	208,377	156.95	7.50	41,664	131.91	6.01	49,508	133.04	5.10
1972/73	712,213	182.36	7.97	290,609	182.98	7.65	56,821	155.08	6.34	73,796	138.76	5.28
1973/74	1,029,558	203.61	8.20	352,214	200.79	7.82	142,758	177.79	6.67	90,774	168.74	5.46
1974/75	1,178,480	300.65	8.37	390,000	300.70	8.00	225,019	292.39	6.99	141,754	276.32	5.64

1 Factory price
2 Expected yield

Source: Sugar Institute, Ministry of Industry.

APPENDIX B.1

PRICE AND YIELD OF COMPETING CROPS IN THE CENTRAL AND EASTERN REGIONS

Year	Central Region						Eastern Region					
	Rice		Maize		Cassava		Maize		Mungbean		Cassava	
	Yield[1] (Tonne)	Price[2] (Baht/Tonne)	Yield[1] (Tonne)	Price[2] (Baht/Tonne)	Yield[1] (Tonne)	Price[2] (Baht/Tonne)	Yield[1] (Tonne)	Price[2] (Baht/Tonne)	Yield[1] (Tonne)	Price[2] (Baht/Tonne)	Yield[1] (Tonne)	Price[2] (Baht/Tonne)
1967/68	0.31	715.50	0.28	870.00*	2.28	400.00	0.32	870.00	0.18	2,859.38	2.46	400.00
1968/69	0.30	666.10	0.30	821.40	2.31	330.00	0.33	821.40	0.18	2,519.40	2.40	330.00
1969/70	0.30	642.80	0.31	878.70	2.33	540.00	0.34	878.70	0.18	2,354.70	2.34	540.00
1970/71	0.30	440.80	0.33	806.70	2.36	470.00	0.35	806.70	0.18	2,530.00	2.28	470.00
1971/72	0.29	615.20	0.34	870.00	2.38	520.00	0.36	870.00	0.18	2,940.00	2.22	520.00
1972/73	0.29	1,006.50	0.36	1,440.00	2.41	410.00	0.37	1,440.00	0.18	3,760.00	2.16	470.00
1973/74	0.28	1,276.10	0.37	1,680.00	2.43	340.00	0.38	1,680.00	0.18	3,810.00	2.10	340.00
1974/75	0.28	1,454.69	0.39	1,850.00	2.46	300.00	0.39	1,850.00	0.18	3,850.00	2.04	300.00

1 Expected yield
2 Regional farm price
3 Whole kingdom farm price
* Estimated figure

Source: Division of Agricultural Economics, Ministry of Agricultural and Cooperatives.

APPENDIX B.2

PRICE AND YIELD OF COMPETING CROPS IN THE NORTHERN AND NORTH-EASTERN REGIONS

Year	Northern Region				North-Eastern Region			
	Cassava		Mungbean		Cassava		Mungbean	
	Yield[1] (Tonne)	Price[3] (Baht/Tonne)	Yield[1] (Tonne)	Price[2] (Baht/Tonne)	Yield[1] (Tonne)	Price[3] (Baht/Tonne)	Yield[1] (Tonne)	Price[2] (Baht/Tonne)
1967/68	2.09	400.00	0.18	2,414.70	2.11	400.00	0.16	2,492.00
1968/69	2.08	330.00	0.18	2,420.00	2.24	330.00	0.16	2,432.00
1969/70	2.07	540.00	0.18	2,295.33*	2.32	540.00	0.16	2,396.00
1970/71	2.07	470.00	0.17	2,220.00	2.40	470.00	0.15	2,330.00
1971/72	2.06	520.00	0.17	2,340.00	2.48	520.00	0.15	2,370.00
1972/73	2.05	470.00	0.17	3,020.00	2.57	470.00	0.15	2,670.00
1973/74	2.04	340.00	0.16	3,140.00*	2.65	340.00	0.15	3,250.00
1974/75	2.03	300.00	0.16	3,440.00	2.73	300.00	0.15	3,540.00

1 Expected yield
2 Regional farm price
3 Whole kingdom farm price
* Estimated figure

Source: Division of Agricultural Economics, Ministry of Agriculture and Cooperatives.

