

# STUDIES ON TECHNOLOGY TRANSFER IN AGRICULTURE IN TAIWAN<sup>1</sup>

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## ABSTRACT

Survey research on technology transfer in agriculture in Taiwan, R.O.C. was conducted with regards to trends in area, production and yield of rice, corn and wheat. Technology and technology adoption, income and expenditure related to technology adoption, government programs and policies, accessibility to institutions and support service, some indicators of social change were also studied.

Agricultural extension work by the Farmers' Associations in cooperation with six District Agricultural Improvement Stations and universities played an important role in conveying the government policies and transferring the technological knowhow to the farmers. Application of modern sciences and technologies through proper extension channels is essential to upgrading the quality of farm products. The adoption of an improved marketing system is fundamental to the enhancement of the well-being of local farmers.

It is understood that current economic internationalization and liberalization policies will have an impact on local agricultural development. The domestic market is becoming increasingly open to international competition. The market share of local farm products will be reduced and so the incomes of local farmers may suffer. In order to cope with this problem, the market-directed system of crop production and technology transfer should be practiced. It is suggested in the present paper that the efficient methods of technology transfer should be devised further to meet the increasing needs of farmers for the production and marketing of the farm products.

**Key words:** Technology transfer, extension work, technology adoption, rice, corn, wheat.

## INTRODUCTION

The structure and technology of agricultural production in Taiwan, R.O.C. have been changed significantly as a result of rapid economic development. The modern agricultural technology introduced in the 1960s has been instrumental to the significant growth of Asian agriculture including R.O.C. in the last two decades. The success was often brought about mainly by the efficient combination of high yielding varieties of crops and improvement in irrigation, fertilizer, machinery and other inputs. This new

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technology which resulted in increased yield and reduced unit cost has become a cornerstone in the overall strategy of promoting agricultural growth in Taiwan.

How these technologies had been developed and how the new technologies were transferred to the farmers of Taiwan in the past are the important problems to be studied.

In 1988, the Asian Productivity Organization (APO) initiated a coordinated research program on survey of technology transfer in agriculture. The objectives of the survey studies are: (1) to undertake a general assessment of the impact of the new agricultural technology on the socioeconomic conditions of rural communities in Taiwan, R.O.C.; (2) to examine: (i) the dissemination of appropriate agricultural technologies, particularly to the small farmers and (ii) the integration of traditional farming techniques and practices with modern technology; (3) to identify problems and constraints and various measures employed by the government to resolve them; (4) to recommend follow-up activities which may be needed to address more fully the requirement of a country in these areas.

The writers took part in that coordinated research work, and the results of the survey was summarized and reported at the APO meeting in Manila in June 1989. The summary report presented at the meeting was rewritten with the updated data and additional information in this paper.

In this paper, the results of survey on technology transfer in agriculture in Taiwan, R.O.C. with regard to trends in area, production and yield of rice, corn and wheat were reported. Technology and technology adoption, income and expenditure related to technology adoption, government programs and policies, accessibility to institutions and support service, some indicators of social change were also surveyed. The roles of extension work played by the Farmers' Associations as well as by Taiwan Provincial District Agricultural Improvement Stations were surveyed.

The writers wish to express their hearty thanks to Asian Productivity Organization for sponsoring the survey studies. Thanks are due to Dr. Aida R. Librero the coordinator of the project and Director, Socio-Economics Research Department, Philippines Council for Agriculture and Resources Research and Development for her kind directions during the survey work.

## **SCOPE AND METHODOLOGY**

This paper attempts to integrate the results of a survey on technology transfer conducted in Taiwan. The scope of the survey mainly centers on an examination of the experiences on agricultural technology transfer and transformation in Taiwan. Accordingly, the topics covered are as follows:

Trends in agricultural productivity, farmers' income level and distribution by size/type of farms; (b) Effects/impact of agricultural technology on the socio-economic conditions in the rural areas; (c) Role of traditional farming techniques and practices: efforts on technology transformation; (d) Problems and constraints related to agricultural technology transfer and transformation; (e) Development of modern technology packages and programs on their dissemination at the farm level; and (f) Suggestions on follow-up activities.

The survey covers three major cereals namely: rice, corn, and wheat. It was conducted by the writers using a common questionnaire.

In general the analysis of trends in area, production, and yield covered the period 1960 to 1987. For specific topics on technology adoption, income and expenditures, etc., attempts were made to cover three periods: (1) the period before the introduction of improved varieties of rice, corn, and wheat; (2) the period immediately after some widespread adoption has taken place; and (3) the more recent years. It was recognized that most of the data may not be available as a time series, hence this report relied heavily on previous studies conducted in Taiwan. Caution, therefore, should be made in interpreting the results some of which may apply not only to specific areas rather than the country as a whole.

## **IMPORTANCE OF RICE, WHEAT AND CORN IN THE ECONOMY**

### **Rice**

Rice is the most important crop in Taiwan. Its area accounts more than one-half of the total cultivated area. After World War II, the government implemented various rural reconstruction measures including improvement of irrigation and drainage facilities and adoption of high yielding varieties, etc. resulting in a drastic increase in rice acreage and production which exceeded the prewar highest level. The acreage reached 766,400 to 776,100 ha occupying 88.2~85.7% of total cultivated area during 1960~1970 (Table 1). To maintain a good rice supply, the government established the Food Foundation in 1974. Starting from the first crop season of 1974, the government set a guaranteed rice price by adding 20 percent profit to the cost of production. In addition to purchasing all farmers' produce at the guaranteed price (the purchased amount has been reduced to 970 kg/ha since 1977), the government also provided interest-free loans to rice farmers. Other measures to improve rice culture included the establishment of numerous rice seedling nursery centers and tournaments of rice yield competition. As a result, rice area reached 790,200 ha in 1970 and rough rice production increased from 2.25 million tons in 1973 to 2.71 million tons in 1976.

Increased living standard and changing dietary habit reduced rice consumption per capita from 130 kg in 1975 to only 87 kg in 1985. This represented a decrease in annual consumption of 33.15 percent. Although Taiwan's population increased from 16 million to 19 million during the same period, rice consumption decreased from 2.09 million tons rough rice to 1.64 million tons.

The total value of rice production accounts for more than 30% of the total value of crop production, especially in 1960 the percentage reached 57% (Table 2).

### **Wheat**

Because of the subtropical climate in Taiwan, local wheat production is very limited. Prior to 1936, wheat was mostly grown in upland areas with an extensive method of culture. Yield was low. After adoption of new varieties suitable for winter relay-interplanting with paddy, wheat acreage increased gradually. In 1950, the acreage reached 18,300 ha and then 25,200 ha occupying 3 percent of the total cultivated land in 1960 (Table 1). The total value of production was equivalent to one percent of the total crop value in that year.

After 1964, wheat was imported (mostly from U.S.A.) at a much lower price than the local one, therefore wheat acreage fell drastically. During 1960~1965 and 1965~1970 acreage went down by 56 percent and 82 percent respectively. Further in 1972, it dropped to 1,000 ha and in 1974 to the smallest acreage of 304 ha. A guaranteed price was offered by the Tobacco and Wine Monopoly Bureau to contracted farmers, hence wheat acreage increased again to about 1,000 ha.

### Corn

Prior to 1960, the local demand for corn was small and no improved varieties were available. The acreage was less than 2% of total cultivated land and value of production was less than 0.5% of all crops (Tables 1 and 2). After 1965, livestock became an important industry, thus corn demand for animal feed increased every year. Research emphasis was laid on breeding for new high yielding varieties. Corn acreage increased rapidly thereafter. Nevertheless, locally produced corn still could not meet the demand, therefore the government began to import a great amount of corn. Because foreign price was lower than domestic price, the acreage of corn in Taiwan did not increase significantly. In 1974 the government provided guaranteed prices for local corn, hence corn acreage increased gradually. In 1984, the government implemented the paddy field diversion program to increase the acreage of upland crops, especially corn and sorghum. Since then corn area increased rapidly exceeding 7% of total cultivated land and corn accounted for 3% of total crop value. Even so self-sufficiency of corn was only 6.65% of the needed amount in 1985.

Table 1. Proportion of rice, wheat and corn to total cultivated area, selected years

Item	1940	1950	1960	1965	1970	1975	1980	1985	1987
(1) Total cultivated area (1,000 ha)	860.5	810.6	869.6	889.6	905.3	917.1	907.4	887.7	886.3
(a) Rice area	638.6	770.3	766.4	772.9	776.1	790.2	638.4	564.4	502.1
(b) Corn area	1.9	5.0	13.9	18.7	22.6	49.7	40.4	62.5	79.3
(c) Wheat area	5.6	18.3	25.2	11.1	2.0	1.3	1.1	1.1	1.3
(2) Percent to total cultivated area									
Rice(a)/(1)	74.2	88.5	88.2	86.9	85.7	86.2	70.4	63.6	56.7
Com(b)/(1)	0.2	0.6	1.6	2.1	2.5	5.4	4.5	7.0	8.9
Wheat (c)/(1)	0.7	2.1	2.9	1.3	0.2	0.1	0.1	0.1	0.1

Sources: Department of Agriculture and Forestry, Taiwan Provincial Government.

Taiwan Agricultural Yearbook. Department of Agriculture and Forestry, Taiwan Provincial Government. 1960, 1968, 1973, 1980, 1981, 1986, and 1988.

Table 2. Proportion of rice, wheat and corn to total value of production, selected years

Item	1940	1950	1960	1965	1970	1975	1980	1985	1987
(1) Crop production	0.459	2.374	431.294	604.038	758.005	1,862.175	2,784.393	3,176.213	4,409.928
(2) Cereal production	0.215	1.279	251.634	301.793	346.735	928.514	1,198.184	1,132.955	1,354.809
(a) Rice	0.213	1.255	245.856	295.393	341.171	905.550	1,167.148	1,035.228	1,180.180
(b) Com	0.535	3.587	1,578.042	3,908.479	5,195.486	22,363.968	29,937.299	96,688.596	171,340.315
(c) Wheat	0.895	20.020	4,199.922	2,492.344	367.531	599.264	1,098.752	1,038.546	3,288.112
(3) Relative percentage to total crop production									
Rice(a)/(1)	46.5	52.9	57.0	48.9	45.0	48.6	41.9	32.6	26.76
Corn(b)/(1)	0.1	0.2	0.4	0.6	0.7	1.2	1.1	3.0	3.89
Wheat (c)/(1)	0.2	0.8	1.0	0.4	0.05	0.03	0.04	0.03	0.07

Sources: Department of Agriculture and Forestry, Taiwan Provincial Government.

Taiwan Agricultural Yearbook. Department of Agriculture and Forestry, Taiwan Provincial Government. 1960, 1968, 1973, 1980, 1981, 1986, and 1988.

Note: (1) & (2): The total value of production multiplied by million US\$.

(a): The value of rice production multiplied by million US\$.

(b) & (c): Respectively, the value of corn and wheat production multiplied by 1,000 US\$.

Data shown for 1940 and 1950 were measured in the local currency (1 unit= 1,000 NT\$) of those years.

