

**Supply, Demand and Marketing System Analysis  
for Rice in Taiwan**

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**Abstract**

This paper examines the supply, demand and marketing of rice in Taiwan. It is found that several issues are involved in the production and consumption for rice. First, over production and farmer's response very little to prices change in planning their acreage in rice. Second, rice consumption decrease and habit formation affects the rice consumption. Third, heavy financial burden of government by the accumulative storage of rice. Policy should be paid attention in the reductions of acreage and government stock accumulation of rice.

國立中興大學 

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**Supply, Demand and Marketing System Analysis****for Rice in Taiwan****Chaur-Shyan Lee\*****(李朝賢)****I. Introduction**

Rice, whatever in production and consumption, has played an important role in the process of economic development of Taiwan. However, the aggregate performance of rice within the context of the economy is declining in the face of structural changes of production and consumption in agricultural products during the past three decades.

The structural change of relative importance of the rice production can be seen in the fact that its share of total agricultural production decreased from 31.37 % in 1951 to 15.29% in 1985, while the share of fishery and livestock production increased from 10.60% to 24.77 % and from 18.50 % to 27.25 % in the same period, respectively.<sup>1)</sup> Nevertheless, the accumulative storage of public food of rice which is operated by the government increased from 18.7 thousand metric tons in 1951 to 1209.5 thousand metric tons in 1985.<sup>2)</sup>

Based on the daily nutrient availability per capita which is compiled by the Council of Agriculture, the percentage of energy intake from rice decreased significantly from 62.61 % in 1951 to 30.12 % in 1985, in which the total energy intake of food increased from 2069 calories to 2815 calories in the same period.<sup>3)</sup>

This paper is divided into four major parts: the first part describes the supply of rice from 1961 to 1985, with a brief historical review of rice supply and a quantitative analysis of Paper Presented at International Seminar on the Diversification of Rice Utilization, October 12-17, 1987, Bangkok, Thailand.

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farmer's response to price change and a short outline of the changing role of rice in the whole economy. The second part is a detailed review and a quantitative analysis of the change of rice consumption based on the data of food balance sheet and household survey. The third part is a presentation of the marketing system of rice which is consisted of marketing channels and marketing costs. Finally, the government purchasing programs and the problems involved in production and marketing of rice are presented in the last part.

## II. Supply of Rice

In this part, we review first the production performance of rice during the period from 1961 to 1985. Second, a quantitative analysis is used to explain the farmer's response to price in rice production. Third, we undertake an analysis of available supply of rice by using the data of the Taiwan food balance sheet. Finally, the contribution of rice production to agricultural production, gross national income and value of export the examined.

### 1. Rice Production

Table 1 shows the production performance of rice in Taiwan. It is based on three items, namely: planted area, amount of production and yield per hectare, with which the whole performance of rice production then can be explained accordingly.

A careful examination of Table 1 indicates at least two phenomena: first, the planted area decreased and both of production and yield per hectare increased during the whole studying period. Second, some marked variation are considerable in the trend performance of different elements of rice production.

Based on the index bases, the planted area of rice decreased 28%, while the both of production and yield per hectare

Table 1: Production of Rice

Year	Planted Area		Production (Brown Rice)		Yield Per Hectare (Brown Rice)	
	ha	index	1000 m.t.	index	kg.	index
1961	782,510	100.0	2,016	100.0	2,577	100.0
1962	794,228	101.5	2,113	104.8	2,600	103.2
1963	749,220	95.7	2,109	104.6	2,815	109.2
1964	764,935	97.8	2,247	111.4	2,937	114.0
1965	772,918	98.8	2,348	116.5	3,038	117.9
1966	788,635	100.8	2,380	118.0	3,017	117.1
1967	787,097	100.6	2,414	119.7	3,067	119.0
1968	789,906	100.9	2,518	124.9	3,168	123.7
1969	786,592	100.5	2,322	115.1	2,952	114.6
1970	776,139	99.2	2,463	122.1	3,173	123.1
1971	753,451	96.3	2,314	114.8	3,071	119.2
1972	741,570	94.8	2,440	121.0	3,291	127.7
1973	724,164	92.5	2,255	111.8	3,114	120.8
1974	777,848	99.4	2,452	121.6	3,153	122.4
1975	790,248	101.0	2,494	123.7	3,156	122.5
1976	787,516	100.6	2,713	134.6	3,450	133.9
1977	779,487	99.6	2,649	131.4	3,406	132.2
1978	752,851	96.2	2,444	121.2	3,249	126.1
1979	722,171	92.3	2,450	121.5	3,400	131.9
1980	638,445	81.6	2,354	116.7	3,692	143.3
1981	668,823	85.5	2,375	117.8	3,560	138.1
1982	659,591	84.3	2,483	123.1	3,765	146.1
1983	645,855	82.5	2,485	123.3	3,850	149.4
1984	585,186	74.8	2,244	111.3	3,825	148.4
1985	563,678	72.0	2,174	107.8	3,856	149.6

increased 7.8% and 49.6%, respectively, during the period of 1961-1985.

With respect to the three different elements of rice production, some distinctive phases of rice production can be found in Table 1, the planted area can be divided into two phases: constant phase from 1961 to 1975, and decreased phase after 1976. The trend of production can be seen in the fact that the years from 1961 to 1968 are characterized by high rate of growth, the years from 1968 to 1973 are the depressing period, from 1973 to 1976 are the rapid increasing period and after 1976 the production has decreased gradually. Owing to the technological change, the yield per hectare has experienced the increasing trend even though some annual variations existed during the period under review.

## 2. Acreage Response to Price Change

In order to understand the farmer's response to prices change in planning their acreage, the partial adjustment model which was developed by Nerlove<sup>4)</sup> is used in this paper. If rice producers have static expectations and base their production plans on prices at the preceding harvest, we can formulate a simple long run supply function as follows:

$$Q_t^* = a + b \left( \frac{Pr}{Pc} \right)_{t-1} + U_t \quad (1)$$

where  $Q_t^*$  is desired or planned long run equilibrium supply in terms of planted area;  $\frac{Pr}{Pc}$  is the price ratio between rice and corn<sup>5)</sup>; and  $U_t$  is a random residual term. The dynamic adjustment equation will be

$$Q_t - Q_{t-1} = \pi (Q_t^* - Q_{t-1}) \quad 0 < \pi \leq 1 \quad (2)$$

where  $Q_t$  is current planted area,  $\pi$  is coefficient of adjustment.