APPENDIX C

AREA (%) OF COMPETING CROPS

Year	Central Region			Eastern Region			Northern Region		North-Eastern Region	
	Rice	Maize	Cassava	Maize	Mungbean	Cassava	Cassava	Mungbean	Cassava	Mungbean
1967/68	0.94	0.04 (0.78)	0.02 (0.23)	0.01	0.01	0.98	0.07	0.93	0.60	0.40
1968/69	0.97	0.01 (0.40)	0.02 (0.60)	0.00	0.04	0.96	0.03	0.97	0.77	0.23
1969/70	0.95	0.03 (0.71)	0.02 (0.29)	0.00	0.00	1.00	0.04	0.96	0.79	0.21
1970/71	0.96	0.02 (0.53)	0.02 (0.47)	0.00	0.02	0.98	0.06	0.94	0.92	0.08
1971/72	0.91	0.04 (0.47)	0.05 (0.53)	0.03	0.02	0.95	0.13	0.87	0.98	0.02
1972/73	0.92	0.05 (0.66)	0.03 (0.34)	0.03	0.01	0.96	0.15	0.85	0.97	0.03
1973/74	0.93	0.06 (0.82)	0.01 (0.18)	0.03	0.01	0.96	0.11	0.89	0.96	0.04
1974/75	0.92	0.06 (0.78)	0.02 (0.22)	0.03	0.00	0.97	0.15	0.85	0.98	0.02

Figures in brackets are area (%) when rice is not included as a competing crop in the Central Region.

Source: Division of Agricultural Economics, Ministry of Agriculture and Cooperatives.

APPENDIX D

REGRESSION ANALYSIS FOR YIELD

Central Region

(1) Sugarcane:

R^2 = 0.06388

a = 1.96369

b = 0.01330
(0.02078)

S.E.E. = 0.13470

(2) Rice:

R^2 = 0.03953

a = -1.16576

b = -0.01280
(0.02576)

S.E.E. = 0.16695

(3) Maize:

R^2 = 0.15429

a = -1.45923

b = 0.05773
(0.05518)

S.E.E. = 0.35760

(4) Cassava:

R^2 = 0.07388

a = 0.62734

b = 0.03373
(0.04875)

S.E.E. = 0.31595

Eastern Region

(1) Sugarcane:

R^2 = 0.61001

a = 1.73522

b = 0.05378
(0.01755)

S.E.E. = 0.11377

(2) Maize:

R^2 = 0.55126

a = -1.28887

b = 0.04966
(0.01829)

S.E.E. = 0.11854

(3) Mungbean:

R^2 = 0.24771

a = -1.69323

b = -0.00806
(0.00573)

S.E.E. = 0.03714

(4) Cassava:

R^2 = 0.37732

a = 1.10895

b = -0.06047
(0.03171)

S.E.E. = 0.20552

Northern Region

(1) Sugarcane:

$R^2 = 0.77035$

$a = 1.24102$

$b = 0.08295$
(0.01849)

S.E.E. = 0.11983

(2) Cassava:

$R^2 = 0.00878$

$a = 0.79773$

$b = -0.00732$
(0.03174)

S.E.E. = 0.20572

(3) Mungbean:

$R^2 = 0.11194$

$a = -2.03386$

$b = 0.02235$
(0.02570)

S.E.E. = 0.16657

North-Eastern Region

(1) Sugarcane:

$R^2 = 0.45179$

$a = 1.33880$

$b = 0.04028$
(0.01811)

S.E.E. = 0.11740

(2) Cassava:

$R^2 = 0.16269$

$a = 0.70292$

$b = 0.03284$
(0.03041)

S.E.E. = 0.19709

(3) Mungbean:

$R^2 = 0.02969$

$a = -1.94789$

$b = 0.01335$
(0.03115)

S.E.E. = 0.20189

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