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Soybean Production in Taiwan: A Farm Survey

About this report

Data in this report are presented in metric units. Monetary values have been converted to U.S. dollars at the May 1978 exchange rate. In a few instances, monetary values are stated in New Taiwanese dollars (NT$) with the exchange rate for US$ in parenthsis.

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Soybean Production in Taiwan: A Farm Survey

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INTRODUCTION

The soybean (*Glycine max*) is perhaps the world's richest source of plant protein, with values from 25-52%. It also has oil content ranging from 12-24% and has been used widely as an oil crop. Thus, it can be a major tool for alleviating both caloric and protein malnutrition.

Scientists at the Asian Vegetable Research and Development Center (AVRDC) have been working since 1973 to improve soybean's contribution to consumer diet and farmer income in Asia. They are seeking to produce high yielding, photoperiod- and temperature-insensitive cultivars resistant to diseases and tolerant of insect pests. They also are striving to develop appropriate, economical management practices for various tropical cropping systems.

Soybean has been a basic food in China for millenia and is esteemed as one of the 5 ancient "grains." In Taiwan it is used as a cooking oil, a source of milk, beancurd, sprouts, fresh seed, dried seed, flour, and a green vegetable (the stems and leaves are fried). It also has been used to make textured vegetable protein products such as artificial chicken, and fish, which, especially when cooked with miso (a fermented soy seasoning), soysauce and other spices, are practically indistinguishable from the real versions. Entire banquets of rice and little else but soybean are routinely served in the vegetarian restaurants and Buddhist monasteries of Taiwan.

Soybean in these and other forms could relieve protein-calorie malnutrition in tropical Asia. The need in Taiwan, however, is to increase domestic production to help offset growing consumer demand and reduce imports.

In 1976, the government of Taiwan started guaranteeing a price of U.S.$277/t to encourage farmers to plant more soybeans. The response has been modest, largely because soybeans have not been as profitable as competing winter crops, such as adzuki bean. Over the period 1967-76, planted area has declined because farmers prefer to grow competing crops. As a result, imports have increased and the percentage of domes-

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Table 1. Supply of domestic and imported soybean, 1967-76; Taiwan. AVRDC, 1978.

Year	Domestic[a] Planted area	Domestic[a] Farm Price	Domestic[a] Production	Imported[b]	Total	Domestic Production / Total consumption
	(1000 ha)	(US$/ton)	----------(1000 t)----------			(%)
1966		188				
1967	52	169	75	347	422	18
1968	49	158	73	385	458	16
1969	45	152	67	472	539	12
1970	43	157	65	618	683	10
1971	40	170	61	525	586	10
1972	36	177	60	712	772	8
1973	36	270	61	626	687	9
1974	44	291	67	529	596	11
1975	41	291	62	827	889	7
1976	36	256	53	780	833	6
1977	-[c]	303	-[c]	663	-[c]	-[c]

[a]Reference 11 and 13. [b]Reference 9. [c]Not available at time of publication.

tic to total supply has diminished (Table 1). Population growth and increases in income have resulted in an increased demand for human consumption and for use in animal feeds.

The present study describes the current profitability and yield from soybean, the motivations and problems of farmers, and the reaction of farmers in the past to measures such as the extension of improved varieties.

METHODOLOGY

To determine the changes in soybean profitability and in producer attitudes, the economics group at AVRDC conducted surveys in the spring of 1975 and 1977-78.[a] For the 1975 surveys, government records showed the districts with largest planted area in 3 major seasons for soybean: winter (Pingtung), spring (Kaohsiung and Yunlin), and summer (Hualien). Within each district, those townships with the largest area were chosen (total, 12 villages; Fig. 1). Within each village, lists of farmers who applied for fertilizer for field crops (including soybean) were used to determine the sample. By random sampling,15 producers per township were selected, except in Yunlin district, where only 12 households were identified for spring production. The final sample size was 152 (Table 2).

In 1977-78, we contacted all previous growers and asked them about growing practices and motivations. We also asked a subsample of 62 households about changes in costs over time. In addition, we asked 15 of the 152 households about production costs for adzuki bean, the major alternative to soybean in the winter.

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[a]A separate analysis of the cultural practices noted in the former year is given in Ref. 1.

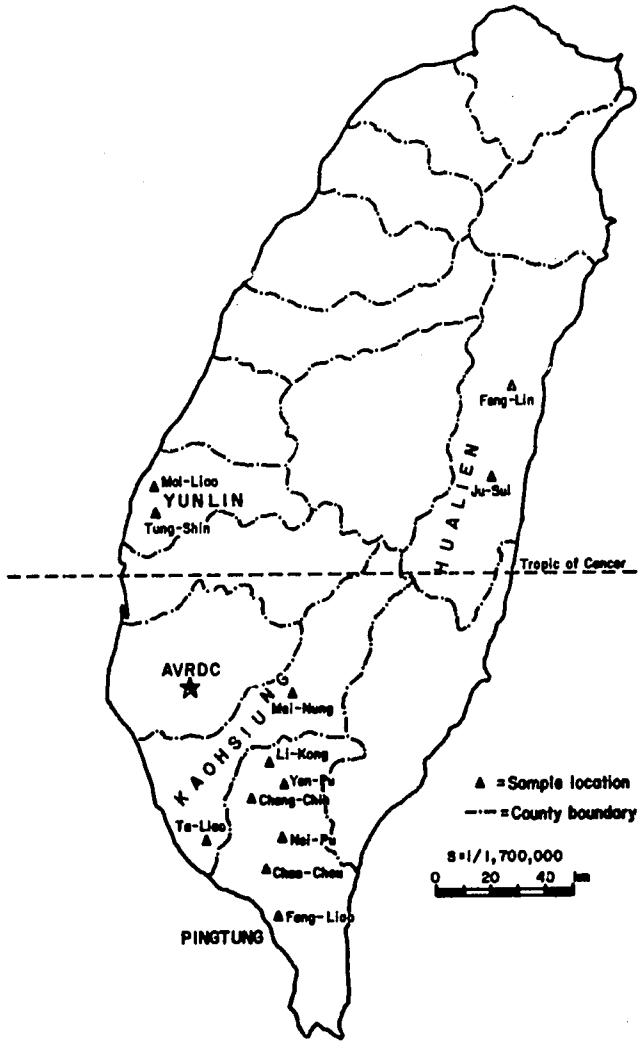

Fig. 1. Sample location of soybean production surveys in Taiwan; AVRDC, 1978.[a]

[a]Surveys, 1975-1977/78.

Table 2. Distribution of soybean farmers in survey sample, 1975 & 1977/78; AVRDC, 1978.[a]

Crop season	Location	Number of farmers interviewed				
		1975		1977/78		
		General survey	Production cost survey	General survey	Production cost survey: Soybean	Production cost survey: Adzuki[c]
Winter	Pingtung & Kaohsiung	104	100	104	40	15
Spring	Kaohsiung & Yunlin[b]	22	22	22	7	-
Summer	Hualien	26	26	26	15	-
Total		152	148	152	62	15

[a]Survey data, 1975 and 1977/78. [b]12 Yunlin spring growers were not included in 1975; therefore, sample size in that year was reported as 140. [c]In addition, 15 adzuki bean producers in Pingtung-Kaohsiung were interviewed about their production costs.