Table 2: A Comparison of Two Regression Equations for Estimating the Coefficients of Adjustment as Measured by the Response of Planted Area to Price for Rice and Corn, 1961-1985

Period	Equations	Coefficient of Adjustment	$\bar{R}^2$	D.W.
1961-1985	$Q_t = 29538 + 0.8474Q_{t-1} + 89051 \left(\frac{Pr}{P_e}\right)_{t-1}$ <p style="text-align: center;">(7.14)                      (2.74)</p>	0.15	0.874	1.8395
1975-1985	$Q_t = -2525 + 0.6181Q_{t-1} + 403350 \left(\frac{Pr}{P_C}\right)_{t-1}$ <p style="text-align: center;">(4.06)                      (3.92)</p>	0.38	0.948	1.8725

(6)

If  $\pi = 1$ , then equation (2) becomes  $Q_t = Q_t^*$ , it means current supply equal to long run equilibrium supply. Substitution of equation (1) in (2) yields a relation which can be estimated statistically

$$Q_t = a \pi + (1 - \pi) Q_{t-1} + b \pi \left( \frac{Pr}{Pc} \right)_{t-1} + U_t \quad (3)$$

The planted area response of rice to price change could be estimated by the estimates of the coefficients in equation (3).

Table 2 shows the coefficients of adjustment estimating from the supply function as measured by the response of cultivated area to price. We compare the coefficients of adjustment in different period showing that the rice growers respond very little to price in planning their acreage, the coefficients of adjustment are 0.15 for the period of 1961-1985 and 0.38 for the period of 1975-1985, respectively.

### 3. Available Supply of Rice

Based on the Taiwan food balance sheet, the available supply of rice is calculated as follows:

Production + change in stock + import - export = available supply. Table 3 summarizes the available supply of rice during the period of 1961 - 1985. There are substantial variations annually in the available supply of rice which is due to the fact of the annual variations in production, change is stock and foreign trade. A clearer picture of the available supply of rice can be seen in the last column of Table 3 in which we can find that there are three distinctive phases of available supply of rice. The first phase is characterized by the increasing trend which covers the years from 1961 to 1974. The highest peak reaches to index of 127.3 in 1974. The second phase is situated in constant trend which covers the years from 1975 to 1977. Then third phase is the decreasing trend after 1978, among

Table 3: Available Supply of Rice

Unit: 1000 metric tons

Year	Production	Change in Stock	Foreign Trade		Available Supply	
			Gross Import	Gross Export	Total	Index
1961	2,016.3	13.4	15.7	90.3	1,928.3	100.0
1962	2,091.7	146.7	10.0	56.9	1,898.1	98.4
1963	2,071.9	- 69.1	2.2	173.3	1,969.9	102.2
1964	2,194.6	123.9	24.4	126.8	1,968.3	102.1
1965	2,271.7	- 92.0	-	294.0	2,069.7	107.3
1966	2,324.5	- 99.8	2.2	218.9	2,207.6	114.5
1967	2,428.8	6.9	6.0	102.0	2,325.9	120.6
1968	2,481.4	69.6	4.4	92.6	2,323.6	120.5
1969	2,537.1	120.1	4.2	34.5	2,386.7	123.8
1970	2,362.4	- 5.3	0.5	4.9	2,363.3	122.6
1971	2,441.4	- 61.9	-	92.8	2,410.5	125.0
1972	2,325.3	- 54.2	6.7	17.0	2,369.0	122.9
1973	2,318.1	-123.8	-	95.6	2,346.3	121.7
1974	2,432.9	111.6	141.0	7.1	2,455.2	127.3
1975	2,487.6	98.4	17.1	1.2	2,405.1	124.7
1976	2,623.8	203.5	4.8	2.0	2,423.1	125.7
1977	2,670.4	91.0	8.4	169.9	2,417.9	125.4
1978	2,563.2	26.9	1.3	281.6	2,256.0	117.0
1979	2,393.2	--218.1	-	429.5	2,181.0	113.1
1980	2,469.6	1.8	0.1	296.7	2,172.2	112.6
1981	2,362.3	194.6	12.6	86.3	2,094.0	108.6
1982	2,427.1	115.2	1.3	258.8	2,054.4	106.5
1983	2,539.6	32.4	2.0	542.2	1,967.0	102.0
1984	2,279.6	- 47.9	2.8	228.0	2,102.3	109.0
1985	2,222.0	- 39.5	2.7	43.0	2,221.2	115.2

Notes: Production included 2/3 of the production of the 2nd rice crop of year t-1 and 1/3 of the 2nd rice of year t and the production of the 1st rice crop of year t.

Source: Taiwan Food Balance Sheet, Council of Agriculture.

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Table 4: Contribution of Rice Production to Agricultural Production, Gross National Product and Value of Export

Year	Rice Production			Rice Export		
	Total Value* (NT\$ Million)	% of Value of Agri. Prod.	% of GNP	Total Value (US\$1000)	% of Export Value of Agri. prod.	% of Total Export Value
1961	10,279	36.22	14.77	9,368	8.12	4.79
1962	9,984	35.03	13.03	6,070	5.62	2.78
1963	10,362	34.47	11.95	17,878	9.15	5.39
1964	11,265	31.39	11.10	19,950	8.01	4.61
1965	11,845	31.61	10.59	41,100	16.93	9.14
1966	12,470	31.14	9.95	29,725	12.33	5.54
1967	13,273	30.30	9.16	20,000	8.13	3.12
1968	14,105	28.85	8.36	12,400	4.97	1.57
1969	12,583	26.36	6.43	5,375	1.97	0.51
1970	13,681	25.74	6.07	775	0.24	0.05
1971	12,894	23.10	4.92	4,500	1.14	0.22
1972	14,525	22.77	4.62	1,875	0.38	0.06
1973	18,824	22.37	4.62	14,364	2.08	0.32
1974	31,534	28.13	5.79	1,319	0.15	0.02
1975	34,456	28.13	5.93	3	0	0
1976	35,165	26.33	5.02	13	0	0
1977	31,677	21.25	3.89	30,334	2.59	0.32
1978	30,386	19.14	3.11	53,127	3.86	0.42
1979	36,956	20.31	3.13	86,545	5.68	0.54
1980	42,087	19.72	2.87	59,998	3.29	0.30
1981	46,369	19.45	2.67	26,824	1.53	0.12
1982	49,575	18.54	2.67	63,429	3.65	0.29
1983	48,616	17.31	2.38	94,269	5.43	0.38
1984	45,244	16.08	1.99	41,752	2.25	0.14
1985	41,306	15.29	1.72	6,235	0.33	0.02

Note: US\$1 = NT\$31 at time of this study.

Source: Compiled from the various issues of Taiwan Agricultural Yearbook and Taiwan Statistical Data Book.

which the lowest available supply of rice reaches to the index of 102 in 1983.