## TRENDS IN AREA, PRODUCTION AND YIELD OF RICE, WHEAT AND CORN, 1960-1987

During the period 1960~1979, rice acreage was stable (Fig. 1). After 1980, the change in dietary structure, which reduced rice consumption significantly, insufficient storage facilities, and the implementation of paddy field diversion program, reduced the acreage of rice gradually. The yield of rice increased considerably because of wide adoption of improved varieties, better irrigation and drainage systems, and the increased amount of fertilizer application. Although there were yield fluctuations due to yearly climatic changes, the yield increase has been stable. Total production of rice also increased steadily up to 1968, then dropped thereafter until 1974. Total production again increased drastically to the highest record of 2.71 million tons in 1976, after which it decreased up to the present. During the period 1960~1987, irrigated paddy area occupied 97.44~99.98% of the total rice acreage. Wheat yield fluctuated between 1.3-3.7 mt/ha during the period 1960~1987 (Fig. 2). The area and production decreased significantly during the same period. Because wheat is usually grown as a relay-winter crop after the second rice crop, all wheat fields are really irrigated paddy fields.

As for corn, acreage, production, and yield tended to increase drastically before 1975, but decreased during the period 1975~1981 after which they increased again (Fig. 3).

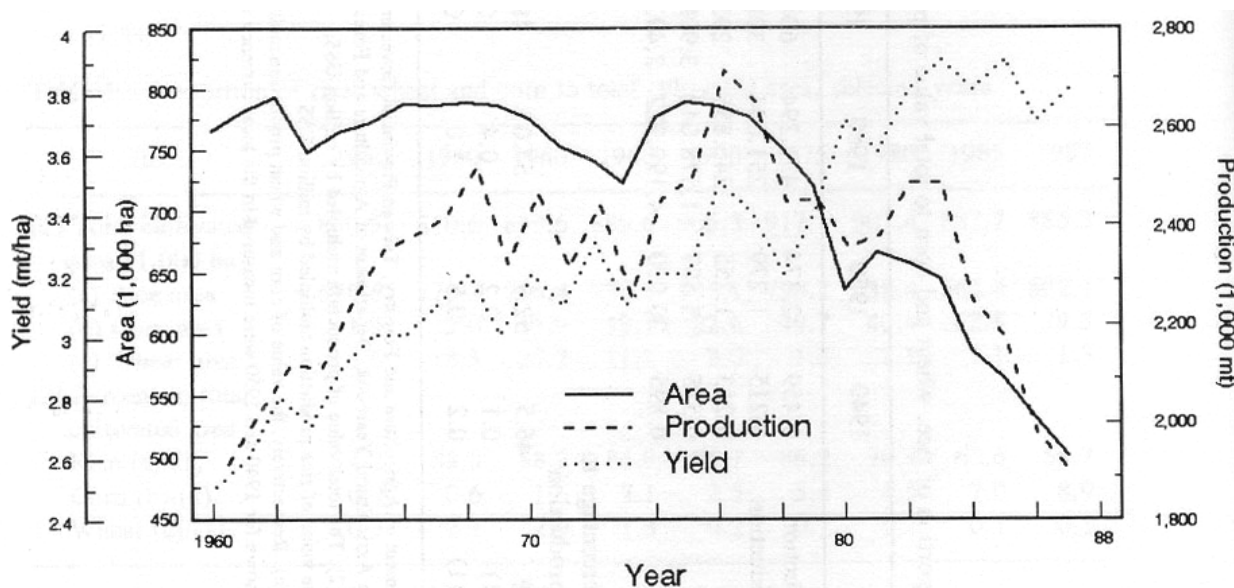


Fig. 1. Trends in rice area, production, and yield from 1960 to 1987.

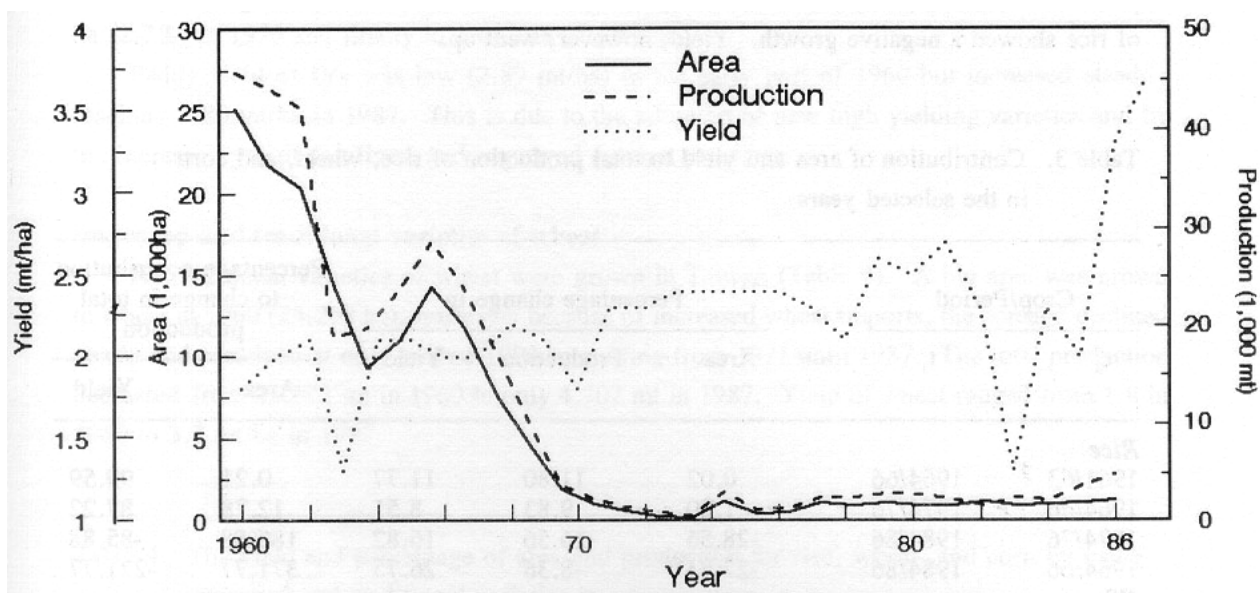


Fig. 2. Trends in wheat area, production, and yield from 1960 to 1987.

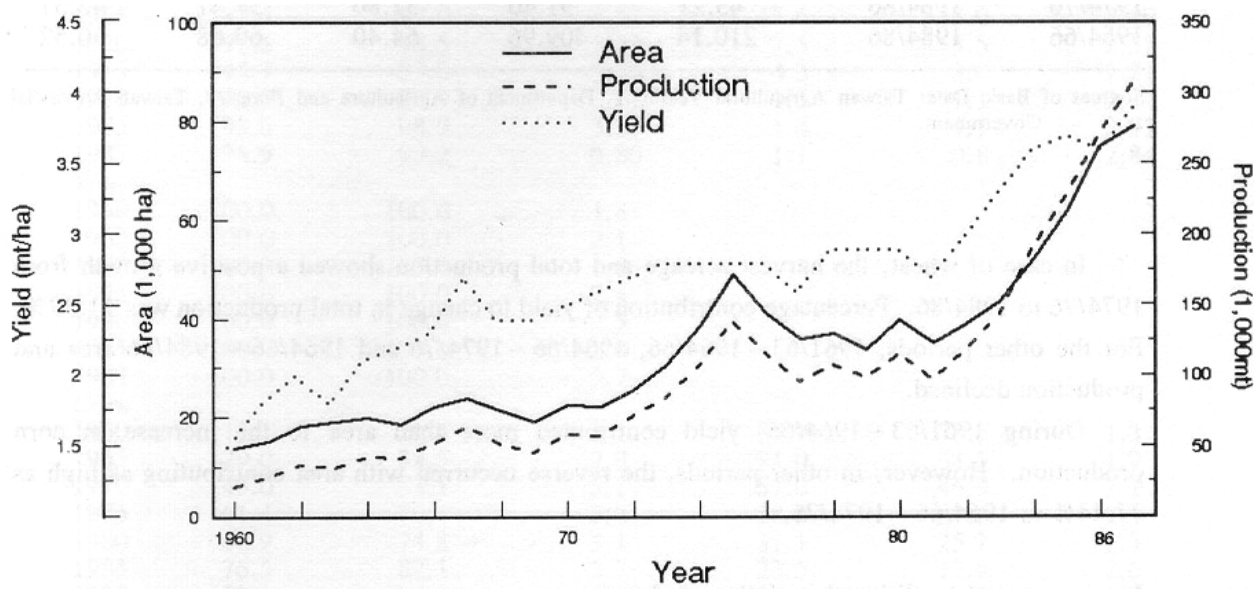


Fig. 3. Trends in corn area, production, and yield from 1960 to 1987.

### Contribution of area and yield to total production of rice, wheat, and corn

During 1961/63~1964/66 and 1964/66~1974/76 yield contributed the most to total rice production (Table 3). In 1974/76~1984/86 and 1964/66~1984/86 the acreage and production of rice showed a negative growth. Yield, however, went up.

Table 3. Contribution of area and yield to total production of rice, wheat, and corn in the selected years

Crop/Period		Percentage change			Percentage contribution in to change in total production	
t <sub>0</sub>	t <sub>1</sub>	Area*	Production	Yield	Area	Yield
<b>Rice</b>						
1961/63	1964/66	0.02	11.80	11.77	0.21	99.59
1964/66	1974/76	1.20	9.83	8.51	12.78	87.22
1974/76	1984/86	-28.56	-16.56	16.82	185.88	-85.88
1964/66	1984/86	-27.71	-8.36	26.75	371.77	-271.77
<b>Wheat</b>						
1961/63	1964/66	-38.28	-31.76	10.55	126.28	-26.28
1964/66	1974/76	-94.06	93.02	17.41	106.02	-6.02
1974/76	1984/86	54.56	63.43	5.72	88.65	11.39
1965/66	1984/86	-90.81	-88.59	24.12	109.95	-9.96
<b>Corn</b>						
1961/63	1964/66	15.11	37.73	19.65	43.96	56.12
1964/66	1974/76	113.57	166.43	24.73	77.44	22.53
1974/76	1984/86	45.21	91.40	31.80	57.47	42.57
1964/66	1984/86	210.14	409.96	64.40	69.68	30.52

Sources of Basic Data: Taiwan Agricultural Yearbook. Department of Agriculture and Forestry, Taiwan Provincial Government.

In case of wheat, the harvest acreage and total production showed a positive growth from 1974/76 to 1984/86. Percentage contribution of yield to change in total production was 11.39%. For the other periods, 1961/63~1964/66, 1964/66~1974/76 and 1964/66~1984/86 area and production declined.

During 1961/63~1964/66, yield contributed more than area to the increase in corn production. However, in other periods, the reverse occurred with area contributing as high as 77.44% in 1964/66~1974/76.

### Improved and traditional varieties of rice

The acreage of improved rice varieties in 1960 was 522,768 ha which accounted for 68.2% of the total area (Table 4). The acreage of the improved varieties (IVs) increased gradually thereafter until 1970 when it reached 717,696 ha, then declined until 1972 to 683,876 ha. It increased again until 1976, then declined until 1987 (495,825 ha). Most farmers used IVs because of the strong recommendations by experiment stations and extension agents. The acreage of IVs occupied 92.5% and 98.9% of total rice area in 1970 and 1987 respectively. On the other hand, the acreage of traditional varieties (TVs) decreased from 243,641 ha (31.8%) in 1960 to 21,231 ha (2.7%) in 1976 and finally to 5,667 ha (1.1%) in 1987.