Seasons and Cultural Practices

Fig. 2 shows that soybeans in Taiwan may be grown as a winter, spring, or summer crop. In the winter, the majority of farmers plant in the hills of rice stubble. This no-tillage method saves time and effort, but also involves extensive use of herbicides to control weeds. A second cultural technique is tillage. This is more frequent on rainfed than irrigated fields and involves more time. The winter production budgets presented in this report represent the combined sample of tillage and no-tillage growers.

Objectives and Hypotheses

The present study was designed to

1. Measure changes in soybean profitability over the three-year period 1974-77 and compare soybean production budgets, yields, and returns in each of the three seasons.

2. Compare the yield and profitability of soybean with adzuki bean.

3. Determine the effect of increasing inputs on yield and return, and the optimal levels of labor and capital inputs for the winter season.

4. Investigate changes in yield and price by cultivars over the three year period and why farmers change cultivars.

5. Determine why farmers grow soybean and the major problems still limiting its planted area.

We formed the following hypotheses:

1. Preferred cultivars differ by season, and change over time.

2. Fluctuations in yield and price are greatest in the summer.

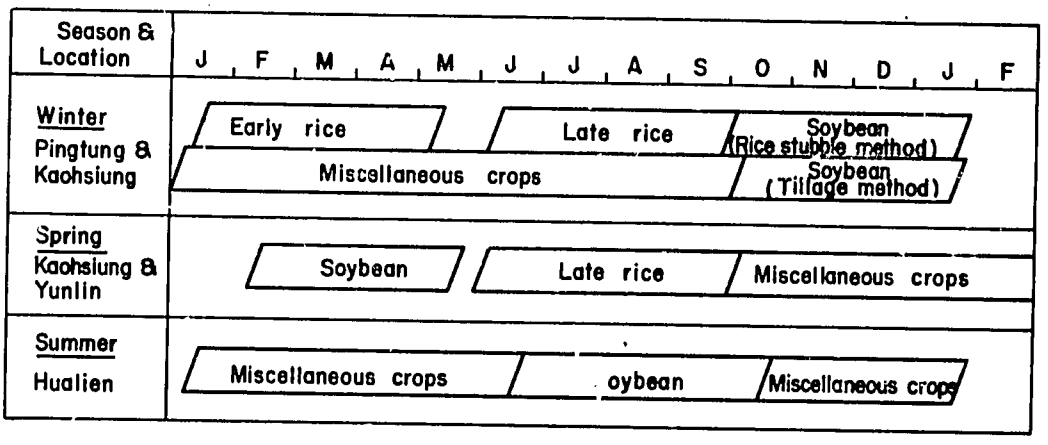

Fig. 2. Common cropping systems for soybean in Taiwan in the winter, spring, and summer, AVRDC, 1978.[a]

[a]Adapted from ref. 1.

3. There has been immediate adoption of improved cultivars.

4. Farmers primarily seek short duration cultivars to fit the multiple cropping system.

5. No significant change occurred in cultural practices or relative input prices between 1974 and 1977 and variations in output price have been responsible for changes in profitability.

6. The higher the investment in weeding, pesticide, and other production inputs, the higher the yield and net return.

7. The major alternative crops to soybean differ by season and have changed in relative importance over the period 1974-77.

8. Adzuki bean is more profitable than soybean only because of higher price.

9. The motives for growing soybean are the same in every season.

10. The major soybean production problem is its low price and profitability.

RESULTS AND DISCUSSION

History of Cultivars in Taiwan

Before 1945 most soybean cultivars in Taiwan were of local origin, with an average yield of only 500-600 kg/ha. However, the governemnt introduced Japanese cultivars such as "Shih-shih" and "Palmetto" in 1952. Since the early 1960s,scientists in Taiwan have also worked to develop improved cultivars by crossing cultivars introduced from abroad (in this report, the former will be termed "improved" and the latter "introduced" cultivars). As a result, the percentage of farmers planting introduced and improved cultivars has increased steadily, from about 53% in 1963 to 92% in 1976 and yield has risen to 1.5 t/ha.

Fig. 3 shows the percentage of area planted to major cultivars in 1974/75-1977/78 for the winter season, in which about 80% of all soybeans are planted. "Wakajima" was the most important, but in the last year was

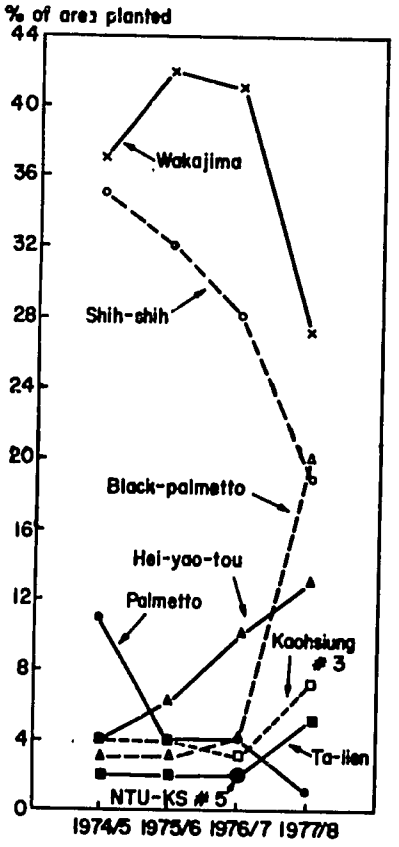

Fig. 3. Percentage area planted to soybean by cultivar, winter, 1974/75-1977/78; AVRDC, 1978.[a]

[a]Survey results, 1975 and 1977/78.

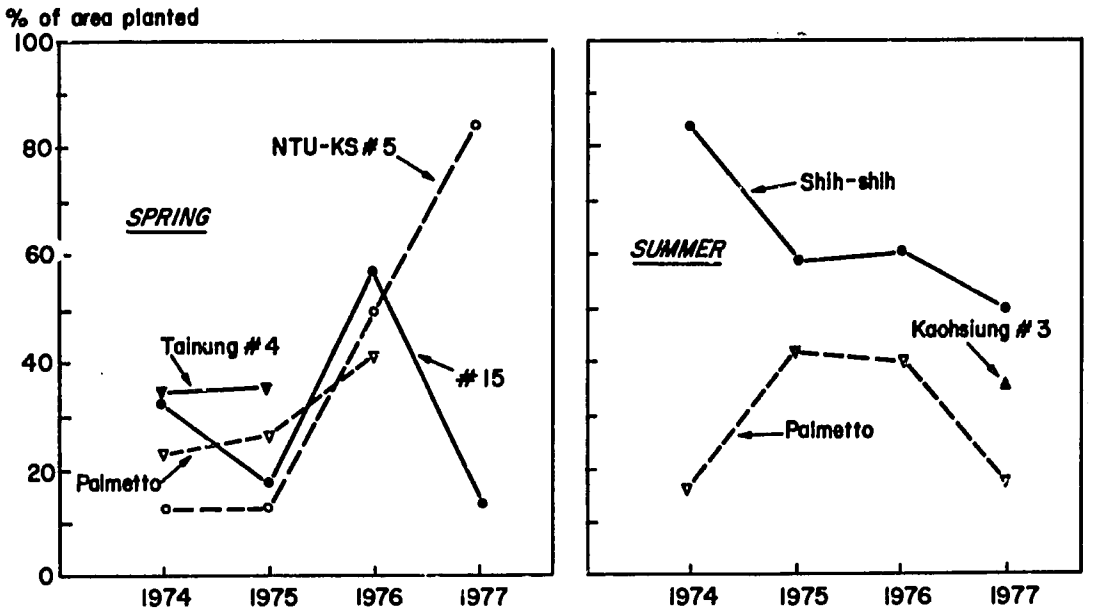

Fig. 4. Percentage area planted to soybean by cultivar, spring, and summer, 1974-77; AVRDC, 1978.[a]