#### 4. Changing Role of Rice in the Whole Economy

In this section, we analyse first the performance of rice production within the agricultural as well as the gross national product (GNP). Second we present the relative importance of the value of rice export to export value of agricultural products and to total value of export in the economy.

Rice production has played an important role whatever in agriculture or in the whole economy at the early stage of economic development. As shown in Table 4, rice production as a percentage of value of agricultural production decreased from 36.22% in 1961 to 15.29% in 1985, while rice production as a percentage of GNP decreased sharply from 14.77% to 1.72% during the same period. This is due to the fact that the growth rate of GNP is much faster than that of the rice production during the past two decades.

The most important observations to be drawn also from Table 4 are the considerable fall in the relative importance of the value of rice export, its share of export value of agricultural products declined from 8.12% in 1961 to 0.33% in 1985, while the share of total value of export in the whole economy fell from 4.79% to 0.02% in the same period.

The above described changes in the role of rice production reflect a continuing move away from the situation of rice production as a major activity in agriculture as well as in the whole economy which prevailed in the years before 1960.

### III. Demand for Rice

#### 1. Disposal of Available Supply of Rice

The disposal of available supply of rice are broken down into five major categories: animal feed, seed, manufacture, loss

Table 5: Disposal of Available Supply in Rice

Year	Available Supply 1000 m.t.	Animal Feed %	Seed %	Manufacture %	Loss %	Food %
1961	1,928.3	4.19	2.03	1.11	2.09	90.59
1962	1,898.1	4.41	2.07	1.03	2.20	90.29
1963	1,969.9	4.21	1.94	0.90	2.10	90.84
1964	1,968.3	4.46	1.95	0.99	2.23	90.37
1965	2,069.7	4.39	1.84	1.15	2.19	90.43
1966	2,207.6	4.21	2.13	1.19	2.11	90.36
1967	2,325.9	4.00	2.03	1.42	2.00	90.55
1968	2,323.6	4.00	2.04	1.70	0.99	91.28
1969	2,386.7	4.25	1.51	1.99	2.12	90.13
1970	2,363.3	4.00	1.51	2.30	2.00	90.19
1971	2,410.5	4.22	1.45	2.01	2.00	90.33
1972	2,369.0	3.00	1.43	1.89	1.00	92.69
1973	2,346.3	3.00	1.45	1.77	1.00	92.78
1974	2,455.2	3.00	1.47	1.27	1.00	93.25
1975	2,405.1	2.00	1.50	1.27	1.00	94.23
1976	2,423.1	2.00	1.48	1.89	1.00	93.64
1977	2,417.9	2.00	1.46	1.91	1.00	93.63
1978	2,256.0	2.00	1.50	2.41	1.00	93.09
1979	2,181.8	2.00	1.97	2.88	1.00	92.16
1980	2,171.2	2.30	1.33	2.32	1.00	93.05
1981	2,094.0	2.00	1.45	2.87	1.00	92.67
1982	2,054.4	2.00	1.47	2.95	1.00	92.58
1983	1,967.0	2.00	1.44	2.77	1.00	92.79
1984	2,102.3	10.04	1.37	2.65	1.00	84.94
1985	2,221.2	14.68	1.20	2.70	1.00	80.41

Source: Compiled from Taiwan Food Balance Sheet, Council of Agriculture.



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Table 6: Average Rice Consumption Per Capita Per Year and Per Day

Year	Based on Household Survey-Per Day			Based on Food Balance Sheet	
	Average	Farm Family	Non-Farm Family	Per Year	Per Year
	gm	gm	gm	kg	gm
1961	383.70	411.80	350.60	136.78	374.74
1962	381.72	415.05	349.64	132.10	361.92
1963	392.60	435.25	353.65	134.36	368.11
1964	395.13	438.94	360.61	129.87	355.81
1965	391.96	453.14	340.52	132.58	363.97
1966	392.92	461.02	337.73	137.42	376.49
1967	394.01	462.37	341.59	141.47	387.59
1968	381.09	439.27	337.92	139.93	383.37
1969	383.59	461.39	325.50	138.74	380.11
1970	384.52	457.01	327.60	134.45	368.36
1971	380.11	456.64	326.03	134.28	367.90
1972	374.23	451.16	322.42	133.52	365.81
1973	363.64	436.34	315.93	129.84	355.74
1974	366.50	439.65	321.95	134.15	367.53
1975	364.16	433.58	324.13	130.39	357.23
1976	350.16	425.51	310.20	128.12	351.01
1977	330.59	404.03	293.69	125.06	342.63
1978	314.72	438.10	281.58	113.99	312.30
1979	296.92	361.25	265.72	107.04	293.26
1980	301.00	357.28	274.76	106.49	289.01
1981	295.51	348.12	270.53	99.44	272.44
1982	280.52	335.47	256.97	95.77	262.38
1983	271.15	325.41	248.07	90.32	247.45
1984	259.55	324.17	235.20	87.17	238.82
1985	240.98	282.58	225.40	85.97	235.53

Source: Household Survey of Rice Consumption comes from Research of Basic Food Consumption, Department of Agricultural Marketing, National Chung Hsing University. Food Balance Sheet comes from Council of Agriculture.

and food. Information on the composition of available supply of rice or demand for rice are indicated in Table 5, which provides the structural changes of the demand for rice annually between 1961 and 1985. With respect to animal feed, its share of total available supply decreased from 4.19% in 1961 to 2% in 1983, but from 1984 to 1985, the animal feed increased significantly which reflected the change of rice consumption from food to animal feed in order to release the burden of rice surplus.

Rice is used as the seed for reproduction, its relative importance to total available supply decreased slightly from 2.03% to 1.20% over the period under consideration. Very little percentage of rice ranging from 3% to 4% which is distributed in both of manufacture and loss, the share of these two items in total available supply of rice remained essentially constant during the period of 1961-1985. Food has played a very important role in the demand for rice. An examination of the last column in Table 5 which reveals the share of food in total available supply of rice is very high and remains very stable trend. From 1961 to 1971, the percentage remained about 90%, from 1972 to 1983, the percentage increased to about 93%. But, from 1984 to 1985, the percentage dropped sharply to 84.94% and 80.41%, respectively, this is due to the fact that the share of rice which using in animal feed is increased greatly.