Paddy yield of IVs was low (2.89 mt/ha) in the early part of 1960 but increased steadily reaching 3.80 mt/ha in 1987. This is due to the adoption of new high yielding varieties and by the increased use of fertilizers and improved cultural practices.

#### Improved and traditional varieties of wheat

No traditional varieties of wheat were grown in Taiwan (Table 4). A big area was grown to wheat in 1960 (25,208 ha), however, because of increased wheat imports, the acreage declined yearly and remained at only around 1000 ha starting from 1971 until 1987. The total production decreased from 45,574 mt in 1960 to only 4,702 mt in 1987. Yield of wheat ranged from 1.8 in 1960 to 3.7 mt/ha in 1987.

Table 4. The yield and percentage of area and production for rice, wheat, and corn by using improved and traditional varieties in selected years

Crop & year	Improved varieties			Traditional varieties		
	Percent of area	Percent of output	Yield (mt/ha)	Percent of area	Percent of output	Yield (mt/ha)
<b>Rice</b>						
1960	68.2	79.0	2.89	31.8	21.0	1.64
1965	82.5	87.0	3.22	17.6	13.0	2.19
1970	92.5	94.5	3.24	7.5	5.5	2.32
1975	95.7	97.0	3.20	4.3	3.0	2.21
1980	98.5	98.9	3.71	1.5	1.1	2.74
1985	98.6	98.9	3.87	1.4	1.1	2.91
1987	98.9	99.2	3.80	1.1	0.8	2.84
<b>Wheat</b>						
1960	100.0	100.0	1.8			
1965	100.0	100.0	2.1			
1970	100.0	100.0	1.8			
1975	100.0	100.0	2.4			
1980	100.0	100.0	2.5			
1985	100.0	100.0	2.0			
1987	100.0	100.0	3.7			
<b>Corn</b>						
1960	15.1	21.4	2.1	84.9	78.6	1.3
1965	29.0	38.5	2.9	71.0	61.5	1.9
1970	43.0	53.1	3.1	57.0	46.9	2.1
1975	61.4	70.4	3.2	38.6	29.6	2.1
1980	68.9	74.8	3.1	31.1	25.2	2.3
1985	76.5	82.1	3.7	23.5	17.9	2.6
1987	79.6	85.8	4.0	20.4	14.2	2.6

Source: Department of Agriculture and Forestry, Taiwan Provincial Government.

### **Improved and traditional varieties of corn**

In 1958, the first hybrid corn variety, Tainan 5, was developed. Later, hybrid corn varieties, Tainan 8, 9, II and Tainung 351, etc., were successfully released. Because the yield of these improved hybrid corn was 50~75% higher than that of traditional varieties (Table 4), the acreage increased from 13,854 ha in 1960 to 30,528 ha in 1973 and 49,717 ha in 1975. However, the acreage dropped again due to the importation of corn starting from 1977 until 1982. In 1984, the government implemented a paddy field diversion program to encourage farmers to grow more upland crops including corn, thus the acreage of corn increased drastically again and reached 79,139 ha in 1987 which is nearly five times greater than that in 1960.

The acreage of improved varieties increased steadily from 1960 to 1987 when area grew 30 times that of 1960. The total production of improved varieties was only 4,432 mt in 1960, but increased to 252,005 mt in 1987 which is 56 times greater than that at the initial stage of 1960. The yield during the period of 1960~1965 was rather low ranging from 2.1~2.9 mt/ha. However, the average yield increased thereafter up to 3~4.0 mt/ha in 1987. This was due mainly to the adoption of the latest high yielding hybrid corn variety, Tainung 351 which often gave its highest yield of 6 mt/ha when it was grown at the right season. In general, the yield of traditional varieties is roughly 50% lower than that of improved varieties.

### **Irrigated acreage in rice and source of water**

Irrigated rice acreage remained stable at 747,107 ha to 765,611 ha during 1960~1970. It dropped gradually from 1971 to 1973 but increased suddenly to the maximum record of 784,720 ha in 1975. The acreage then dropped again thereafter from 749,415 ha in 1978 to 501,370 ha in 1987. In its desire to reduce rice surplus, the government has diverted paddy fields, thus the sharp decline in irrigated area.

Irrigation and drainage facilities were quite good and only about 2.5% of rice field was unirrigated in 1960~1963. This proportion was reduced to about 2% during the period 1964-1971. Starting from 1972 the irrigated acreage increased from 99.1% to 99.9% in 1980, and finally increased to 100% in 1984 to the present.

### **Yield and income by size of farm**

After the implementation of the land-to-tiller policy in 1953, no more big landlords existed. Thus farm size became smaller. A farm over 1.5 ha is considered a big farm; 0.5 to 1.5 ha and under 0.5 ha is classified as medium and small farms respectively. For rice, medium sized farms occupied 47.8% (1966) and 46.6% (1980) of all rice farms in the country (Table 5). The large sized farms occupied 20.6% in 1966 and only 15.9% in 1980.

Farm size distribution in wheat farms in 1966 was very similar to that of rice. Medium-sized wheat farms occupied 56.8% of the total number of wheat farms while small and large-sized farms occupied 33.2% and 10.7% respectively.

Table 5. Distribution of farms by size and crop, before and after using improved varieties

Size of farm	Rice		Corn	
	Before (1966)	After (1980)	Before (1966)	After (1980)
<b>Number of farms</b>				
Small (under 0.5 ha)	206,539	191,787	-	39,483
Medium (0.5 to 1.5 ha)	311,898	238,306	-	19,054
Large (over 1.5 ha)	134,342	81,314	-	3,588
Total	652,780	511,407	-	62,125
<b>Percentage of farms</b>				
Small (under 0.5 ha)	31.6	37.5	18.6	63.5
Medium (0.5 to 1.5 ha)	47.8	46.6	46.3	30.7
Large (over 1.5 ha)	20.6	15.9	35.1	5.8
Total	100.0	100.0	100.0	100.0

Sources: Report on the 1966 and 1980 Agriculture Census of Taiwan, R.O.C. Committee on Census of Agriculture, Taiwan Provincial Government, 1967 and 1982, respectively.

The situation in corn is quite different with small-sized farms occupying only 18.6% in 1966 but by 1980 the group constituted 63.5 % of all corn farms. On the other hand, the proportion of large farms of 35.1% in 1966 dropped to 5.8% in 1980. In general, the small sized farms tended to increase in number whether rice, wheat or corn.

Regardless of farm size, yield of irrigated rice in 1980 was 5% (2nd crop) to 10% (1st crop) higher compared with 1967 (Table 6). Increasing from 227.3 US\$ in 1967 to 1,051.1 US\$ in 1980 average income/ha rose by approximately 3.5 times. In real terms, however, income went up only 40%.

Practically all wheat varieties cultivated since 1967 are improved varieties. Yield in 1980 was 3.0 mt/ha compared with 2.0 mt in 1967. The income from wheat farming in 1980 was 448.0 US\$/ha compared with 47.5 US\$ in 1967 representing an increase of 8 times at current prices but in real terms was only 2 times.

For corn, yield in 1967 was 4.3 mt while that of 1980 was 4.5 mt. The average income per ha of corn increased drastically from 144.5 US\$ in 1967 to 390.0 US\$ in 1980. However, real income decreased 15% in 1980 compared with that in 1967.

Table 6. Yield and income by size and type of farm, before and after using improved varieties

Size of farm	Rice-irrigated				Wheat		Corn	
	Yield (mt/ha)		Income (US\$/ha)		Yield (mt/ha)	Income (US\$/ha)	Yield (mt/ha)	Income (US\$/ha)
	1st crop	2nd crop	1st crop	2nd crop				
<b>Small</b>								
Before (1967)	5.5	4.5	330.8	254.7	2.0	45.9	4.4	146.5
After (1980)	5.5	4.4	1,164.7	975.7	2.9	527.1	4.7	367.9
<b>Medium</b>								
Before (1967)	4.9	4.2	263.4	222.6	1.9	41.2	4.4	141.9
After (1980)	5.2	4.3	1,142.4	1,021.0	3.0	419.2	4.1	462.5
<b>Large</b>								
Before (1967)	4.5	4.0	228.4	218.9	2.4	62.8	3.5	126.2
After (1980)	5.1	4.3	1,110.4	1,063.7	-	-	5.2	622.4
<b>All Farms</b>								
Before (1967)	4.8	4.1	252.1	227.3	2.0	47.5	4.3	144.5
After (1980)	5.3	4.3	1,144.5	1,015.1	3.0	448.0	4.5	390.0

Sources: The Report on Production Cost Survey of Major Crops in Taiwan, PDAF. 1968

The Report on Production Cost Survey of Other Major Grains in Taiwan, PDAF. 1968.

The Report on Production Expense Survey of Rice in Taiwan, Food Bureau, Taiwan Provincial Government, 1981.

Note: Income includes the cost of family labor and the rent of owner's farmland.

## TECHNOLOGY ADOPTION

### Sources of information on production technology

New technologies developed by research stations are usually transferred through field demonstration, training and mass media such as radio, print, television, etc. Extension workers in Taiwan play a very important role in transferring new technologies to farmers. In case of rice, 50% to 60% of information are provided through extension workers while that for wheat and corn is 70~73% and 65~70%.

Native varieties are often planted in the remote mountainous regions where information is transferred mainly by other farmers, friends, and input dealers. A small part (roughly 10%) of the information is provided by the extension workers. The rate of information transfer through print media and television is increasing, but that through radio is decreasing.

Nowadays, every farmer has one or two sets of television. Half an hour farmers' programs are broadcasted by three TV Stations every day. The farmers' program is produced by TV Stations themselves with the help of various Agricultural Improvement Stations and extension workers of Farmers' Associations. Six Provincial District Agricultural Improvement Stations have their own facilities for processing and editing video tapes. A list of video tapes is available for farmers' use at the District Agricultural Improvement Stations.

Training is another effective way of technology transfer to farmers. Each District Agricultural Improvement Station has its own training center offering short agricultural production courses for farmers and extension workers. The duration of training ranges from 3 to 15 days depending on the importance of the subject. Field exercise and on the spot discussion are usually included in the training course. All training expenses are paid by the government. Approximately 5,000~6,000 persons receive various training courses on crop production every year.

Another effective measure for technology transfer is holding periodic consultation meetings with groups of farmers. Farmers' questions are answered by subject matter specialists from experiment stations and extension professors from the universities. Questions and answers are then recorded and printed in the form of extension bulletins which are then distributed upon request to interested farmers free of charge.

### **Extent of adoption of recommended technology**

Degree of acceptance of recommended technology depends greatly on its quality and ease of application. For instance, rice variety Tainung 67 which is characterized by its high yielding capacity and wide adaptability is the most adopted variety in Taiwan today. About 70% of rice farmers cultivate this variety. The newly released rice varieties, Taichung 189 and Tainung 70, which are characterized by good grain qualities are used by 10~20% of farmers. Mechanization of transplanting rice is as high as 95 %. This is due to its high efficiency and labor saving features in comparison with hand transplanting.