[a]Survey results, 1975 and 1977/78.

substantially replaced by "Black Palmetto".[a] Shih-shih also has declined steadily as other cultivars increased. There also has been a decline in soybean planting overall as the importance of adzuki beans has increased. largely for export to Japan. In the period 1974/75-1977/78 the area planted to winter soybean declined from about 25,000 ha to 14,000 ha, while that to adzuki beans increased from 5,000 to 17,000 ha.

Ten percent of all soybean planted area is cultivated in the spring. Taichung No. 4 was most popular in the early years, No. 15 in the middle years, and NTU-KS No. 5 in the last year. (Fig. 4) Over the 4-year period, the latter increased from 12% to 83% of the planted area because it suited spring conditions. Indeed, farmers in Yunlin abandoned Kaohsiung No. 3 after 1975 because its production period was too long and it suffered yield loss from summer rains.

Still different cultivars were preferred by summer farmers (Fig. 4), who grow 8% of the total planted area. Shih-shih and Palmetto have always been the major cultivars, but government extension promoted Kaohsiung No. 3 on about 35% of the land in 1977. This has replaced Palmetto and to a lesser extent Shih-shih.

We may accept hypothesis 1, that preferred cultivars of soybean differ by season and change over time.

Trends in Yield

Soybean yields depend on both cultivar and weather and management.

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[a]A local cultivar.

Fig. 5 shows winter yield fluctuations by cultivar from year to year. For all cultivars yield increased from 1.8 tons in 1974/5 to 2.2 t in 1976/7 but fell back to 1.9 t in 1977/8 because cold weather restricted growth. However, both Shih-shih and Wakajima had excellent yield in 1977-78. They continued their 4-year steady yield increase at rates of growth higher than other cultivars.

Average yields for the 4 years were more consistent in spring than in winter despite wide fluctuations among the cultivars grown. Fluctuations in yield were largely due to different weather and cultural practices associated with different cultivars. Palmetto and NTU-KS No. 5 showed yield improvement, while Tainung No. 4 and No. 15 declined (Fig. 6). NTU-KS No. 5 now dominates planted area in the spring.

Summer yield showed the most fluctuation (Fig. 6). This is because summer has the highest and most variable rainfall and the severest storms. Shih-shih yielded the most consistently under such conditions. Kaohsiung No. 3 had such a low yield in 1977 because it was planted after the onset of the monsoon. Rainfall shortly after planting severely reduced the germination rate.

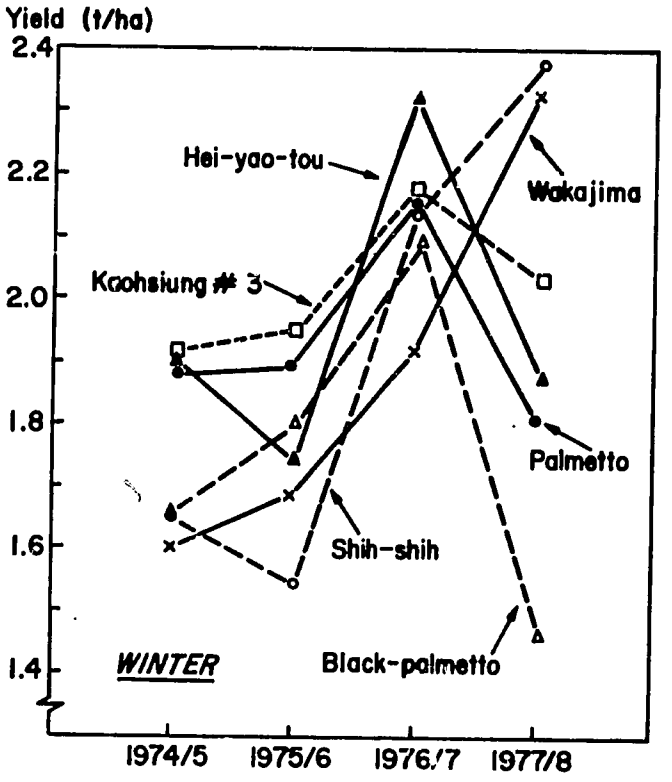

Fig. 5. Yield of soybean by cultivar, winter 1974/75-1977/78; AVRDC, 1978.[a]

[a]Survey results, 1975 and 1977/78.