## 2. Trends in Rice Consumption

The data of rice consumption in Taiwan comes from two sources: (1) data of household survey which is collected by the Department of Agricultural Marketing, National Chung Hsing University, the various issues of the Survey of Basic Food Consumption are available for the study, and (2) data of Taiwan Food Balance Sheet which is compiled by the Council of Agriculture. These two data can be used as a bases for trends

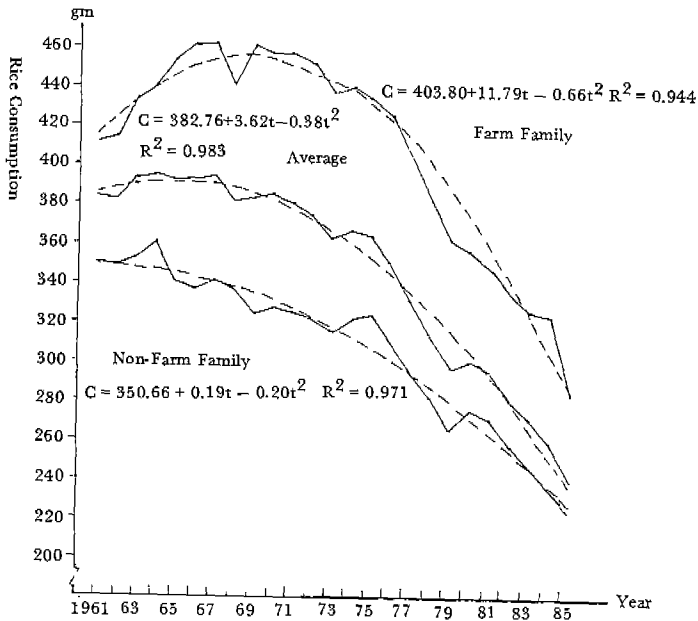


Figure 1: Trends in Rice Consumption Per Capita Per Day—  
Based on Household Survey, 1961-1985

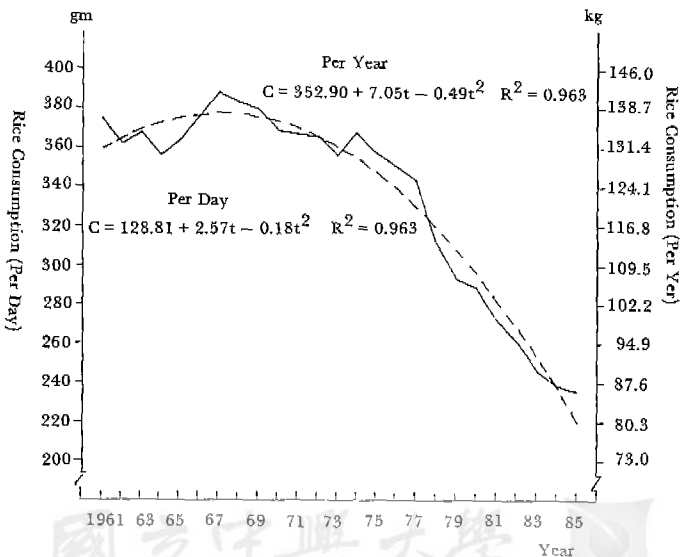


Figure 2: Trend in Rice Consumption Per Year and Per Day  
— Based on Taiwan Food Balance Sheet, 1961-1985

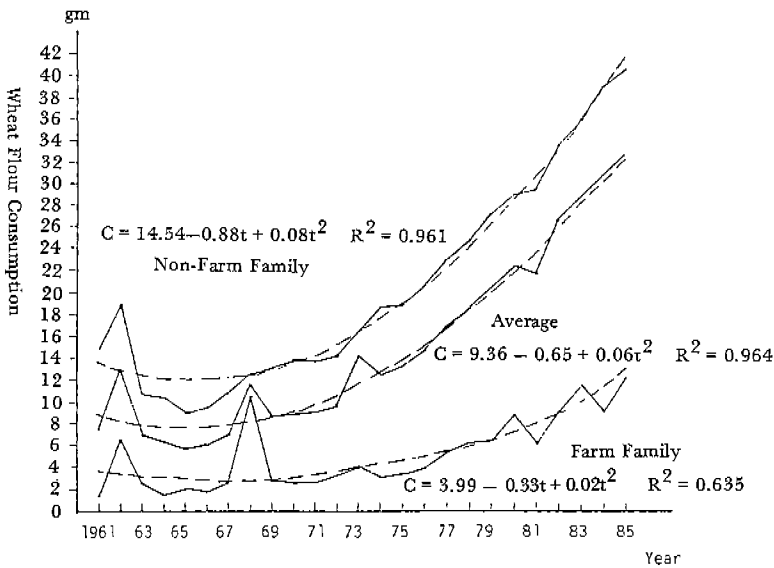


Figure 3: Trends in Wheat Flour Consumption Per Capita Per Day — Based on Household Survey, 1961-1985

and quantitative analysis for rice consumption.

As indicated in Table 6 and 7, and Figure 1 and 2, rice consumption in Taiwan has experienced a downward trend during the past two decades. Based on the data from household survey, the average rice consumption per capita per day increased from 383.70 gm in 1961 to 394.01 gm in 1967. After 1968, the average rice consumption per day decreased from 381.09 gm to 240.98 gm in 1985. In addition, based on the data of Food Balance Sheet, the rice consumption per capita per year and per day appears almost the same trend, the rice consumption per capita per year increased from 136.78 kg in 1961 to 141.47 kg in 1967, and then the average rice consumption per capita decreased from 139.93 kg in 1968 to 85.79 kg in 1985. While the average rice consumption per day increased from 374.74 gm in 1961 to 387.59 gm in 1967, but after that year, downward trend was very significant for the period from 1968

to 1985, the average rice consumption per day dropped from 383.37 gm to 353.53gm.

Downward trends of average rice consumption were apparent for the period from 1968 to 1985 (Figure 1 and 2). However, what is the major substitute food for rice, from the data of household survey as shown in Figure 3 can give the answer, the wheat flour consumption per capita per day has experienced the upward trends whatever in farm family, non-farm family or average family during the period under consideration. This is due to the fact that personal income has increased and consumption habit has changed.

### 3. Habit Formation and Demand for Rice

This section we try to understand whether the habit formation affects the demand for rice. The current demand depends not only on current price and income, but also on the individual's price-income-consumption position in the previous period (Farrell, 1952). This implies that the habit formation is involved in the demand function. How to introduce habits in demand function, the state adjustment model (SAM) which was developed by Houthakker and Taylor (1970)<sup>6</sup> is used in this paper. The basic demand function of rice can be expressed as follows:

$$Q_t = \theta + \alpha S_t + \beta_i P_{it} + \gamma Y_t \quad (4)$$

where

- $Q_t$ : annual consumption of rice per capita (measured as kg) in year  $t$ .
- $S_t$ : stock of rice per capita represents the habit formation in year  $t$ .
- $P_{it}$ : annual price of rice or other goods per kg deflated by the general index of consumer price of food in year  $t$ .



$Y_t$ : disposable income per capita in constant price in year  $t$ .