Fifty percent of rice fields have had their soil tested once, and 20% had soil testing twice a year by the research stations. Practically all rice farmers used pesticides to control insects and diseases. Almost all rice fields use herbicides for weed control.

A wheat variety, Taichung (s) 2, is cultured exclusively (99%) because of its adaptability to winter. All wheat fields are planted using non-tillage direct sowing. Ninety percent of wheat farms apply the standard level of fertilizer of 100:54:90 kg NPK/ha by hand dressing once as basal fertilizer. Soil is not tested but all wheat farms use chemicals for pest and disease control and weeding.

Extent of adoption of recommended technology in corn is more or less the same as that in wheat. A 100 percent acceptance was recorded for the recommended HYV Tainung 351 and methods of pest, disease and weed control. Ninety percent of corn farmers always applied fertilizer and the remaining 10% accepted it occasionally.

### **Comparison of recommended technologies and actual production practices**

In general, farmers follow recommended technologies for variety, method of planting, fertilizer application, pest and disease control and weeding, etc. These facts indicate that the recommended varieties or cultural technologies have been good and that farmers trusted extension workers.

### **Improved varieties developed and extent of adoption**

Crop breeding work is usually carried out by the Taiwan Agricultural Research Institute and by the six Taiwan Provincial District Agricultural Improvement Stations. Crosses of proper combinations are done initially, followed by a series of selection procedures, primary and secondary yield trials, regional yield trial and finally registration. After the official registration of new varieties, they are introduced to farmers through field demonstration. An extension booklet containing characteristics of a new variety and

methods of culture, etc. are then distributed to the farmers. The video tape on the new crop variety is shown on television frequently so as to introduce the newly developed variety to the farmers. Government policy dictates that unregistered strains or lines should not be used.

Introduction of new corn seeds are somewhat different from this system. The inbred lines of corn are developed and propagated by the research stations. They are then supplied to the government operated Seeds Service for production of F1 hybrid seeds. The corn farmers buy hybrid seeds from the Seeds Service.

### **Extent of adoption of fertilizer and pest/disease control technology**

Inorganic fertilizer used to be applied only by two percent of rice farmers in 1965. This increased to 5.2% in 1970 and to 94.2% in 1987. A drastic increase in using inorganic fertilizer but decreased use of organic fertilizer is the scene today. The rate of combined use of inorganic and organic fertilizers in paddy fields dropped from 90.1% in 1965 to 87.5% in 1976 and to only 5.8% in 1987. Lack of organic matter in paddy soils caused serious soil erosion and soil acidity problems. The problem of pest and disease epidemic is especially serious in crop production under the subtropical climatic condition in Taiwan. Chemical control has been proven to be the most effective way of controlling insect pests and diseases. Practically all farmers used chemicals for pest control.

Fertilizer is applied regardless of farm size, or variety or crop. Since many local factories manufacture fertilizers and various agricultural chemicals, supply has been adequate. Abundance of capital and easy access to information have led not only to popular but over use of fertilizers and chemicals.

## **INCOME AND EXPENDITURES RELATED TO TECHNOLOGY ADOPTION**

### **Costs and returns of production per farm in rice**

Averaging 0.60 ha in both first and second crops in 1970, rice farm area increased to 0.84 ha for the first crop and 0.86 ha for the second crop in 1986 (Table 7). The increasing size of rice farms in recent years is due to the government policy of encouraging farmers to join entrusted farming and integrate small farms into bigger cooperative farms for easy mechanization.

Rice yield in the second crop season is generally about 20~25% lower than that of the first crop, therefore net income is also lower. The average output per farm in 1970 was 2.8 mt (0.61 ha/farm) and 2.1 mt (0.60 ha/farm) for first and second crops, respectively, and that in 1986 was 4.6 mt (0.84 ha/farm) and 4.0 mt (0.86 ha/farm) for first and second crop, respectively. Rice price increased by about 3.5 times in 1986 compared with 1970.

Table 7. The costs (US\$) and returns of production per farm for rice by using improved varieties

Item	Improved variety adoptor (Japonica rice)			
	1970		1986	1985
	1st	2nd	1st	2nd
(1) Average size of farm (ha)	0.61	0.60	0.84	0.86
(2) Average total rice output per farm (mt)	2.8	2.1	4.6	4.0
(3) Quantity sold (mt)	-	-	-	-
(4) Price/mt	110.5	112.2	398.9	382.0
(5) Gross returns	332.8	260.5	1,824.8	1,551.1
(6) Cash income	-	-	-	-
(7) Total variable costs	200.7	195.4	1,354.9	1,207.8
(a) Cash	131.1	128.6	888.2	746.7
(b) Noncash	69.6	66.8	466.7	461.1
(8) Total fixed costs	78.2	78.8	387.7	301.0
(9) Total cost	278.9	274.2	1,742.6	1,508.8
(10) Returns over variable costs	132.1	65.1	469.9	343.3
(11) Net cash income	-	-	-	-
(12) Returns over total cost	53.9	-13.7	82.2	42.3
(13) Percent return to total cost	19.4	-5.0	4.7	2.8

Source: Report on Production Cost Survey of Farm Products in Taiwan, PDAF, 1971 and 1987.

Note: Data of (9), (10), (II), (12), and (13) were obtained from (7)+(8), (5)-(7), (6)-(a), (5)-(9), and [(12)/(9)]x100, respectively.

From an area of 0.6 ha, gross returns per farm amounted to 332.8 US\$ during the first crop and 260.5 US\$ for the second crop of 1970. The corresponding gross returns in 1986 was 1,824.8 US\$ (0.84 ha) for the first crop and 1,551.1 US\$ for the second crop from an average farm of 0.84 ha. For the same season, the total variable cash and noncash costs per farm increased from 200.7 US\$ in 1970 to 1,354.9 US\$ in 1986. The total fixed cost per farm also increased. Returns over total cost increased in absolute terms but percent return to cost decreased from 19.4% (1st crop) in 1970 to only 4.7% in 1986. The percentage in return to total cost is becoming smaller due to high inputs, nevertheless, the market price of rice has been too low compared with other agricultural products such as fruits, flowers, mushrooms, etc.

#### Costs and returns of production per farm in wheat

A 1987 survey indicated that gross return per farm of 0.5 ha was 1,201.0 US\$ and return over total cost was 405.7 US\$. Percent return to total cost was 51 % which was much higher than that of rice.

#### Costs and returns of production per farm in corn

Average size of corn farm in 1975 was 0.39 ha but increased to 0.7 ha in 1987 (Table 8). Because the farm size doubled in 1975, the average total corn output per farm also doubled (3.6 mt) in 1987 compared with 1.6mt in 1975. The price of corn increased from 144.8 US\$/mt in 1975 to 526.4 US\$/mt in 1987. Total cost increased from 278.3 US\$ (0.39 ha) in 1975 to 1,391.7 US\$ (0.7 ha) in 1987.

A negative return over total cost was obtained in 1975 however, in 1987 this rose by 35% or 487.5 US\$/ha. This primarily due to the guaranteed price of corn under the paddy-field diversion program implemented in 1984.

Table 8. The costs (US\$) and returns of production per farm for corn by using improved varieties

Item	Improved variety adoptor	
	1975	1987
(1) Average size of farm (ha)	0.39	0.7
(2) Average total corn output per farm (mt)	1.6	3.6
(3) Quantity sold (mt)	-	-
(4) Price/mt	144.8	526.4
(5) Gross returns	225.9	1,879.2
(6) Cash income	-	-
(7) Total variable costs	227.4	12,17.0
(a) Cash	139.6	783.3
(b) Noncash	87.8	433.7
(8) Total fixed costs	50.9	174.7
(9) Total cost	278.3	1,391.7
(10) Returns over variable cost	-1.5	662.2
(11) Net cash income	-	-
(12) Returns over total cost	-52.4	487.5
(13) Percent return to total cost	-18.8	35.0

Source: Report on production Cost Survey of Farm Products in Taiwan, PDAF, 1971.

Note: Data of (9), (10), (11), (12), and (13) were obtained from (7)+(8), (5)-(7), (6)-(a), (5)-(9), and [(12)/(9)]x100, respectively.

### Costs and returns of production per hectare, wheat and corn

Yield of rice increased and so did the gross returns. The gross return per ha in the 1st crop of 1986 was 3 times higher than that in 1970 while total cost was 3.5 times higher (Table 9). Return over total costs was 97.7 US\$/ha in the 1st crop of 1986 and 88.5 US\$/ha in 1970, an increase of only 9.2 US\$. Therefore, percent return to total costs became smaller, 4.7% in 1986, in comparison with 19.4% in 1970. Returns/mt in 1986 was 402.3 US\$ compared with 118.6 US\$ in 1970. The situation in the second crop differed a little, -4.9% return to total cost in 1970 and only 2.8% in 1986.

Yield per ha in wheat had increased from 2.2 mt in 1972 to 3.9 mt in 1987. Return over variable and fixed costs in 1972 was negative 180.1 US\$ but increased to 811.4 US\$ in 1987. Returns/mt in 1972 was 112.2 US\$ and rose to 615.9 US\$ in 1987. With yield of corn being higher in 1987 than 1975 and price 2.6 times higher, the gross returns of improved variety production was 3.6 times higher than that of 1975 (Table 10).

Table 9. The costs (US\$) and returns of production per ha for rice by using improved varieties

Item	Improved variety adoptor (Japonica rice)			
	1970		1986	1985
	1st	2nd	1st	2nd
(1) Yield/ha (mt)	4.6	3.5	5.4	4.7
(2) Quantity, sold/ha (mt)	-	-	-	-
(3) Price/mt	110.5	112.2	398.9	382.0
(4) Gross returns	545.7	434.3	2,172.3	1,803.6
(5) Cash income	-	-	-	-
(6) Total variable costs	329.0	325.6	1,613.0	1,404.4
(a) Cash	214.9	214.3	1,057.4	868.2
(b) Noncash	114.1	111.3	555.6	536.2
(7) Fixed costs				
(a) Depreciation	9.8	10.6	13.0	-
(b) Interest on investment	7.7	7.6	15.4	15.4
(c) Others	110.7	113.1	433.2	334.6
(d) Sub-total	128.2	131.3	461.6	350.0
(8) Total cost	457.2	456.9	2,074.6	1,754.4
(9) Returns over variable costs	216.7	108.7	559.3	399.2
(10) Net cash income	-	-	-	-
(11) Returns over total cost	88.5	-22.6	97.7	49.2
(12) Percent return to total cost	19.4	-4.9	4.7	2.8
(13) Returns/mt	118.6	124.1	402.3	383.7

Sources: Report on Production Cost Survey of Farm Products in Taiwan, PDAF, 1971 and 1987.

Note: Data of (8), (9), (10), (II), (12), and (13) were obtained from (6)+(7), (4)-(6), (5)-(a), (4)-(8), [(I)/(8)]x100, and (4)/(I), respectively.

### Disposal of harvest of rice, wheat, and corn

In 1969, more than one-half of total output value of rice was sold and 47.3% was used at home. The remaining 1.2% was used for other purposes including landlord's share.