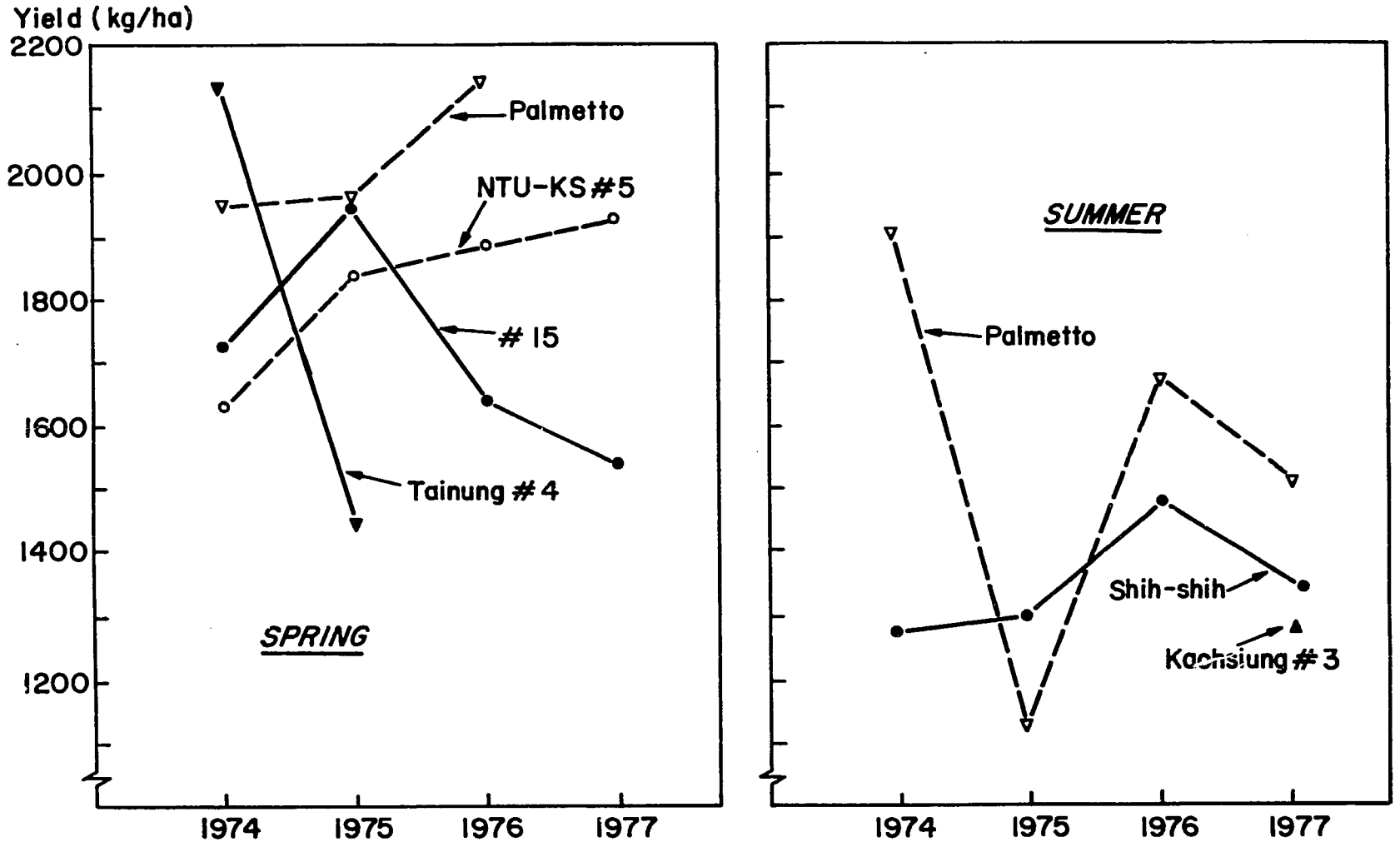

Fig. 6. Yield of soybean by variety, spring, and summer 1974-77; AVRDC, 1978.[a]

[a]Survey results, 1975 and 1977-78.

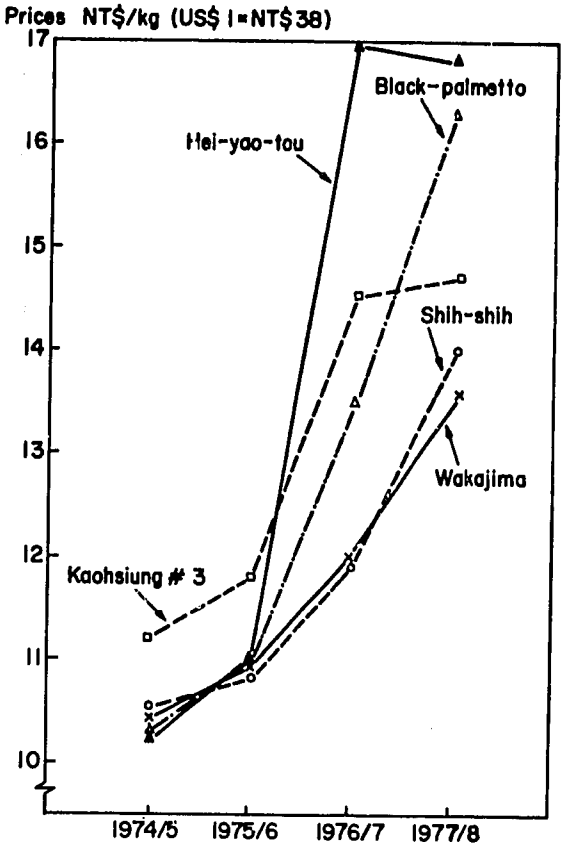

Fig. 7. Soybean prices by variety, winter 1974/75-1977/78; AVRDC, 1978.[a]

[a]Survey results, 1975 and 1977/78.

Price Fluctuations by Cultivar

Fig. 7 shows a sharp increase in prices of winter soybean from 1974/75-1977/78. In 1973/74 the world price of soybean rose. Major increases since have been due to inflation and increased demand in Taiwan (2). Bad weather in the USA in 1978 also led to increases in world soybean prices. In general, the relative price differences between cultivars have remained similar, except that demand for Black Palmetto and "Hei-yao-tou" has increased proportionately more. Black Palmetto makes naturally colored soysauce. As incomes increase,this partly replaced artificially colored soysauce. Hei-yao-tou has a black seed coat but a green interior. It is used for Chinese medicines in Hong Kong and Singapore.

Kaohsiung No. 3 has been higher priced than the average of cultivars because processors prefer its quality, seed size, and color. It also contains more oil and protein than Wakajima and Shih-shih.

[a]For a quantitative assessment of these characteristics, see reference10.
[b]Oil: Kaohsiung No. 3, 19.35%; Shih-shih, 18.55%. Protein: Kaohshiung No. 3, 37.92%; Shih-shih, 37.77%.

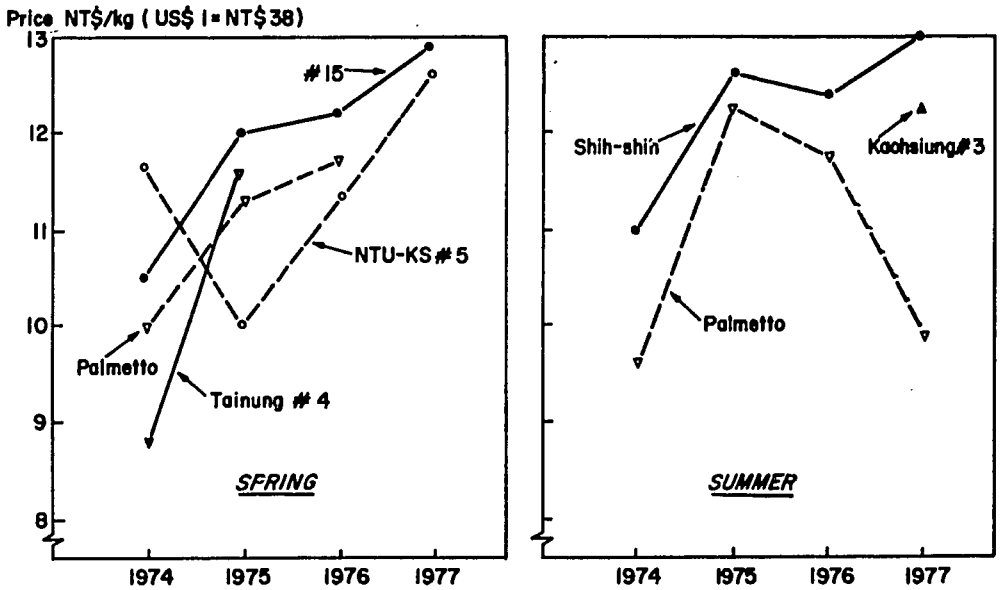

Fig. 8. Soybean prices by variety, spring, summer, 1974-77; AVRDC, 1978.[a]

[a]Survey results, 1975 and 1977/78.

Spring prices (Fig. 8) are lower than winter prices because of cultivar differences and lower quality due to rain damage. Prices have climbed, but less than in other seasons. Only the price of NTU-Kaohsiung No. 5 declined in 1975 because of rust and lodging.

Figures 6 and 8 allow us to accept hypothesis 2, that fluctuations of yield and price are greatest in the summer. Prices and yields may either move in opposite directions because of supply and demand, or in the same direction because adverse weather lowers both yields and quality. The figures show that in 1974-76 the former was the case and in 1977 the latter.