Using the method of variable transformation which was developed by Box-Cox (1964) and Zarembka (1968), the general form of dynamic demand function can be expressed as follows:

$$Q_t^{(\lambda)} = a_0 + \sum_{i=1}^n a_i P_{it}^{(\lambda)} + \sum_{i=1}^n a_{i+n} P_{it-1}^{(\lambda)} + a_{2n+1} Y_t^{(\lambda)} + a_{2n+2} Y_{t-1}^{(\lambda)} + a_{2n+3} Q_{t-1}^{(\lambda)} \quad (5)$$

Based on the method of Box-Cox variable transformation, the variable power  $\lambda$ , such as  $Q_t^{(\lambda)} = \frac{Q_t^\lambda - 1}{\lambda}$  is measured

by the method of maximum likelihood estimation (MLE) in this paper. In general, when  $\lambda = 1$ , the function is linear form, and  $\lambda = 0$ , the function is logarithmic form. The  $\lambda = 1$  and  $\lambda = 0$  are the special cases of Box-Cox variable transformation.

After having the value of  $\lambda$ , which estimated by MLE, the following equation is used for this study.

$$Q_t = a + b_0 P_{rt} + c_0 P_{wt} + d_0 Y_t + b_1 P_{rt-1} + c_1 P_{wt-1} + d_1 y_{t-1} + e Q_{t-1} + U_t \quad (6)$$

where  $P_r$  and  $P_w$  represent the price of rice and price of wheat flour, respectively, and  $U_t$  presents a random residual term.

The results of estimating equation of demand for rice based on equation (6) are as follows:

$$Q_t = -157520 + 9101.1 P_{rt} + 4259.4 P_{wt} - 1.014 Y_t - 5605.1 P_{rt-1} - 8578.1 P_{wt-1} - 4.623 Y_{t-1} + 8898.3 Q_{t-1} \\ (1.116) \quad (1.814) \quad (-1.224) \quad (-1.683) \quad (-1.550) \quad (-1.107) \quad (2.757) \\ \lambda = 3.01, R^2 = 0.961, D - W = 2.184 \quad (7)$$

In the equation, the t-values are given in the parentheses. Equation (7) indicates the coefficients of variables presenting the relationships between dependent variable and independent variables with which the elasticities of variables in demand function by using the method of Box-Cox transformation then can be estimated correctly. The elasticities of demand for rice with respect to independent variables concerned are as follows:

$$\begin{aligned} EP_{rt} &= 0.1180, & EP_{wt} &= 0.0528, & EY_t &= -0.0190 \\ EP_{r\ t-1} &= -0.0724, & EP_{wt-1} &= -0.1035, & EY_{t-1} &= -0.0909 \\ EQ_{t-1} &= 0.5433 \end{aligned}$$

The elasticity of demand, whatever in rice price itself or cross elasticity of demand are inelastic. But cross elasticity of demand is positive, in this case, rice and wheat flour are substitute for each other. Income elasticity is negative which means that the rice consumption declines as income increases, rice in Taiwan is considered as an inferior goods.

By judging the impact of habit formation on demand for rice, we differentiate the elasticities of price and income with respect to habit variable, respectively. If the derivative value is zero, which means that there is no impact of habit on demand, if the value is larger than zero which represents the impact of habit formation is positive, and if the value is less than zero, then the impact of habit formation on demand is negative.

After having the calculation of the derivative value of the relevant elasticities, the result are as follows<sup>7)</sup>:

$$\begin{aligned} (-\alpha_i \beta_i) &= -5.34628 < 0 \text{ and } \frac{\partial EP_{rt}}{\partial S} = -0.000615 < 0 \\ (-\alpha_i \beta_i) &= -0.000587 < 0 \text{ and } \frac{\partial EY_t}{\partial S} = -0.000053 < 0 \end{aligned}$$

Based on this empirical estimation as indicated above, the values of differentiating elasticity of price and elasticity of income with respect to habit variable are negative, these results indicate that the habit formation is an important factor which affects the demand for rice.

#### 4. Relative Importance of Rice Consumption to Household Expenditure

According to the Engel's law, the percentage importance of food expenditure declines as income increase. Expenditure on many food items goes up and people eat more in variety and eat better in quality as income increases. They shift away from cheap carbohydrates and starch food to more expensive meats and proteins.

Table 7 summarizes the rice expenditure performance of the household expenditure in terms of Engel's coefficient of rice consumption during the period from 1966 to 1985. The average expenditure of rice as percent of total consumption expenditure decreased from 17.20% in 1966 to 4.01% in 1985, while the average expenditure of rice as percent of food expenditure also decreased from 35.50% to 10.92% in the same period. The downward trends of the Engel's coefficients of rice consumption were apparent for the period from 1966 to 1985 in Taiwan.

Table 8 reveals very clearly the fact that the percentage importance of rice expenditure declines as income increases. The average of expenditure for rice as percent of total consumption expenditure decreased from 5.69% in the income group under NT\$60,000 to 1.55% in the income group over one million new Taiwan dollar. With respect to proportion of rice expenditure to total food expenditure, the last column of Table 8 shows that, the percentage decreased from 13.90% to 7.50% for the same income groups.

Table 7: Engel's Coefficient of Rice Consumption, 1966-1985

Year	Unit: Per Family							
	Total Income	Total Consumption Expenditures		Expenditure for Food		Average Expenditures of Rice		
	NT\$	NT\$	% of Total Income	NT\$	% of Total Consumption Expenditure	NT\$	% of Total Consumption Expenditure	% of Food Expenditure
1966	33,535	28,611	85.32	13,865	48.46	4,922	17.20	35.50
1968	40,618	35,097	86.41	15,853	45.17	4,985	14.20	31.45
1970	44,175	38,131	86.32	17,365	45.54	5,280	13.85	30.41
1971	48,704	42,027	86.29	19,664	46.79	4,990	11.87	25.38
1972	56,697	46,790	82.53	20,756	44.36	5,009	10.71	24.13
1973	68,158	55,325	81.17	25,040	45.26	5,971	10.79	23.85
1974	94,191	76,026	80.71	36,553	48.08	9,626	12.66	26.33
1975	101,339	80,657	79.59	36,893	45.74	10,010	12.41	27.13
1976	120,592	90,226	74.82	39,645	43.94	9,013	9.99	22.73
1977	135,334	97,279	71.88	39,855	40.97	7,389	7.60	18.54
1978	165,042	113,418	68.72	45,447	40.07	7,659	6.75	16.85
1979	201,073	137,666	68.47	52,905	38.43	8,558	6.22	16.18
1980	250,484	170,178	67.94	63,936	37.57	9,900	5.82	15.48
1981	285,831	187,480	65.59	68,430	36.50	10,202	5.44	14.91
1982	295,051	196,809	66.70	71,363	36.26	10,665	5.42	14.94
1983	315,899	210,362	66.59	78,107	37.13	9,711	4.62	12.43
1984	341,727	229,049	67.03	85,710	37.42	10,084	4.40	11.77
1985	348,195	231,276	66.42	84,971	36.74	9,275	4.01	10.92

Note: See Table 4.  
Source: Calculated from various issues of Report on the Survey of Family Income and Expenditure, Taiwan Province, Department of Budget, Accounting and Statistics, Taiwan Provincial Government, R.O.C.