The picture in 1985 was quite different. The average output of rice per farm increased from 7.8 mt in 1969 to 9.8 mt in 1985 with total values increasing by 4.3 times. Marketed proportion increased to 84.8% of total value in 1985 while home consumption went down to 12.3%.

In case of wheat, the average output of wheat per farm increased from 2.4 mt in 1968 to 3.9 mt in 1987 with its value II times higher. A large proportion of 95.4% was sold in 1987 as against 74.0% in 1968. Only 4.6% as compared with 26.0% was used at home in 1968. In case of corn, 16.3% was used at home in 1968.

Table 10. The costs (US\$) and returns of production per ha for corn by using improved and traditional varieties

Item	Improved variety adoptor		Non-IV adoptor
	1975	1987	1964
(1) Yield/ha (mt)	4.0	5.1	2.4
(2) Quantity sold/ha (mt)	-	-	-
(3) Price/mt	144.8	526.4	91.3
(4) Gross returns	579.3	2,684.6	226.4
(5) Cash income	-	-	-
(6) Total variable costs	583.2	1,738.6	168.0
(a) Cash	357.9	1,119.0	-
(b) Noncash	225.3	619.6	-
(7) Fixed costs			
(a) Depreciation	14.7	25.6	-
(b) Interest on investment	19.3	26.1	-
(c) Others	96.6	197.8	-
(d) Sub-total	130.6	249.5	39.3
(8) Total cost	713.8	1,988.1	207.3
(9) Returns over variable costs	-3.9	946.0	58.4
(10) Net cash income	-	-	-
(11) Returns over total cost	-134.5	696.5	19.1
(12) Percent return to total cost	-18.8	35.0	9.2
(13) Returns/mt	144.8	526.4	94.3

Sources: Report on Production Cost Survey of Farm Products in Taiwan. PDAF. 1965, 1971 and 1987.

Note: Refer to winter feed corn.

Data of (8), (9), (10), (II), (12), and (13) were obtained from (6)+(7), (4)-(6), (5)-(a), (4)-(8), [(II)/(8)]x100, and (4)/(I), respectively.

## GOVERNMENT PROGRAMS AND POLICIES

### Government programs and policies on rice production, marketing and trade

#### *Guaranteed price policy for rice*

One of the measures taken to increase the profit of rice growers was the guaranteed price policy for rice. The government purchases rice from farmers at a guaranteed price 20% higher than the production cost. The purpose of this policy was to provide basic profit to the farmers and to maintain the supply and demand of this staple food in balance. Therefore, rice export is necessarily aimed to solve the problems of over-production due to good harvest and surplus stock from the previous years.

In practice, the government purchased 970 kg/ha of rough rice at the guaranteed price through the Farmers' Association. The total quantity of purchase varied from year to year depending on the budget and the capacity of warehouses. Rice is stored to stabilize the price of rice. At present, the government purchases 850 kg/ha of surplus rice for the first crop and 500 kg/ha for the second crop at the price of 15.8 NT\$ (0.56 US\$)/kg for Japonica rice and 14.8 NT\$ (0.53 US\$)/kg for Indica rice.

*Rice production projects and paddy field diversion*

The per capita consumption of brown rice was 98.2 kg in 1984 and is estimated to be only 89.7 kg in 1989. Total rice needed will be reduced from 2.02 million mt in 1984 to 1.836 million mt in 1989.

For the six-year (1984~1989) Paddy Field Diversion Plan, it estimated that rice acreage of paddies converted to non-agricultural use would amount to 20,000 ha. On the other hand, acreage of paddies diverted to other crops or to fishery use is expected to increase from 43,700 ha in 1984 to 126,500 ha in 1989.

Current policy on wheat production is to culture wheat by contract farmers. Output of 2,000 kg + 20% of wheat per ha is usually purchased at the guaranteed price of NT\$19.5/kg by the Tobacco and Wine Monopoly Bureau. A total of 750 mt of wheat is purchased by the Bureau as material for wine making.

Current policy on corn is to attain the total output set under the paddy-field diversion program. To compensate for the high cost of local corn production price will not be affected by imported corn.

**The role of extension in agricultural technology transfer**

Technologies for agricultural production have continuously been developed. How to transfer these technologies to the farmers is very crucial for the advancement of agriculture. In Taiwan, agricultural extension work is primarily carried out by the Farmers' Associations with the help of the District Agricultural Improvement Stations (DAIS) (Fig. 4).

*Person-to-person contact type of extension work*

This category includes field demonstrations, training courses and consultations. Field demonstrations are carried out with the help of the extension workers from Farmers' Associations. The subject matter specialists from DAIS provide all information related to the subject and serve as lecturer in training courses organized by the Farmers' Association. Similarly, extension professors from the university also help to solve various farmers' problems.

The other person-to-person contact type of extension work is through consultations. An interdisciplinary team of subject matter specialists and extension professors answers questions raised by the farmers at the meeting for a given subject such as corn production. A visit to the farmer's field by the specialists is made when needed. Questions and answers are printed in leaflet or booklet form by DAIS and distributed to other farmers free of charge. This type of person-to-person type of extension work is welcomed by the farmers and has proven to be one of the most effective ways of transferring new technologies to the farmers.

*Non-person-to-person contact way of extension work*

This is carried out mostly through mass-communication media such as publications, television, radio, and telecommunications. Extension bulletins are mostly written by subject matter specialists and research workers of DAIS and other research institutions. Whenever new varieties or new technologies are developed, they are printed in a special bulletin or leaflet immediately and distributed through the DAIS or Farmers' Association. The content of the bulletin is broadcasted through the agricultural program of the radio stations. Television programs produced by both DAIS and TV stations are shown on TV

everyday. Budget is allocated by the government to DAIS to produce TV and radio programs. A chart indicating the system of agricultural technology transfer in Taiwan is given in Fig. 4.

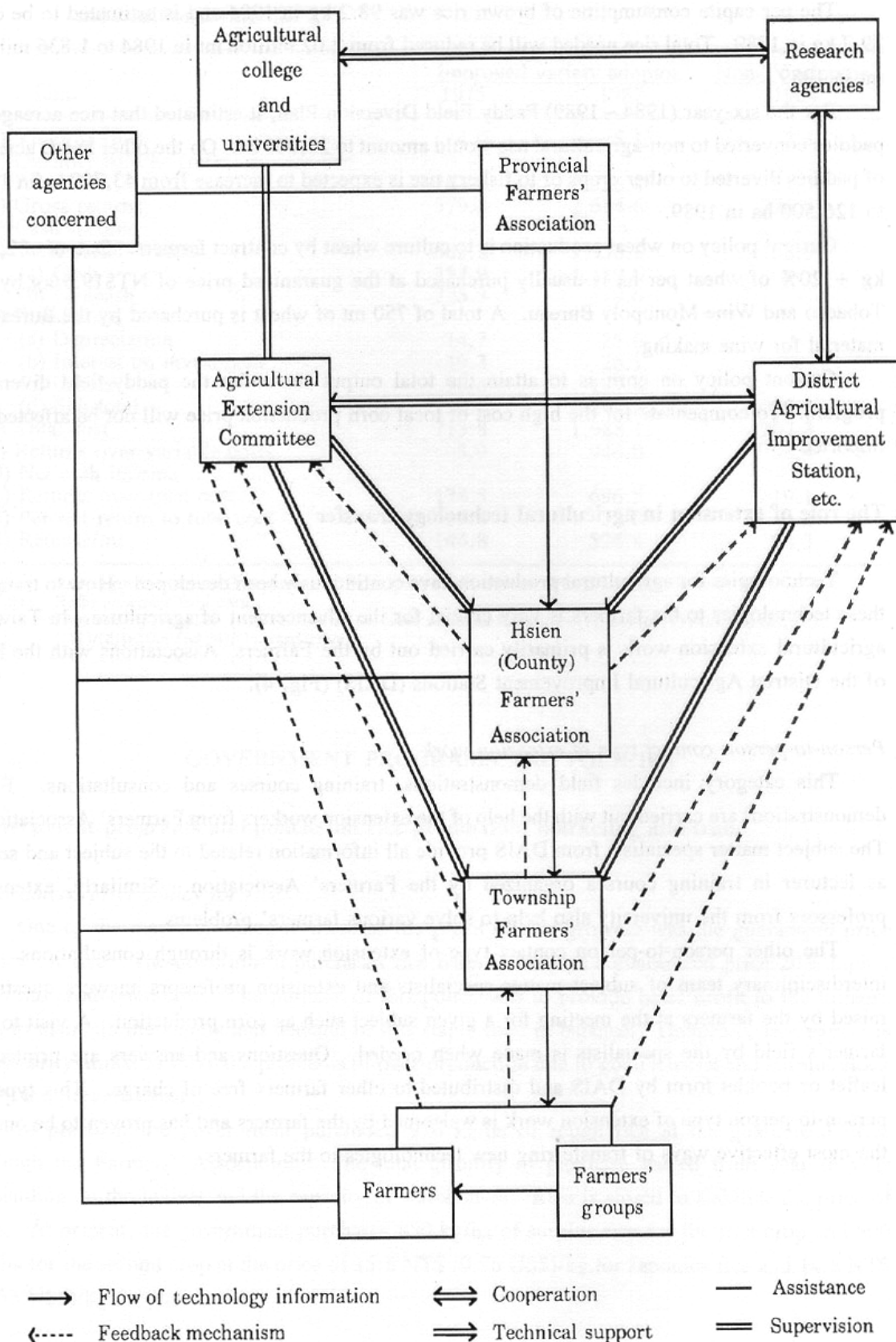


Fig. 4. Chart indicating a hypothetical flow of technology information including feedback mechanism.

*Number of Agricultural Extension Workers and Government Budget for Extension*

There were 1,162 extension workers in 1965, 1,354 in 1977 and 1,770 in 1985. These numbers are not enough for the heavy extension work in Taiwan today. Number of extension workers per 1,000 farmers increased from 0.94 in 1965 to 1.30 in 1985. Approximately half of all extension workers (49.7~57%) are involved in rice, wheat and corn.

Government budget for extension increased yearly from 231,700 US\$ in 1965 to 1.448 million US\$ in 1977 and to 10.397 million US\$ in 1985. The government policy of putting more weight on extension work can be seen from the budget figures in recent years.

In Taiwan, the agricultural production area can be divided into four regions, namely: northern, central, southern and eastern regions. The number of extension workers varied with the number of Farmers' Associations which in turn is determined by farmers' population and area cultivated. The Taiwan Provincial Farmers' Association supervises the activities of all Farmers' Associations at County and Township levels, therefore it is counted separately from the above mentioned four regions. Only a small percentage (4.7% in 1977, 5.3% in 1988) of extension workers is assigned in the eastern part of Taiwan. This is because this region is less developed in terms of agricultural area, has inferior climate (typhoons, etc.) and inconvenient traffic. Only 1.2 extension workers per 1,000 farmers are assigned in the eastern region, a ratio far from the needed number for successful extension work in Taiwan today. Government is now seriously considering to increase the number and quality of extension workers.

*Profile of Extension Workers of Farmers' Association*

Extension workers of Farmers' Associations are assisted by subject matter specialists from research institutions and DAIS. Only the profile of extension workers from Farmers' Association will be described here.