Farmers' Reasons for Choosing Cultivars

Farmers choose their cultivars because of : 1) length of growing season, 2) yield, 3) quality and price, 4) production costs, and 5) market demand. In Taiwan, where land use is intense and farms are small (average 1.06 ha), reason 1 is most important overall, though rankings differ by season.

Winter producers are concerned with harvesting the crop between their monsoon and spring rice crop. They often plant directly in the rice stubble (Fig. 2). They choose cultivars of short duration and tolerance for low temperatures. They also consider price and resistance to insects and diseases in that order (Table 3).

Spring farmers face devastating rains at harvest but cannot plant too early for fear of cold damage. They also rank short duration as the major selection criterion. Other reasons are good price and quality.

In summer (June to Sept/Oct), heat, rain, and typhoons may interfere

Table 3. Preferred soybean varietal characteristics by season; AVRDC, 1978.[a]

Characteristics	Winter n=251	Summer n=66	Spring n=61	Total n=378
	----------%----------			
Short duration	26	33	39	29
High yield	21	29	16	22
Good quality	25	2	2	17
High price	8	18	20	12
Low production cost	6	10	13	8
Good sales outlet	6	8	7	6
Resistance to pests	8	-	3	6

[a]Survey results, 1977.

with every stage of soybean growth. Farmers seek cultivars with good yield, high price and short duration to fit the cropping system.

Factors Limiting the Adoption of Cultivars Improved through Crossing

The main reason farmers reject improved cultivars is that they know little of them and fear failure. Small holders must avoid risk. Moreover, experience shows that such cultivars have no better yield, pest resistance, or price than introduced cultivars. Farmers also are uncertain of market outlets for improved cultivars. Improved cultivars also are of longer duration than many introduced varieties, and will fit less easily into the cropping system. Finally, there are special uses for local cultivars which make them more attractive.

We reject hypothesis 3, that there has been an immediate adoption of improved cultivars.

Ideal Soybean Cultivar by Season

Table 3 shows for each of the 3 seasons the criteria farmers felt were most important.

We accept hypothesis 4, that farmers primarily seek short duration cultivars to fit the multiple cropping system. This is because soybeans are used as a catch crop. Short duration was particularly important to the Yunlin area spring growers, who must harvest the crop before the typhoon season and in time for planting summer rice. They usually plant in March and harvest by the end of June (Fig. 2).

High yield was also a major criterion, especially in the summer. In 1975, only 9% of the soybean area was planted in the summer, yielding only 7% of annual production. Summer heat, rain, and typhoons demand cultivars which can yield well under adverse conditions.

Quality was most important in the winter. Because most production occurs in this season, soybeans must compete in quality to sell at accep-

Table 4. Relative price movements for factor inputs in soybean production, 1976/77-1977/78; AVRDC, 1978.[a]

Factor Input	Quantity	1976/77	1977/78	Increase or Decrease
		------US$-----		-%-
General wage :	Male day	5.11	5.53	8.22
	Female day	3.08	3.24	5.20
Planting wage:	Male day	5.06	5.53	9.29
	Female day	3.24	3.29	1.55
	Ha (contract)	5.61	5.98	6.59
Pesticide spraying:	Male day	7.96	8.67	8.92
	Container	0.40	0.42	5.00
	Ha (contract)	1.03	1.05	1.95
Weeding:	Female day	3.35	3.11	-7.16
Threshing:	Male day	5.32	5.77	8.46
	Female day	3.14	3.37	7.33
	100 kg	0.93	1.20	29.04
	Ha	4.35	4.48	2.99
Land preparation and intertillage:	Cattle day	10.01	10.99	9.79
	Machine day	5.96	6.51	9.23
	Ha	6.64	6.14	-7.53
Pesticide expense:	Dithane kg	4.24	3.95	-6.84

[a]Survey data, 1976-78.

table prices. In the other seasons, high price itself was important because other profitable crops could be grown.

Surprisingly, low production costs, good sales outlet, and resistance to pests were not particularly important to farmers. Winter growers considered pest resistance most critical in winter, when green worm, red spider mite, beanfly, aphid and rust are the major problems.

Trends in Factor Input Prices

Relative output prices determine which crops to grow, and input prices how to grow them. Shifts in production technology over time partly reflect the changes in these prices.[a] Table 4 shows the relative price movements in the two most recent crop years.

The major cost change is skyrocketing threshing costs per kg. In part, this is because of increasing fuel and labor costs.

The most persistent change has been increased male wages. These have risen 8.3% overall, and have increased even more for planting, pesticide spraying, and threshing. At the same time, the female wage rate has not risen rapidly, and has even declined in weeding. These trends reflect the largely male migration to urban employment. Women are often underemployed and willing to do work such as weeding with relatively little compensation.

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[a]Such shifts also reflect changes in technology which enhance the productivity of some inputs over others. In the short period under study it is unlikely that technological change is significant.

The cost of land preparation and intertillage has increased substantially, but slightly more for animal than machine power. The per ha cost of animal power is also significantly higher. This reflects the fact that appropriately-designed power tillers have greatly increased efficiency of agriculture in Taiwan. Because of this, the cost per ha of land preparation and intertillage has gone down by 8%. As power tillers replace cattle, the supply of the latter seems to have fallen faster than the demand, accounting for the relative rise in animal power prices.

The cost of pesticides also declined, because of the governments' decision to reduce import taxes on them.

Cost and Return Structure by Season and Year

How have inputs,yield,and profit changed in response to new cultivars and input costs (Table 4)? Table 5 shows production budgets for the winter, spring, and summer of 1974/75 and 1976/77.

Although average yield is high and stable in the spring, yields in the other two seasons vary greatly from year to year. Yield in 1976/77 was far superior to that in 1974/75. This was mainly because of favorable weather but also a result of higher investment and superior cultivars.

Average net return and farm income also were highest and most stable in the spring crop, followed by the winter and the summer crop. Still, expenses were highest in the spring and lowest in the summer, suggesting levels, applied in appropriate balance, can produce both high yield and high returns.

In all seasons farmers greatly increased production inputs in anticipation of higher prices between the two years (1974-75 & 1976-77). The rate of increase was lowest for winter, where labor was substituted for capital. This suggeests that labor is not a binding constraint in the cool season. In particular, labor for intertillage and weeding increased, while investments in seed, pesticides and herbicides declined.

The rise in overall expenses was second highest in the spring. Capital expenses declined, fixed costs increased, and the relative proportion of labor in total costs remained the same. Expenditures for seed and irrigation increased, while the amount of fertilizer applied declined.

Production costs and yield increased most in the summer. Capital was substituted for labor, which was needed to plant, care for, and harvest the crop. "Other" capital expenses, mainly fuel for motorized pumping sets, increased most.

We rejected hypothesis 5, that no significant change occurred in cultural practices or relative input price between 1974 and 1977 and variations in output price have been responsible for changes in profitability.