(20)

Table 8: Engel's Coefficient of Rice Consumption by Income Groups, 1985

Unit: Per Family

Income Groups NT\$	Total Consumption Expenditures		Expenditure for Food		Average Expenditures of Rice		
	NT\$	% of Total Income	NT\$	% of Total Consumption Expenditure	NT\$	% of Total Consumption Expenditure	% of Food Expenditure
Under 60,000	50,615	92.03	20,278	40.95	2,881	5.69	13.90
60,000 – 120,000	87,236	96.93	33,527	38.43	3,859	4.42	11.51
120,000 – 180,000	135,401	90.27	51,483	38.02	6,362	4.70	12.36
180,000 – 240,000	182,518	86.91	66,660	36.52	7,825	4.29	11.74
240,000 – 300,000	224,434	83.12	78,721	35.08	8,720	3.89	11.08
300,000 – 360,000	265,355	80.41	88,607	33.39	9,252	3.49	10.44
360,000 – 420,000	304,800	78.15	96,925	31.80	9,767	3.20	10.08
420,000 – 480,000	339,020	75.34	103,826	30.63	9,939	2.93	9.57
480,000 – 540,000	370,464	72.64	109,862	29.66	10,308	2.78	9.38
540,000 – 600,000	409,670	71.87	114,247	27.89	9,923	2.42	8.69
600,000 – 660,000	432,017	68.57	120,901	27.99	10,771	2.49	8.91
660,000 – 720,000	479,117	69.44	129,658	27.06	11,025	2.30	8.50
720,000 – 780,000	518,997	69.20	127,721	24.61	9,978	1.92	7.81
780,000 – 840,000	525,694	64.90	136,234	25.92	11,085	2.11	8.14
840,000 – 900,000	587,615	67.54	130,620	22.23	9,728	1.66	7.45
900,000 – 960,000	584,272	62.83	141,289	24.18	11,126	1.90	7.87
960,000 – 1,020,000	670,570	67.73	141,979	21.17	10,008	1.49	7.05
Over 1,020,000	793,348	63.47	164,746	20.77	12,305	1.55	7.50

Note: See Table 4.

Source: Report on The Survey of Family Income &amp; Expenditure, Taiwan Province, 1985.

This phenomenon of Engel's coefficient of rice consumption indicates that during the process of economic development, the relative importance of rice consumption to total consumption and food consumption expenditures decreased significantly. People do like to use their extra money on nonfood consumption instead of food or rice consumption when their income rise.

#### IV. The Rice Marketing System

##### 1. Marketing Channels

Rice is a staple food in Taiwan, people have to eat every day. In order to adjust the supply and demand for rice and stabilize the price of rice, government has played an important role to intervene the rice marketing. Therefore, rice in Taiwan has been marketed through a two-way mechanism—partial control and partial free marketing. In other words, rice marketing is classified into two channels: (1) the government-managed channel and (2) the open market channel.

Figure 4 indicates the whole pictures of rice marketing channels in Taiwan. This figure is drawn from data obtained

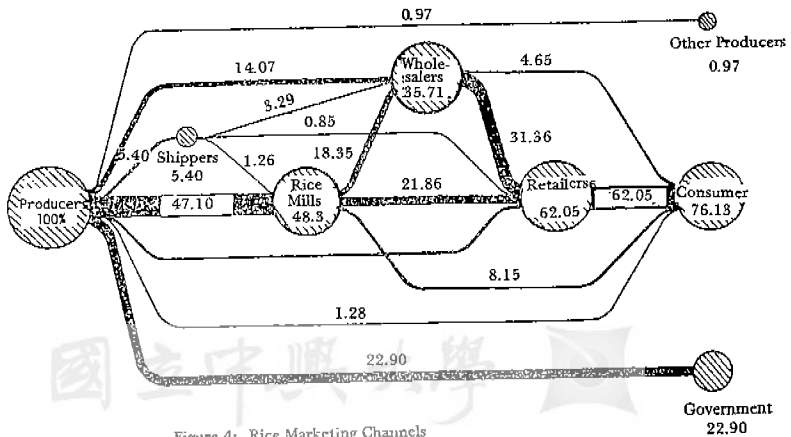


Figure 4: Rice Marketing Channels  
Source: Hsu, W. F. et al, 1975, P. 28.

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from a survey made in 1975, in which 77% of rice sold commercially through the free open market and 23% through the government channel. The proportions have changed gradually from year to year. In the recent years, the rice is acquired through different ways by the government has reached to about 33%.<sup>8)</sup> The government purchasing program will be explained in the next part.

Under this current situation, about 65% to 75% of rice market in Taiwan is operated by the free open market, its major channels of rice marketing are:

Producers → Collectors and Shippers → Rice Mills →  
Wholesalers → Retailers → Consumers.

Rice farmers were found to sell 47.10% of their products to rice mills and then 62.05% to retailers (Figure 4). In the whole marketing channels, 35.71% of rice sells to wholesalers, both of rice mills and wholesalers play a very important role in rice marketing in free open market.

## 2. Marketing Cost

Marketing cost can be calculated by two ways: based on the items of marketing function and the marketing expenses, since the former represents the expenses added by the different items of marketing function which are provided by the merchants; the latter represents the expenses added by marketing activities, the cost includes both of fixed and variable expenses.

The marketing cost of rice per 100 kg polished rice by marketing function is presented in Table 9. The marketing cost is calculated from the stage of farm price of paddy to retailer, the marketing cost of relative share of wholesale to total marketing cost is 62.95%, while the marketing cost of retail accounts for 37.05% in the retail stage.