Extension work includes farmers' education and technical services, hence the number of extension personnel affects the efficiency of extension work. The total number of extension workers of Farmers' Association in 1985 was 1,770, 56.67% of whom take charge of agricultural production, 22.32% of home economics and 21.0% of 4H club activities. These figures have not changed much in the last 10 years. Extension workers in 1985 were a little younger (40 years old) than those in 1977 (50 years old). Educational background has not also changed much. For instance, 95% were vocational graduates, while only 5% were university graduates in 1985. Because most extension workers received low education, they are given very intensive on-the-job training at DAIS or universities every year. In view of the fast advancing agricultural technologies today, more qualified university graduates should be employed to serve as extension workers. On the average, an extension worker attended training courses on production technology for 2.98 days in 1977 and 6.86 days in 1985.

*Technology Dissemination*

The objectives of extension work are twofold, (1) to convey new policies on production and (2) to transfer new technologies to the farmers. An introduction of government policies such as the Paddy Field Diversion Program, etc. is made through person-to-person contact (training courses, meetings, etc.) coupled with mass communication media. If necessary, a meeting is organized by the extension agency to

explain the latest policies and new measures to the farmers. Such meetings are done several times until the farmers completely accept the new policy.

The official flow of technology transfer includes: (1) holding a demonstration farm show, (2) training courses, (3) consultation meetings, and (4) through the mass communication media.

#### **Availability of capital as a constraint in technology adoption**

Because of rapid adoption of new technologies, almost every kind of crop is now over-produced. Since some capital has been already invested in farm infrastructure, machinery and transportation facilities, the new loans are used for expenses on farm management, post harvest handling, and marketing. When a young farmer wishes to start farming, he can loan a maximum sum of NT\$ 6 million from the government with a relatively low interest of 4.5%/year. This system of obtaining capital to start a farm has proven to be very helpful in adopting new technologies in agriculture.

Rice production loan can be obtained from the Taiwan Provincial Food Bureau. The total amount loaned out for this purpose was around 100 million US\$ each year except in 1972 and 1973 when a smaller amount was loaned out. However, starting from 1974, the government offered interest-free loans to rice farmers, hence the total amount of loan increased between 1974 and 1983 then dropped to zero when the Paddy Field Diversion Program was implemented.

The net loan for rice production in 1967 and in 1987 constituted only 1.88% and 0.001 % of the overall net loan for agricultural production (including agriculture, forestry, fishery and animal husbandry).

Since the current acreage of wheat as well as the number of contracted farmers is small, very small amount of money has been loaned out for wheat production.

## **ACCESSIBILITY TO INSTITUTIONS AND SUPPORT SERVICES**

### **Accessibility of inputs**

After World War II, agricultural productivity in Taiwan was very low. This was attributable to the serious destruction of agricultural installations by the war and the short supply of materials needed for agricultural production. In order to supply fertilizers at stable price, the government implemented the "Fertilizer-Rice Exchange" measure in 1949 whereby fertilizers were obtained through the exchange of rough rice instead of cash. This measure was enforced by the Taiwan Provincial Food Bureau and carried out by Farmers' Associations. Fertilizers were rationed to rice growers according to farm size. The large quantity of rice collected through the exchange of fertilizers was stored and used for adjusting food supply. Food supply in Taiwan had been very stable so that in 1973 it was terminated because it was no longer necessary. From 1973, fertilizers were distributed through the Food Bureau or through private fertilizer dealers.

The total number of fertilizer dealers increased from 326 in 1965 10318 in 1970 and 1,016 in 1987, a three fold increase in the past 25 years. In 1987, 86.8% or 882 fertilizer dealers were concentrated in the Central and Southern regions and only 13.2% in the Northern and Eastern regions. Similarly, 85.0% or

4,409 of chemical dealers were concentrated in the Central and Southern regions in 1987. These figures indicated that crop production activities in these two regions were more intense than those of other regions. The number of chemical dealers in 1987 totalled 5,189 which was 10.2 times of that in 1965 (507) and 4.3 times of that in 1970 (1,193).

#### **Fertilizers used and distribution for rice, wheat, and corn**

Since 1965, the quantity of fertilizers rationed was enough for rice culture. The amount of nitrogen fertilizer rationed, sometimes exceeded the amount actually needed. The excess amount was often used for upland crop production or other purposes. During the period 1970~1973, fertilizer distribution was based on the quantity ordered by the farmers through the Farmers' Associations.

Table 11. Total quantity of fertilizer used (in nutrients) and percentage of distribution for rice, wheat, and corn, 1965 to 1987

Year	Total (mt)	Rice	Wheat	Corn
1965	158,569.0	98.10	0.71	1.19
1966	184,419.0	97.98	0.79	1.22
1967	178,395.0	97.97	0.67	1.36
1968	179,598.0	98.37	0.43	1.20
1969	174,942.0	98.08	0.31	1.61
1970	90,899.0	96.11	0.26	3.64
1971	126,083.0	97.01	0.10	2.90
1972	97,711.0	95.54	0.08	4.38
1973	166,172.0	96.80	0.04	3.16
1974	169,985.0	95.65	0.03	4.31
1975	189,028.0	94.98	0.12	4.89
1976	200,187.0	94.22	0.07	5.71
1977	221,332.0	96.31	0.06	3.63
1978	194,228.0	95.31	0.14	4.55
1979	186,413.0	95.67	0.12	4.21
1980	203,283.0	95.37	0.13	4.51
1981	200,826.0	95.73	0.12	4.15
1982	163,346.0	94.28	0.14	5.58
1983	163,786.0	93.61	0.18	6.22
1984	154,551.0	91.95	0.15	7.90
1985	153,255.0	90.33	0.16	9.51
1986	152,276.0	88.08	0.17	11.75
1987	143,654.0	86.92	0.21	12.87

Sources: Taiwan Food Statistics Book, Food Bureau, Taiwan Provincial Government, R.O.C.  
Taichung District Agricultural Improvement Station, Taiwan, R.O.C.

The total quantity of nutrients used varied each year. The lowest quantity was 90,899 mt in 1970 and the highest was 221,332 mt in 1977 (Table II). Fertilizer consumption declined to 143,654 mt in 1987 thus crop production activities slowed down recently.

The bulk (90~96%) of total fertilizer consumption during 1965~1985 was for rice culture. The percentage declined to 88.1% in 1986 and 86.9% in 1987. Further reduction is expected in the future as the Paddy Field Diversion Program continues.

Less than 1% of fertilizers was used for wheat production in the past 23 years. In 1965~1967 about 1,200 mt or 0.7% of total fertilizers were used for wheat production annually, however, with the decline in wheat area it dropped to about 0.1~0.2%.

Fertilizer use in corn production increased gradually from 1.19% of total quantity or 1,888 mt in 1965 to 12.87% or 18,483 mt in 1987. An increased use of fertilizer indicated increased acreage and activities in corn production recently.

### Allocation, sales, and prices of fertilizers

The price based on the nutrient element price per mt. of fertilizer was measured. The nutrient price of ammonium sulphate during 1965~1969 was stable and ranged from 409.7 US\$/mt to 433.4 US\$/mt. The price began to drop to 344.4 US\$ in 1970 and to 297.1 US\$ in 1973 (Table 12). However, the price went up again from 385.5 US\$/mt in 1974 to 788.7 US\$/mt in 1986, on 82% hike in price compared with 1965.

Table 12. Allocation sales prices (US\$) of commonly used inorganic fertilizers and their index compared with the data of 1965 for rice, wheat, and corn, 1965-1986

Year	Ammonium sulphate		Urea		Calcium superphosphate		Potassium chloride	
	Price/m.t.	Index	Price/m.t.	Index	Price/m.t.	Index	Price/m.t.	Index
1965	433.4	100.0	353.1	100.0	235.4	100.0	124.7	100.0
1966	427.4	98.6	346.9	98.2	235.4	100.0	124.7	100.0
1967	427.4	98.6	346.9	98.2	235.4	100.0	124.7	100.0
1968	427.4	98.6	330.7	93.7	235.4	100.0	124.7	100.0
1969	409.7	94.5	303.5	86.0	235.4	100.0	124.7	100.0
1970	344.4	79.5	252.1	71.4	235.4	100.0	124.7	100.0
1971	308.7	71.2	218.7	61.9	235.4	100.0	116.5	93.4
1972	292.0	67.4	206.0	58.3	235.4	100.0	116.5	93.4
1973	297.1	68.6	217.4	61.6	248.4	105.5	122.9	98.6
1974	385.5	88.9	282.3	79.9	322.7	137.1	159.5	127.9
1975	474.4	109.5	347.4	98.4	397.1	168.7	196.3	157.4
1976	474.4	109.5	347.4	98.4	397.1	168.7	196.3	157.4
1977	474.4	109.5	347.4	98.4	397.1	168.7	196.3	157.4
1978	500.7	115.5	366.7	103.9	419.1	178.0	207.2	166.2
1979	500.3	115.4	366.4	103.8	418.8	177.9	207.0	166.0
1980	500.6	115.5	366.6	103.8	419.0	178.0	207.1	166.1
1981	552.4	127.5	415.4	117.6	499.9	212.4	216.9	173.9
1982	750.8	173.2	538.5	152.5	709.0	301.2	321.1	257.5
1983	744.0	171.7	533.7	151.1	585.6	248.8	318.2	255.2
1984	759.1	175.1	517.0	146.4	590.3	250.8	324.6	260.3
1985	751.9	173.5	512.0	145.0	577.9	245.5	321.6	257.9
1986	788.7	182.0	528.8	149.8	582.0	247.2	337.6	270.7

Sources: Taiwan Food Statistics Book, Food Bureau, Taiwan Provincial Government, R.O.C. 1987.

Note: The nutrient element of fertilizer were (N): Ammonia sulphate, urea; (P<sub>2</sub>O<sub>5</sub>): Calcium super phosphate; (K<sub>2</sub>O): Potassium chloride.

The nutrient price of urea dropped from 353.1 US\$/mt in 1965 to 206.0 US\$/mt in 1972, then remained stable at about 360 US\$/mt during 1975-1980. The price of urea increased by 52.5% in 1982-1983 compared with 1965.

The nutrient price of calcium superphosphate was fixed at 235.4 US\$/mt during 1965~1972. The price rose by 5.5% in 1973, 37.1% in 1974, 69~78% in 1975~1980, 112.4% in 1981 to the highest record of 201 % hike in 1982. The rate of increase dropped to 150% in 1983~1986.

The nutrient price of potassium chloride was fixed at 124.7 US\$/mt during the 1965~1970. A 6.6% drop in the price was observed during 1971~1972 but price rose by 27.9% in 1974, 57.4% in 1975~1977, 157.5% 321.1 (US\$/mt) in 1982~1985 and 170.7% 337.6 (US\$/mt) in 1986 in comparison with that in 1965.

Further comparison of the fertilizer price with the farm price of rice, wheat and corn showed that the fertilizer-rice price ratio exhibited a strong downward trend from 1965 to 1974. After 1974, the ratio became fluctuating up and down but in general it exhibited a decreasing trend during 1965~86. As for wheat and corn, the ratio seemed to show a downward trend too. Therefore, it could be concluded that based on the fertilizer-product price ratio, the period in 1965~86 was profitable for the production of rice, wheat and corn.