Farmers in the winter spent the most both in absolute and percentage terms on pesticides and herbicides, although the labor involved is often

Table 5. Comparative cost and return structures of soybean, winter, spring and summer, 1974-77; AVRDC, 1978.[a]

Item	WINTER				SPRING				SUMMER			
	1974/75		1976/77		1974		1977		1974		1977	
YIELD (kg/ha)	1700		2158		2085		2049		1056		1646	
REVENUE (US$)	501		864		603		862		355		591	
	US$	%	US$	%	US$	%	US$	%	US$	%	US$	%
EXPENSES												
Seed	66	12	49	7	30	5	49	7	25	7	24	4
Fertilizer	62	12	71	10	68	13	65	8	43	11	22	3
Pesticide & Herbicide	57	11	56	8	37	7	61	8	23	6	51	9
Other	4	1	3	-	50	9	45	6	3	1	118	13
ALL CAPITAL	188	36	178	27	184	34	220	31	95	25	175	30
Land preparation[b]	15	4	15	2	73	13	91	12	43	11	11	2
Sowing	54	10	60	9	20	4	13	2	31	8	32	5
Fertilizing	13	2	16	2	8	1	16	9	7	2	19	4
Intertillage & weeding	40	7	88	13	79	15	95	13	56	15	79	12
Chemical spraying	36	7	41	6	26	5	56	8	30	8	46	8
Irrigation	6	1	11	2	27	5	43	6	1	-	6	1
Harvesting	39	7	53	8	24	4	32	5	28	7	59	10
Threshing, cleaning	39	7	53	8	47	9	56	8	31	8	64	11
Transportation	9	2	8	1	19	3	14	2	12	3	5	1
ALL LABOR	252	47	345	52	322	59	415	59	240	62	320	54
Irrigation fee	2	-	24	4	-	-	24	3	1	-	24	4
Land tax	20	4	25	4	7	1	8	1	9	2	14	2
Interest on land	62	12	83	12	24	5	33	5	37	10	52	9
ALL FIXED COSTS	89	17	138	21	36	7	71	10	50	13	95	16
TOTAL EXPENSES	529	100	661	100	543	100	706	100	385	100	590	100
NET RETURN	-28		203		60		155		-30		1	
FARM INCOME	135		409		258		372		139		216	

[a]Survey data, 1975, 1977-78. All prices are actual for the years reported. [b]Although most winter growers used the no-tillage rice stubble method, those who did not had input costs for land preparation and intertillage.

Table 6. Soybean diseases reported by farmers; AVRDC, 1978.[a]

Disease name	Winter N=101	Spring N=48	Summer N=84
	----------	%	----------
Rust	62	75	38
Purple seed stain	11	11	22
White powder disease[b]	17	5	13
Rot	2	-	13
Leaf-spot	6	-	4
Nail-head spot	-	5	4
Leaf-curl	-	-	8
Downy mildew	-	7	-
Wilt	3	-	-

[a]Survey data, 1977-78. [b]Although plant pathologists have not identified powdery mildew as a major problem in Taiwan, the farmers report it to be a problem. They call it "white powder disease."

Table 7. Soybean insects reported by farmers; AVRDC, 1978.[a]

Insect name	Winter N=74	Spring N=90	Summer N=78
	----------	%	----------
Green worm[b]	27	34	38
Beanfly	23	35	34
Aphid	19	23	16
Red spider mite	26	7	6
Caterpillar	-	-	9
Pod borer	4	-	-
Bean-bug	2	3	-
Leaf-roller	-	2	-

[a]Survey results, 1977-78. [b]Local name. The scientific name of the pest and the true extent of its damage are unknown.

less than in other seasons. Tables 6 and 7 show no special disease and insect incidence in the winter. Winter growers manage their crops intensively to achieve high profits.

Land preparation in the spring takes the most time because of plowing with draft animals. However, sowing in the winter is the most labor in-

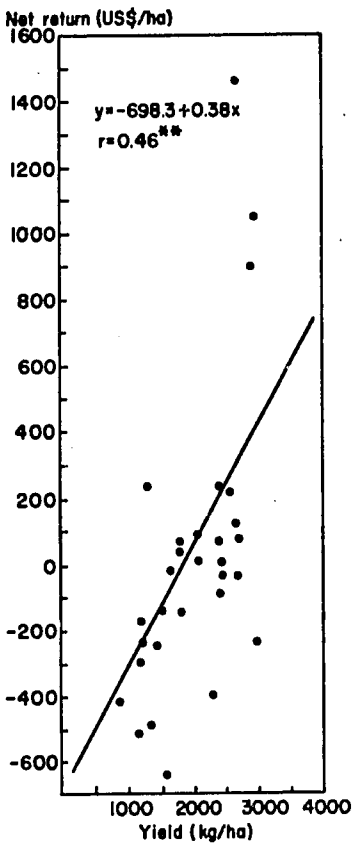

Fig. 9. The effect of increasing yield on net returns in winter soybean, 1976-77; AVRDC, 1978.[a]

[a]Survey data, 1977-78.

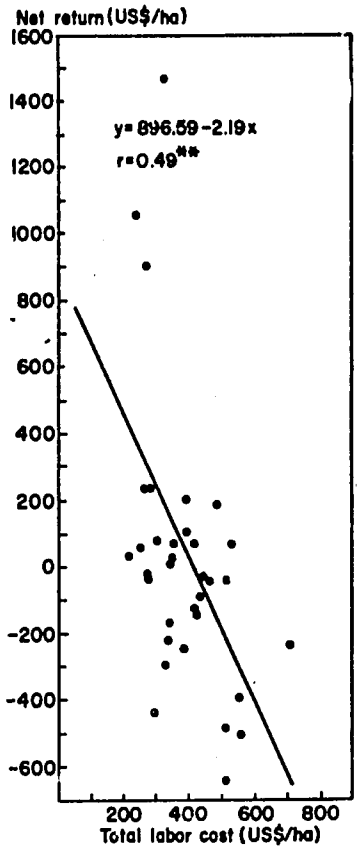

Fig. 10. The effect of increasing total labor cost on net returns in winter soybean, 1976-77; AVRDC, 1978.[a]

[a]survey data, 1977-78.

tensive because farmers in Pingtung prefer the laborious rice-stubble planting. These figures reflect the seasonal variation in cultural practices.

Determinants of Yield and Net Return

Fig. 9 shows that, for the 35 winter producers surveyed in 1977, there was a significant relationship between yield and net return: as yield increased by 100 kg/ha, net return improved by US$38. The question, then, is how to increase yield? When yield was regressed separately on total capital cost, total labor cost, fertilizer cost, weeding labor, and pesticide and herbicide labor, none of these relationships were significant. That is, yield cannot be improved by increasing inputs, but must be improved through plant breeding.

Before getting plant breeding advances, are there short run methods of improving profit? Fig. 10 shows a strong negative relationship between total labor costs and net return. As total labor cost is increased by

US$1/ha, net return falls by $2.19. Within total labor, the negative relationship between weeding labor and net return is particularly strong (Fig. 11). As weeding labor increased by US$1/ha return declined by $2.94. Therefore, we rejected hypothesis 6, that the higher the investment in weeding, pesticides, and other production inputs, the higher the yield and net return.