With respect to the different stages of the marketing cost

Table 9: Marketing Cost of Rice-Per 100 kg Polished Rice  
— Based on Marketing Function, 1984

Item	NT\$	% of Retail Price %	% of Total Marketing Cost %
(1) Farm Price of Paddy (138 kg of Paddy)	2,042.40	77.22	
Collection expenses	51.00	1.93	8.46
Warehousing expenses	20.07	0.76	3.33
Processing expenses	68.28	2.58	11.33
Packing expenses	17.38	0.66	2.88
Transportation expenses	41.99	1.59	6.97
Selling	86.45	3.27	14.35
Wholesale margin	94.17	3.55	15.63
Sub-total	379.34	14.34	62.95
(2) Wholesale Price	2,421.74	91.56	
Packing expenses	10.40	0.39	1.73
Selling expenses	154.68	5.85	25.67
Retail margin	58.18	2.20	9.65
Sub-total	233.26	8.44	37.05
(3) Retail Price of Polished Rice	2,645.00	100.00	
(4) Total Marketing Cost (1) + (2)	602.60		100.00

Source: Shyu, R. Y., 1985, PP. 7-8



relate to retail price, rice farmers receive 77.22% of the retail price, with the remaining 22.78% absorbed in the marketing process.

Marketing cost is calculated by the marketing expenses as indicated in Table 10. The marketing cost can be broken down into wages, transportation, packing, interests, rents, maintenance and depreciation of facilities, loss, profit and other expenses. The most important cost is profit and wages of merchants which accounts for 25.28% and 21.95%, respectively, of the total marketing cost, the packing and loss are the minor ones which accounts for only 4.13% and 2.11% individually.

Table 10: Marketing Cost of Rice Per 100 kg Polished Rice  
— Based on Marketing Expenses, 1984

Item	NT\$	% of Total Marketing Cost
Wages	132.30	21.95
Transportation	72.49	12.03
Packing Expenses	24.86	4.13
Interests	69.89	11.60
Rents	53.70	8.91
Maintenance and Depreciation of Facilities	45.73	7.59
Waste and Loss	12.71	2.11
Profit	152.35	25.28
Other Expenses	38.57	6.40
Total Cost	602.60	100.000

Source: Shyu, R. Y., 1985, P. 9.

## V. Government Purchasing Programs and the Surplus of Rice

In order to maintain an adequate price level of rice and stabilize the farm income of rice producers, government takes her strong powers of intervention to the production and marketing of rice. The government acquires rice mainly through direct purchase and collection programs in order to meet her needs for public food of rice. Much of this rice is used for providing military and public servants, relief, government institutions and subsidy of rice conversion program, animal feed and exports. In addition, a part of the government-managed rice is used for price control and adjusting the supply and demand in the markets.

### 1. Government Purchasing Programs

The government acquires rice through four major sources as follows:

- (1) land tax in kind collected, compulsory purchase of paddy through land tax in kind and rent of public land received.
- (2) fertilizer-rice barter program.
- (3) purchase and loan of rice production fund received.
- (4) imports

Table 11 gives the whole picture of composition of government rice which influences the price level of rice and adjusts the demand and supply in the rice market. Government rice as percent of total production varied year by year ranging from the lowest level of 9.36% in 1973 to the highest one of 38.51% in 1983 during the period under review.

As regard to the sources of government rice where they come from, Table 11 presents these apparently structural changes. The fertilizer-rice barter has play a very important role of the sources of government rice from 1961 to 1972.<sup>9)</sup>

Table 11: Purchase and Collection of Rice by Government

Year	Unit: Brown Rice, 1000 m.t.						
	Control Quantities by Government	Total Production	Government Rice as % of Total Production	Structure of Government Land Tax in Kind Collected, Compulsory Purchase of Paddy through Land Tax and Rent of Public Land Received	Rice Acquired Through Different Sources* (%)	Purchase and Loan of Rice Production Fund Received	Total
	(A)	(B)	(A/B) %	%	%	%	%
1961	623.4	2,016.3	30.92	37.9	59.4	2.7	100.0
1962	636.9	2,112.9	30.14	39.2	57.6	3.2	100.0
1963	664.7	2,109.0	31.52	32.4	64.1	3.5	100.0
1964	660.5	2,246.6	29.40	30.6	66.5	2.9	100.0
1965	678.1	2,348.0	28.88	29.0	68.4	2.6	100.0
1966	643.8	2,379.7	27.05	27.0	70.2	2.8	100.0
1967	638.7	2,413.8	26.46	33.6	63.8	2.6	100.0
1968	706.5	2,518.1	28.06	32.2	65.4	2.4	100.0
1969	461.4	2,321.6	19.87	35.8	61.1	3.1	100.0
1971	416.0	2,313.8	17.98	46.5	49.2	4.3	100.0
1972	350.5	2,440.3	14.36	54.5	32.3	13.2	100.0
1973	211.0	2,254.7	9.36	80.6	4.4	15.0	100.0
1974	425.7	2,452.4	17.36	59.9	0.7	39.4	100.0
1975	536.7	2,494.2	21.52	46.9	0.7	52.4	100.0
1977	736.7	2,648.9	27.81	29.1	2.4	68.5	100.0
1978	561.0	2,444.5	22.95	30.0	1.7	68.3	100.0
1979	659.8	2,449.8	26.93	20.7	0.7	78.6	100.0
1980	653.1	2,353.6	27.75	20.8	0.5	78.7	100.0
1981	811.9	2,375.1	34.18	15.7	—	84.3	100.0
1982	762.8	2,482.6	30.73	18.1	—	81.9	100.0
1983	957.1	2,485.2	38.51	12.5	—	87.5	100.0
1984	640.8	2,244.2	28.56	17.9	—	82.1	100.0
1985	717.8	2,173.5	33.02	15.6	—	84.4	100.0

\* Import and Farmer's rice held in Farmer Association for the payment in kind of land taxes and surplus of the rice which provide to military and public servants are excluded.

Source: Huang, T. C., 1987, P. 25.

Rice comes from the land tax in kind collected is also a very important source of government rice, but its share of total quantities which controlled by the government decreased from 80.6% in 1973 to 15.6% in 1985. The other source of government rice comes from the purchase and the loan of rice production fund received, its relative importance to total government rice increased from the lowest proportion of 2.7% in 1961 to the highest proportion of 84.4% in 1985. In other words, the major source of government rice comes from the purchase and the loan of rice production fund received, the percentage is over 50% since 1975 until now.

## 2. Surplus of Rice

With regard to compare the receipts with the payments of government rice, Table 12 shows that the government stock accumulation of rice varied significantly year by year, ranging from the lowest of 68.1 thousand metric tons in 1966 to the highest level of 1,306.3 thousand metric tons in 1983 during the period from 1961 to 1985. In the latest five years from 1981 to 1985, the accumulative storage of rice is over one million metric tons of brown rice every year. The heavy burden of financial support by the government increased greatly.

Table 12: Receipts and Payments of Government Rice

Unit: Brown Rice, 100 m.t.