#### **Regional distribution of seed dealers/outlets and volume handled**

The number of rice seed dealers represented the number of contracted seed producers. Total number of rice seed dealers in 1970 was 1,162 which fell to 1,065 in 1986. The quantity of seeds handled by each seed dealer in 1970 was 3.68 mt, that in 1986 was 4.27 mt. The total volume of seeds handled was 4,555 mt in 1986 which was greater than that in 1970 (4,278 mt). In 1970, 72.8% (847) of seed dealers were located in the Central and Southern regions, the rest were in the Northern and Eastern regions. In 1986, half of dealers (52.1 %) was located in the Central region, 32.0%(341) in the Southern region and the remaining 0.15% was distributed in the Northern and Eastern regions.

Because the wheat acreage is very small, wheat seeds are usually provided by the Taichung District Agricultural Improvement Station or propagated by the farmers themselves.

The government-operated Seeds Service is responsible in propagating and selling hybrid corn seed. The acreage for corn seed production in 1971 was 10.5 ha which produced 21.18 mt of seeds. However, since the implementation of the Paddy Field Diversion Program, the demand for corn seeds has increased remarkably. Acreage for corn seed production in 1986 increased to 208.87 ha which is almost 20 times higher than that in 1971. The volume of seeds handled in that year was 422.12 mt which was also nearly 20 times larger than that in 1971.

#### **Price of seeds**

The price of seeds of rice improved varieties was 0.1 US\$/kg in 1965, it increased steadily year after year and reached 0.58 US\$/kg in 1987, an increase of 480% compared with that in 1965. On the other hand, wheat seed price was fixed at 0.12 US\$/kg during 1965 - 1972, after which it increased steadily and reached 1.07 US\$/kg.

The tendency of price increase in corn seeds was very similar to that in wheat. At the initial stage (1965-1970), the price of corn seeds was fixed at 0.42-0.45 US\$/kg. However, after 1973, the price of corn began to increase and reached 2.62 US\$/kg in 1987 which is 5 times higher than that in 1965.

#### Levels and trend in prices at the farms, wholesale, and retail levels

The price of rice tended to increase gradually starting from 1965 (Table 13). The farm price jumped from 523.8 US\$/mt in 1986 to 626.6 US\$/mt in 1987 due primarily to the government policy of growing high quality rice. The trend in wholesale and retail prices was the same as that of farm price. Except recent 3~4 years, the price margin from farm to wholesale was smaller than that from wholesale to retail.

Table 13. The farm, wholesale, and retail prices (US\$/mt) for rice of improved varieties, 1965-1987

Year	Farm price	Wholesale price	Retail price
1965	143.8	144.2	148.9
1966	144.9	145.2	149.9
1967	153.3	153.4	158.4
1968	161.7	161.8	167.3
1969	156.9	161.3	172.3
1970	171.6	176.0	181.0
1971	162.7	167.6	184.0
1972	172.5	175.5	196.0
1973	208.9	214.9	235.5
1974	374.5	385.5	459.9
1975	405.4	416.9	474.6
1976	389.5	411.6	468.1
1977	325.5	354.0	417.1
1978	349.3	379.5	453.6
1979	424.6	462.3	540.7
1980	519.0	579.0	665.3
1981	517.6	564.3	656.6
1982	545.2	606.4	692.7
1983	489.4	547.6	623.3
1984	537.3	606.8	663.2
1985	489.3	551.9	608.5
1986	523.8	602.3	669.5
1987	626.6	742.3	-

Sources: Taiwan Rural Price Statistics Book, Food Bureau, Taiwan Provincial Government, R.O.C.

Industry of Free China. Council for Economic Planning and Development, Executive Yuan, R.O.C.

Taiwan Food Statistics Book. Food Bureau, Taiwan Provincial Government, R.O.C.

Note: Presented as polished rice per mt.

The calculation was based on 140 kg rice grain equal to 100 kg polished rice.

Wholesale price was based on price of the second grade Japonica rice.

The locally produced wheat in Taiwan is mainly used to make wine, therefore it is primarily purchased by the Tobacco and Wine Monopoly Bureau. Wheat is normally sold to the Bureau directly. The price of wheat dropped to some extent in 1968~1971, however it increased in later years. In 1974, the price rose suddenly to 315.4 US\$/mt which was attributed to the insufficient supply of local wheat due to

the land reconstruction project carried out that year. The farm price of wheat dropped again to 215.4~277.2 US\$/mt in 1975~1979. The price then increased greatly thereafter to 681.8 US\$/mt in 1987 which is 5.8 times higher than that in 1965.

Grown primarily for livestock feed, corn is usually purchased directly by the feed processors from the farmers. There are practically no wholesalers and retailers. Nevertheless the retail price of the imported corn is given for reference. The farm price and retail price of both improved and traditional varieties are somewhat lower during the period 1965~1971, then increased steadily thereafter (Table 14). The farm price in 1986 rose to 421.9 US\$/mt which is 3.1 times higher than that in 1965. The retail price went up to 627.7 US\$/mt in 1987 which is four times higher than that in 1965. The farm price of traditional varieties went up to 331.9 US\$/mt in 1985 which is 4.3 times higher than that in 1965 63.1 US\$.

The price margin from farm to retail was small (22.2~35.9 US\$ /mt) during the early part of 1965-1972. After 1974, the value suddenly increased to 211.5 US\$/mt and then to the peak of 398.0US\$/mt in 1981, then dropped again gradually to 214.0US\$/mt in 1987. The decreasing tendency of farm to retail price margin in recent years is due to the upgraded guaranteed price of corn lately.

Table 14. The farm and retail prices (US\$/mt) for corn of improved and traditional varieties, 1965-1987

Year	Improved variety		Traditional variety
	Farm price	Retail price	Farm price
1965	102.5	124.7	63.1
1966	100.0	131.7	60.3
1967	89.8	135.2	57.3
1968	79.1	110.5	55.2
1969	80.3	108.2	58.8
1970	85.5	114.0	66.4
1971	84.8	115.5	75.2
1972	86.8	122.7	53.2
1973	105.3	191.3	76.7
1974	122.7	334.2	189.8
1975	136.9	338.4	149.6
1976	149.5	393.4	157.8
1977	157.7	395.0	153.2
1978	213.6	466.0	155.0
1979	232.3	500.4	177.9
1980	263.4	597.8	227.2
1981	311.4	709.4	282.1
1982	358.6	661.4	274.0
1983	372.0	628.6	300.0
1984	379.6	623.0	331.9
1985	375.9	615.3	331.9
1986	421.9	635.9	-
1987	-	627.6	-

Sources: Taiwan Agricultural Prices Monthly, PDAF; Taiwan Agricultural Prices and Costs Monthly, PDAF; Taiwan Rural Price Statistics Book, PFB.

Note: Retail price was based on imported corn in US\$ per mt.

### **Distribution of demonstration farms**

Demonstration farms serve as the show window for new technology. In Taiwan, demonstration farms are operated mostly by government agricultural research stations with the cooperation of Farmers' Associations. New varieties and cultural technology are introduced to the farmers through demonstration farms which are set either at the experimental field or at a farmer's field. The demonstration farms are usually set at the roadside, with a big sign board on which the objectives, name of new varieties, rate of fertilizer application, pest resistance, sponsoring unit, etc. are written. The farmers are called to participate in the field day to see the actual performance of the new variety or new technology.

Farmers are briefed by the extension agents. After seeing 2~3 demonstration farms at different places, the farmers usually proceed to the meeting room of the Farmers' Association to discuss problems of common interest with subject matter specialist from research institutions.

A total of 91 field demonstrations for rice culture were held in 1987, 59.3% or 54 in the Central and Southern regions. One fifth or 19 demonstration farms were located in the Northern region and the remaining 8.7% in the Eastern region.

Wheat is grown only in the Taichung area, thus only two field demonstrations for wheat were held in Taichung in 1987. Corn is grown mostly at the Central and Southern regions and a total of 9 demonstrations were held. Only one demonstration in Northern region and 2 in Eastern region were held in 1987.

### **Distribution of research stations among the different regions**

There are eight Agricultural Research Institutes, six District Agricultural Improvement Stations, one Tea Improvement Station, one Honeybee and Silk Worm Improvement Station, and one Seed Improvement and Propagation Station.

The Basic Research Institute includes Taiwan Fishery Research Institute (Northern region), Taiwan Hog Science Research Institute (Northern region), Forestry Research Institute (Northern region), Taiwan Agricultural Research Institute (Central region), Taiwan Agricultural Chemicals and Toxicity Research Institute (Central region), Taiwan Animal Husbandry Research Institute (Southern region), and Taiwan Banana Research Institute (Southern region).

Six District Agricultural Improvement Stations (DAIS) include Taoyuan DAIS (Northern region), Taichung DAIS (Central region), Tainan DAIS (Southern region), Kaohsiung DAIS (Southern region), Taitung DAIS (Eastern region), and Hualien DAIS (Eastern region).

The research activities of Taiwan Agricultural Research Institute are focused on crop based basic researches, including genetics, plant breeding, plant physiology, tissue culture and biotechnology, etc. Various crops including rice, corn, peanut, medicinal plants, vegetables, fruit trees and ornamental flowers etc. are studied. In addition to these researches, soil chemistry, pesticide chemistry, entomology, plant pathology and agricultural engineering etc. are also under study.

Six District Agricultural Improvement Stations (DAIS) are mandated to do research and extension. The research activities include crop improvement, entomology, plant pathology, agricultural machinery, etc. Extension activities include training courses for crop production technology, home economics and

extension through the use of mass communication media and holding various field demonstrations and technical consultations, farm management and agricultural economics, etc. It should be stressed that DAIS has played a very important role in agricultural extension work in Taiwan in the past which will continue in the years to come.

### **Rural based Farmers' Organizations**

#### *System of agricultural extension in Taiwan*

The Council of Agriculture (COA) of Executive Yuan is the highest government body responsible for planning, budgeting and supervision of extension work. The extension work is also supervised by the Department of Agriculture and Forestry of the Taiwan Provincial Government. It is carried out by the government of counties, townships, village office, and then through farmers' operational groups. The other system of extension is through the Provincial Farmers' Association which is under the supervision of the Taiwan Provincial Department of Agriculture and Forestry. The extension work is actually carried out through the Farmers' Associations at the county, city, and township levels. Each Farmers' Association has its extension section which consists of 3~5 extension workers. This section is in charge of activities of (1) crop production group, (2) 4-H club group, and (3) home economics groups. In addition, subject matter specialists from DAIS and extension professors from the universities help in the extension work of Farmers' Associations. The role of DAIS in extension work becomes more important as farmers fully trust the expertise of research workers. All technical matters from different sources (University, Agricultural Research Institutes, etc.) are first digested by the subject matter specialists from the Stations. The digested new technologies are transformed into easily understandable forms, and then passed through various media (leaflet, radio, TV.) and through person-to-person contact (training course, consultations, etc.).