Increasing total capital cost, however, has no significant effect on net return (r=-0.16). But it is possible that, up to a point, increasing capital costs may improve the level of yield and net return. Table 8 shows the average levels of yield from various management intensity cells, defined as ranges in the level of capital costs (horizontal index) and labor costs (vertical index) for the 35 sample farms. It is clear that:

1. Most farmers over-invested in both capital and labor, given the yields they achieved.

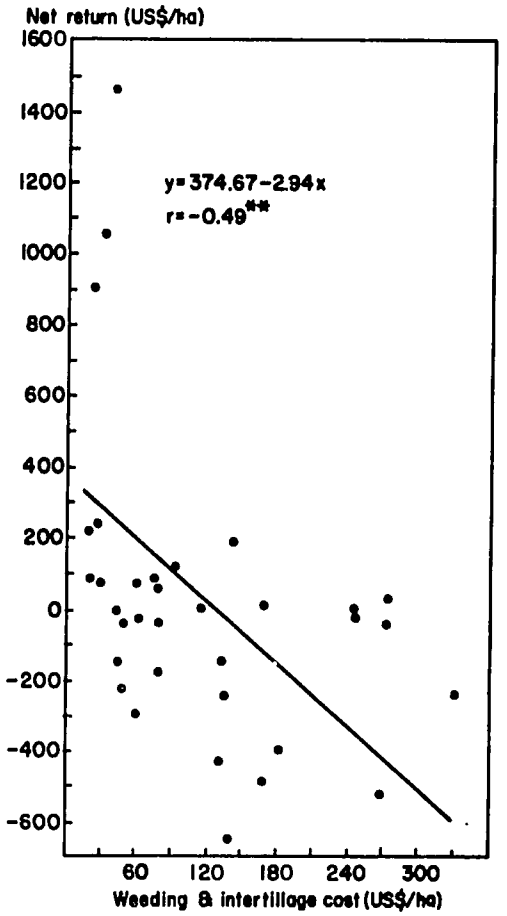

Fig. 11. The effect of increasing weeding and intertillage on net returns in winter soybean, 1976-77; AVRDC, 1978.[a]

[a]Survey data, 1977-78.

Table 8. Yield (kg/ha) of soybean by management intensity cell, 1976-77; AVRDC, 1978.[a]

Labor costs (US$)	CAPITAL COSTS (US$) I 146	II 147-199	III 200-252	IV 253-305	V 306
A 315	n=5 2095	n=4 2100	n=1 2400	-	n=1 900
B 316-414	n=3 1580	n=4 2248	n=3 1929	n=2 1950	-
C 415-513	n=2 1650	-	n=2 3000	n=2 1560	n=2 2000
D 514-612	n=1 2700	n=1 1200	n=1 2314	-	-
E 613	-	n=1 3000	-	-	-

[a]Survey data, 1977-78. Black box shows range over which increases in investment lead to consistent increases in yield.

Table 9. Net return (US$/ha) from soybean by management intensity cell, 1976-77; AVRDC, 1978.[a]

Labor costs (US$)	CAPITAL COSTS (US$) I 146	II 147-199	III 200-252	IV 253-305	V 306
A 315	271	522	901	-	(-) 413
B 316-414	(-) 101	57	(-) 55	592	-
C 415-513	(-) 91	-	83	(-) 261	(-) 361
D 514-612	79	(-) 506	(-) 382	-	-
E 613	-	(-) 230	-	-	-

[a]Survey data, 1977-78.

2. When farmers spent extreme amounts on either capital or labor they spent only medium or low amounts on the other input. No farmer had both high labor and capital costs.

3. As a general rule, increases in labor costs did not improve yield (confirming the regression results), but at low levels of labor, increases in capital consistently increased yield, outlined in black, Table 8.[a]

Farmers are interested in profit, not yield. Table 9 also shows the sample distributed by management intensity, except that the numbers in the body of the table refer to net return rather than yield. Again,

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[a]Although cells ID , IIE and IIIC had higher yields than IIIA, farmers would have to go through management levels with negative marginal yields to reach them.

many farmers spent too much, so that there was no general response in either yield or net return to higher labor or capital. However, as in Table 9, farmers using little labor could profitably increase their capital investments up to US$200-252 per ha. Cell IIIA had the highest net return. Farmers in the short run should use this balance of factor inputs.

Major Competitive Crops by Season

Farmers must choose among crops of varying potential profit and risk. Table 10 shows that in the winter (between October and January), adzuki bean was soybean's major competing crop. Growing export demand has increased the profitability of adzuki bean relative to soybean. The increasing importance of winter adzuki bean has been primarily at the expense of cantaloupe.

In the summer the major alternative is sugarcane, largely because of low risk. Sugarcane is relatively resistant to summer typhoons, which can damage soybean. Between 1976/77 and 1977/78, however, such crops as cassava and pineapple began to replace sugarcane.

In the spring, major alternatives were seed melon in 1976/77 and rice and peanut in 1977/78. In spring, there is a range of crops which compete equally with soybean.

We accepted hypothesis 7, that the major alternative crops to soybean differ by season and have changed in realtive importance over the period 1974-77.

Table 10. Percent of farmers listing major competitive crops of soybean, by season; AVRDC, 1978.[a]

	SEASON					
	Winter		Summer		Spring	
	1977/8	1976/7	1977/8	1976/7	1977/8	1976/7
	%					
Adzuki bean	66	62				
Green soybean[b]	6	2				
Cantaloupe	6	14				
Tobacco	7	6				
Vegetables	12	14				
Corn	3	2	20	20		13
Sugarcane			40	60	10	13
Cassava			20	-	-	-
Pineapple			10	-	-	-
Watermelon			10	20	-	13
Mint					20	-
Rice					30	-
Seed-melon					-	39
Peanut					30	26

[a]Survey data, 1976-78. [b]Eaten fresh as a vegetable.

Comparative Production Budgets for Winter Soybean and Adzuki Bean

Table 11 shows the remarkable similarity in production costs for winter soybean and adzuki bean. Labor allocation was almost indentical because basic cultivation practices were the same. Greater costs went for seed in adzuki bean, and fertilizer and interest on land in soybean. More also was spent on pesticides and herbicides in adzuki bean. Adzuki bean harvest labor was more efficient ($22/t) than soybean ($25/t).

However, for all practical purposes costs of producing the two crops were the same, as was yield. But the volatile market for adzuki bean in 1977 was offering about US$700/t vs only $400 for soybean. This made all the difference in net return and farm income. We accepted hypothesis 8, that adzuki bean is more profitable than soybean only because of higher price.

There is no guarantee of such a high relative price for adzuki bean in the future, so farmers in the Kaohsiung-Pingtung area must gamble on which crop to plant in any given year.

Table 11. Comparative cost and return structures of soybean[a] and adzuki-bean[b], 1976/77; AVRDC, 1978.

Item	Soybean		Adzuki-bean	
Yield (kg/ha)	2158		2274	
	US$	%	US$	%
Revenue	864		1597	
Expenses:				
Seed	49	7	83	12
Fertilizer	71	10	65	9
Pesticide & herbicide	56	8	62	9
Other	3	-	3	-
ALL CAPITAL	179	27	212	30
Land preparation	15	2	18	3
Sowing	60	9	62	9
Fertilizing	16	2	21	3
Intertillage & weeding	88	13	90	13
Chemical spraying	41	6	52	7
Irrigation	11	2	6	1
Harvesting	53	8	51	7
Threshing, cleaning	53	8	53	8
Transportation	8	1	2	-
ALL LABOR	345	52	356	51
Irrigation fee	24	4	24	4
Land tax	25	4	23	3
Interest on land	83	12	75	11
Interest on capital	5	1	5	1
ALL FIXED COSTS	137	21	127	19
TOTAL EXPENSES	660	100	695	100
NET RETURN	203		902	
FARM INCOME	409		1168	

[a]35 samples from the Pingtung-Kaohsiung area. [b]15 samples from the Pingtung area. Although this sample is small compared with the soybean sample, it is large enough to indicate the general structure of adzuki bean production costs.