Year	Land Tax in Kind Collected, Compulsory Purchase of Paddy through Land Tax and Rent of Public Land Received	Fertilizer-Rice Barter	Receipts			Rice Used by the Government	Adjustment of Supply and Demand in the Market (Included the Subsidy of Rice Conversion Program)	Payments			Accumulative Storage at End of the Year	
			Purchase and Loan of Rice Production fund Received	Import	Others*			Subtotal	Export	Others*		Subtotal
1961	256.1	370.3	16.9	13.8	93.1	730.3	328.7	183.2	91.3	80.1	682.3	102.5
1962	249.8	366.8	20.2	—	109.2	746.1	315.6	218.6	36.2	98.8	669.3	179.3
1963	215.2	426.0	23.0	24.2	123.9	812.8	321.7	144.6	182.1	106.2	754.5	237.6
1964	202.2	439.2	19.2	2.0	126.5	789.2	334.6	164.5	231.2	107.1	837.5	189.4
1965	196.6	463.9	17.6	—	144.5	822.6	348.0	100.7	234.5	106.1	789.4	222.6
1966	174.0	452.0	17.8	4.4	111.6	759.8	360.2	261.3	213.0	79.8	914.4	68.1
1967	214.5	407.3	16.9	4.4	113.6	756.7	364.5	212.0	78.4	101.5	756.4	68.4
1968	227.4	462.4	16.7	5.5	120.4	832.4	367.4	22.7	46.6	102.5	539.1	361.6
1969	165.3	281.8	11.3	3.1	85.9	550.4	338.5	182.6	44.4	62.3	627.8	284.2
1970	209.0	283.9	17.6	4.6	90.3	605.4	317.2	176.2	26.2	51.5	571.0	318.6
1971	193.5	204.5	17.9	6.8	84.5	507.3	264.5	142.4	79.3	43.1	519.2	296.7
1972	191.0	113.3	46.3	3.3	28.1	381.9	279.2	6.4	24.9	4.3	314.9	363.7
1973	170.0	9.3	31.6	141.0	29.6	381.6	316.7	139.3	73.0	5.1	533.9	211.4
1974	254.9	2.8	167.9	7.7	32.1	465.5	337.8	17.6	0	3.7	359.1	317.9
1975	251.6	3.8	281.5	3.9	34.4	575.0	310.2	64.1	0	5.5	379.9	513.0
1976	264.1	14.0	555.1	7.7	42.4	863.5	387.1	64.2	0.5	10.5	462.4	914.1
1977	211.0	17.8	504.9	4.4	40.2	781.3	364.1	78.0	323.9	31.1	797.1	898.4
1978	168.2	9.9	383.0	—	59.1	620.1	370.9	68.2	263.5	16.7	719.3	799.2
1979	136.5	4.9	518.4	—	42.8	702.6	375.9	20.4	505.0	34.2	935.5	566.3
1980	135.7	3.1	514.3	13.2	60.9	727.2	343.4	3.6	127.4	6.7	481.1	812.4
1981	127.7	—	681.2	—	34.4	846.3	344.1	97.9	73.0	2.8	517.8	1,140.9
1982	148.3	—	624.5	—	24.2	787.0	187.3	57.7	648.8	9.3	903.1	1,024.8
1983	119.4	—	837.7	—	33.2	990.2	195.7	112.2	395.4	5.4	708.7	1,306.3
1984	111.8	—	526.1	—	21.4	662.3	196.4	106.3	111.7	292.9*4.5	711.8	1,256.8
1985	111.7	—	606.1	—	18.5	736.3	197.1	142.5	146.5	289.348.2	783.6	1,209.5

\* The item of others includes the farmers rice held in farmer's association for the payments in kind of land tax and the surplus of the military and public servants supply of rice.

\* Animal feed.

Source: Haung, T. C., 1987, P. 26-27.

## VI. Conclusions

As Taiwan's economic growth has quickened and per capita income increased, the structure of production and consumption of agricultural products has changed year by year. Under present condition, the rice production has increased owing to the technological change in farming operation, and rice consumption decreases as income increases. As a result, the problems of rice surplus has become a serious issues of agricultural production in Taiwan.

This paper concludes with some suggestions for the problems involved in production and marketing of rice in the interest of policy makers.

There are at least three issues involved in production and marketing in rice as follows:

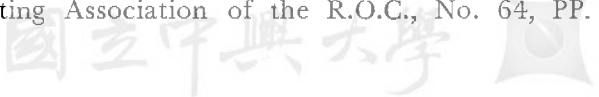
1. Over production and farmer's response very little to prices change in planning their acreage. In order to reduce the rice production, government has to create suitable incentives not only in prices but also in production environments, the conversion program from rice to other crops then can be easily realized accordingly.

2. Rice consumption decreases and habit formation affects the rice consumption. For maintaining the level of rice consumption in quantities, the more attention should be paid in the diversified utilization of rice. The rice is consumed not only in the form of staple food but also in the form of new different processing and diet designs which to be developed by some research institutes concerned.

3. Heavy financial burden of government by the accumulative storage of rice. In order to limit the government stock accumulation of rice each year, both measures of reduce the supply of rice through declining the planted area of rice and increase of outlet for export and animal feed are necessary.

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1. See Taiwan Agriculture Yearbook.
2. See Huang, T.C., 1987, P. 26.
3. See Taiwan Food Balance Sheet, Council of Agriculture.
4. See Nerlove, M., 1958.
5. For estimating the acreage response to price in rice production, theoretically, the price of rice is a very important variable, but in real situation of rice supply in Taiwan, the price of rice could not play an important role for shaping farmers decisions to plant their rice. Therefore, the price ratio between rice and corn is effectively used in this study.
6. The origin idea comes from Marshall (1920), he introduced three idea in demand theory: (1) the adaptation to a change in price is gradual; there is a partial adjustment, (2) the movement along a demand curve is irreversible, when habits have developed in the meantime, (3) the effect of habits is positive (Philips, 1983, P. 169).
7. The procedures of calculations, see Philips, L., 1983, Chapters 6 and 7.
8. See various issues of Taiwan Food Statistics Book and Table 11.
9. Since 1973, the fertilizer-rice barter program was abolished.

Supply, Demand and Marketing System Analysis  
for Rice in Taiwan

# 台灣稻米供需與運銷制度之分析

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## 摘 要

本文針對台灣稻米供需與運銷制度的分析有幾個發現：(1)稻米生產過剩以及稻農對稻米價格變動的反應不太敏銳，(2)稻米的消費遞減，以及稻米消費受消費習慣的影響很大，(3)每年稻米累積盤存量的增加使政府的財政負擔大增。今後稻米政策的重點在於減少稻米種植面積以及稻米公糧的盤存量，至於以政策來鼓勵國民多消費食米，由於國民消費習慣已形成，這方面的政策很難收預期效果。

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