#### *Number of agricultural extension workers*

According to the statistics of 1988, 753 persons were in charge of crop production extension work, 264 of 4-H club extension work and 379 of home economics extension work, a total of 1,396 persons. The township level extension workers accounted for 91.7%, those at county level, 6.4%, and at central and provincial governments, 1.9%.

#### *Number of extension activities*

In 1988 there were a total of 26,136 study groups including 14,541 in crop production, 5,019 in 4-H club, and 6,576 in home economics. Total membership of the three groups was 434,941 persons. A total of 18,592 cases of educational activities (including three study groups) were held in 1988. A total of 532,671 persons of 3 study groups participated in various types of educational activities. The total number of farmers who received individual instructions (person-to-person contact) was 303,430.

#### *Source of funds for extension work*

According to the statistics in 1984, the Council of Agriculture (COA) provided 3.17 million US\$ for extension work which represented 16.59% of the total budget. The Taiwan Provincial Department of Agriculture and Forestry allocated 2,057,085 US\$ or 11.5% of the whole budget. The Provincial Farmers' Association provided 466,093 US\$ (2.44%); County and City governments, 178,019 US\$ (0.94%);

County and City Farmers' Association provided 2,372,948 US\$ (12.4%); Township government, 181,774 US\$ (0.97%). Township Farmers' Associations provided 10,516,909 US\$ or 55.08%. The total budget allocated for extension work was 19,852,408 US\$. This sum is increasing yearly, in view of the importance of extension work in this country.

### **Major types of agricultural extension work**

To organize and to plan extension activities, groups more than 7,000 study groups were organized with more than 80,000 farmers participating.

As part of 4-H club activities, approximately 5,500 young farmers received various kinds of training courses. They then got started in their own farms with a low interest loan from the government at the maximum amount of NT\$ 4 million 142,800 (US\$). Scholarships amounting to NT\$ 4,000/person for young farmers to study at the Junior Agricultural College or Agricultural vocational schools were also provided. Qualified young farmers are also selected for exchange visit with their counterpart from other countries to learn more about the production technologies of other countries.

Home economics extension guides and organizes various activities in home economics, improvement of nutrition and living environment, and assistance to farmers in keeping accounts of family management.

Mass communication activities include editing and printing extension leaflets or booklets. This work is mainly done by DAIS. In the past three years, a total of 106 kinds of booklets totalling 120,000 copies had been printed. Policies and technical news are published and audiovisual materials are produced. Radio programs are produced by the DAIS with the help of Farmers' Associations.

## **SOURCES OF FARM LABOR**

Labor intensive agriculture had been carried out in the past in Taiwan. However, starting from 1970, agricultural labor became insufficient because of the fast industrialization. The young rural workers drained off to the factories and only old workers remained in the farms resulting in a serious labor shortage. Because of this, farm wages rose forcing a speedy farm mechanization in recent-years. In 1970 farm labor for production of rice for 2 crops per ha per year needed 192.1 man-days which included 48.6% hired labor and 51.4% family labor (includes farmer operator and exchange labor) (Table 15). The situation changed greatly in 1986 when a total of only 77.0 man-days (12% hired and 88% family labor) was used to produce two crops of rice per ha per year.

Except seed solving, all farm operations in wheat production are done by machines. In 1968, average labor needed to operate one hectare of wheat field was 76.6 man-days which included 54.8% hired labor was reduced to 17.7 man-days which included 2.3% hired labor and 97.7% family labor.

In 1970 average labor requirement in corn farm was 111.8 man-days/ha which included 24.5% hired and 75.5% family labor. The corresponding requirement in 1987 was 55.7 man-days which included 42.4% hired and 57.6% family labor. From the above figures, it could be seen that farm operation shifted to labor-saving and capital-intensive type of farm operation. The annual income of each household by

growing rice increased from 1,037 US\$ in 1965 to 1,169 US\$ in 1970 to 10,126 US\$ in 1987. Farm income accounted for 81.3% of the total income of rice farmers in 1965. This became 61.3% in 1975 and 24.3% in the most recent year of 1987. The trend of decreasing farm income by the farmers is mainly due to the slowing down of agricultural development in recent years.

Table 15. The sources of farm labour for rice

Source	Improved variety adoptor	
	1970	1986
<b>Man-days per ha per year</b>		
Farmer operator	-	-
Hired	93.3	9.3
Family (includes farmer operator and exchange)	98.8	67.7
Exchange	-	-
Total	192.1	770.
<b>Percent</b>		
Farmer operator	-	-
Hired	48.6	12.0
Family	51.4	88.0
Exchange	-	-
Total	100.0	100.0

Sources: Report on Production Cost Survey of Agricultural Products in Taiwan, PDAF. 1971.

Report on Production Expense Survey of Rice in Taiwan, Food Bureau, Taiwan Provincial Government, R.O.C. 1987.

## SOME INDICATORS OF SOCIAL CHANGE

### Education and experience

The educational level of rice, wheat and corn farmers during the period 1970~1985 was generally low, especially that of wheat farmers. Some 71.1% of rice farmers received primary or secondary education in 1970. The percentage for 1985 was 61.1%. The increased percentage (38.89%) of non-educated farmers in 1985 compared with that (29.11%) in 1970 is due to the increased number of well educated young farmers migrating to the cities and factories, resulting in an increased number of uneducated old farmers remaining in the rural areas.

No remarkable change in the status of educational level for wheat farmers was seen during the same period. Wheat production experience by farmers was 18.3 years in 1970 and 28 years in 1987. This again indicated the increased age of the wheat farmers. Only 8.51% of corn farmers received education of more than 7~10 years or longer in 1970. The figure increased to 27.7% in 1985, while the rate of non-educated farmers was 26.3% in 1970 and 28.7% in 1985.

### Distribution of farmers by tenure

The old system of land rent practiced in the years before 1949 was not very ideal. The tenant had to pay 50~70% of farm produce to the landlord. The low returns from the farm operation made the tenant farmers unwilling to invest more on crop production which resulted in low productivity. In addition, the

right to use the land was based on the agreement between the landlord and the tenant. This situation did not provide incentive for adoption of new technologies. Thus the government promulgated the Land Reform Law in 1949 whereby the tenant was obliged to pay land rent at a reduced rate of 37.5% of the farm output. The policies of land-to-tiller and selling public land to the tillers were then followed. Because of these measures, the farm income increased gradually. The farmers started to adopt new technologies and improve their cultural practices according to their own will.

After the land reform program, land owners consisted the major group of farm operators. Also, the share of returns by the tenant was greatly increased, therefore there is no marked differences in the willingness of technology adoption between the land owners and the tenants.

### **Ownership of house and household appliances**

Statistics on house ownership by IV adoption is incomplete. Nevertheless, in 1985 almost 98% of rice farmers owned their houses which were constructed of either strong or medium type materials. In case of wheat growers, in 1987, 95% owned houses, 41% made up of strong materials. Similarly, almost all corn growers owned their houses which are made either of strong or medium type materials. The recent economic growth in Taiwan brought per capita income up to 6,100 US\$ in 1988, and many farmers rebuilt their houses into 2 to 3-story houses with modern facilities which are not different from those found in the city houses.

The proportion of farmers having different modern appliances and other items increased considerably from 1970 to 1985. For instance, TV sets increased from 17.9% to 95.0%, refrigerator from 4.1% to 98.1%, telephone from 1.2% to 75.6%, washing machine from 0.8% to 66.4%. Subscribers of newspaper increased from 10.2% to 48.9% and periodicals from 2.4% to 4.3%. Ownership of other major items such as air conditioner, Hi-Fi stereo set, video cassette, piano and electric organ, motorcycles and automobile, etc. is increasing in numbers in recent years. Ownership of household appliances by wheat farmers is much better than that of rice farmers. In 1987, over 90% of wheat farmers owned radio/cassette, TV set, refrigerator, electric light, electric fan, electric cooker, motorcycle, and telephone. Over 80% of wheat farmers owned sewing machine, washing machine and subscribed newspapers. Some 58% of farmers owned camera, 21 % owned air conditioner, 49% owned Hi-Fi stereo set, 50% owned video cassette, 8% owned piano and electric organ. About one-third of wheat farmers owned automobiles and almost one half subscribed periodicals. The tendency to own various household appliances and other items by corn farmers is the same as that in rice and wheat.

## **CONCLUSIONS**

The modern agricultural technology introduced in the 1960's has been instrumental in the significant growth of Asian agriculture including Taiwan in the last two decades. The success was often brought about mainly by the efficient combination of high yielding varieties and improvement in irrigation, fertilizer, machinery and other inputs. This new technology which resulted in increased yield

and reduced unit cost has become a cornerstone in the overall strategy of promoting agricultural growth in Taiwan.

Agricultural extension work through Farmers' Associations with the help of the District Agricultural Improvement Stations and universities played an important role in conveying the government policies and transferring the technological knowhow to the farmers.

The number of persons involved in extension work and the amount of budget allocated for extension work increased steadily from the second phase of agricultural improvement. New varieties of crops have been continuously developed and more fertilizers, farm machineries, agricultural chemicals have been used to promote yield.

Agricultural production shifted from labor intensive to form capital intensive. As in many other countries, farmers in Taiwan are financially less well-off than the general population. Their per capita incomes are considerably lower than average. To achieve a balance in well-being among urban and rural communities, the government is taking more measures to speed up agricultural development and intensify rural development. Both short-term and long-term measures would have to be taken to promote future agricultural development.

Application of modern science and technology through extension work by the Farmers' Associations and government sectors is essential to upgrade the quality of farm products, and the institution of an improved marketing system is fundamental to enhancement of the well-being of local farmers.

Trade expansion and liberalization policies will have an impact on local agricultural development. The domestic market is becoming increasingly open to international competition. As this happens, the market share of local farm products will be reduced and so the incomes of local farmers may suffer. In order to cope with this problem, crop production should be market-oriented. The collection of information on agricultural production and marketing through various channels including Farmers' Association is then very important. The low input technologies of agricultural production including breeding of high quality crop varieties and mechanized farming, etc. should be developed further. Efficient methods of technology transfer should be designed to meet the increasing needs of farmers for the production and marketing of farm products.

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# 台灣農業技術轉移之研究<sup>1</sup>

謝順景 林月金<sup>2</sup>

## 摘 要

本文針對台灣過去27年來(1960~1987)之稻米、玉米與小麥之栽培面積、總產量、單位面積產量之變遷、對此等作物生產技術之應用採行、農家所得及支出與技術採行的關係、政策措施、研究機構與相關支援機關之通達性,以及社會改變的一些指標進行調查以分析研究台灣過去的農業技術轉移的情形。

在本研究中得知,過去在傳達政府的政策與轉移農業技術的過程中,農會、區農業改良場及大專院校之合作工作扮演了非常重要的角色。在現代農業技術不斷地在提昇,農產品之精緻化之高度需求下,完善的運銷制度亦急需建立以謀農民的福祉。

在當前經濟自由化、國際化之政策下,台灣的農業將受到不少的衝擊。為提升農產品之愈來愈大的國際競爭壓力,本文認為將來的農業技術轉移,應針對以市場為導向的生產技術及制度來進行,同時認為需進一步設計更有效的技術轉移制度及方法才能解決問題。

**關鍵字：**技術轉移、推廣工作、農業技術採行、水稻、玉米、小麥。

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