Table 12. Motives for planting soybean, 1976-77: AVRDC, 1978.[a]

Motive	Total n=625	Winter n=380	Spring n=94	Summer n=151
	----------	----------	%	----------
No other crops suitable in that season	32	35	18	33
Fully utilize land	22	20	8	36
Save labor	18	18	31	9
Increase land fertility	7	10	2	3
Low production cost	6	3	20	7
Good profit	4	3	5	5
Others	11	11	16	7

[a]Survey results, 1977-78.

Motivations for Planting Soybean

Planting motives differed by season because of alternative crops or cultivars, weather expections, and price and yield variability (Table 12). We rejected hypothesis 9, that the motives for growing soybean are the same in every season. In winter, and for the sample as a whole, lack of suitable alternative crops was most important. That this reason was also a strong factor in summer reflects the fact that soybean is grown on land which cannot be devoted to monsoon rice. Table 5 shows that the average return to soybean in these seasons was less than in spring.

In the spring the main motive was to save labor because of the need for harvesting spring rice and planting monsoon rice. Table 5 shows that spring soybean growers already invest the most labor. This suggests that alternative crops are even more labor intenstive. In the spring low production costs overall also were a major motivation.

In summer the main motive for planting soybean was to fully use land. This is closely related to the lack of other suitable crops for upland fields.

Surprisingly, few farmers listed good profit as a reason for planting soybeans, and only in winter was the contribution to land fertility noted. We concluded that soybean is often grown as a last resort to fill in when no other low-labor crops are available. For soybean to become appealing through price supports or input subsidies, the order of reasons in Table 12 would have to be reversed.

A number of farmers in the original sample chose not to plant soybean in the 1976/77 crop year. The major reason overall and for the winter season was low price in comparison with adzuki bean (Table 13). Low yield also was significant.

In the spring the major reason was a shortage of land, followed by shortage of labor. The latter corresponds well with the reasons for planting soybean in the spring and reinforces the picture of labor shortage in that season. These two reasons also were the most important in the summer. Thus, farmers who have abandoned soybean head the list with economic factors, while farmers who still plant list agronomic

factors. To lure back those who have abandoned the crop, improved prices and yields should be assured.

Why did farmers who rejected soybean in 1976/77 plant other crops (Table 14)? The chief reason for winter farmers and the sample as a whole was price and profit, suggesting that farmers who abandoned soybean are more business-minded than those who continue to plant. Need for marketing outlet also was mentioned.

In the spring, the major reason was the rotation system. High price and good profit also were important.

In the summer, the major reason for planting other crops was to save labor. Table 5 shows that summer farmers already use the least labor. This suggests that those farmers who abandoned soybean in the

Table 13. Motives for not planting soybean, 1976-77; AVRDC, 1978.[a]

Motive	Total n=396	Winter n=309	Spring n=52	Summer n=35
	----------%----------			
Low price compared to adzuki-bean	40	50	6	-
Low yield	16	19	2	11
Labor shortage	13	9	10	34
Land shortage	10	4	14	34
High production costs	6	7	3	-
Natural factors	4	4	2	-
Bad quality	1	-	-	11
Others	10	7	63	10

[a]Survey results, 1977-78.

Table 14. Reasons for planting alternative crops, 1976-77; AVRDC, 1978.[a]

Reasons	Total n=413	Winter n=316	Spring n=55	Summer n=42
High price and good profit	58	68	27	17
Good outlet	13	14	11	14
Crop rotation system	9	3	31	21
Save labor	8	4	15	31
Personal preference	1	2	-	-
Others	11	9	16	17

[a]Survey results, 1977-78.

Table 15. Major problems encountered in planting soybean, 1976-77; AVRDC, 1978.[a]

Problems	Total n=587	Winter n=389	Spring n=15	Summer n=123
Rain during planting time	38	36	35	46
Low price and profit	31	41	23	2
Low yield	12	8	13	25
Bad quality seed	4	2	9	9
High production cost	4	5	4	-
Outlet not good	3	3	-	4
Low germination	-	1	-	-
Low temperature	3	3	-	4
Others	5	1	16	10

[a]Survey results, 1977-78.

summer have such limited families or available labor that they could not plant soybean even by substituting capital for labor. The crop rotation system was also noted.

Major Problems in Planting

The major difficulty was rain at planting time (Table 15), mostly in summer, when rain and typhoons peak in southern Taiwan. However, rain also was the first limiting factor in spring and the second in winter.

Low price and profit were mostly problems in the winter. We accepted hypothesis 10, that the major soybean production problem is its low price and profitability; but only for the winter sample. This is something of a surprise, because the winter price in 1977 was only slightly lower than in spring and higher than in summer. However, winter growers are sensitive to price and profit due to the availability of more economic alternative crops. Table 5 shows that they earned both the highest net return and farm income in 1977 of all three seasons. Spring farmers also noted low price and profit as a problem, but summer growers were not concerned with this, despite their low returns (Table 5).

Low yield also was a problem, mainly in the summer, as Table 15 shows. This is coupled with high rain damage. Farmers have adjusted by lowering costs.

The strategy to increase soybean production should be geared to the motivations and problems of farmers in the 3 seasons. For example, a support price in winter and typhoon resistant cultivars in summer could be a double-pronged approach to increasing year-round production levels.

The Incidence of Insects and Disease by Season

Varying temperature and moisture conditions throughout the year create periods in which insects and disease can flourish. Table 7 shows that farmers rated green worms as the most serious insect pest in soybean overall, but particularly in spring. Beanfly was less a problem in winter than in the other seasons. However, the red spider mite was active

in winter because of its ability to thrive under cooler conditions. Aphids were most serious in summer.

The major disease in all seasons was rust (Table 6). Spring rust was most severe. Purple seed stain was most damaging in the summer, and a powdery disease[a] in the winter. Other diseases were negligible.

SUMMARY AND CONCLUSIONS

In 1975 and 1977, the Asian Vegetable Research and Development Center conducted surveys of soybean producers in winter, spring, and summer to develop an understanding of the status and potential of soybean production in Taiwan. The objectives were to:

1. Measure changes in soybean profitability over the three-year period 1974-77 and compare the soybean production budgets, yields and returns in each of the 3 seasons.

2. Compare the yield and profitability of soybean with adzuki bean.

3. Determine the effect of increasing inputs on yield and return; and the optimal levels of labor and capital inputs for the winter season.

4. Investigate the changes in yield and price by cultivar over the three year period and why farmers change cultivars.

5. Determine why farmers grow soybean and the major problems still limiting its planted area.

The data show that the cultivars preferred by farmers differed by season and have changed over time due to yield and price trends. Price and yield fluctuations were greatest from year to year in summer because of temperature, rain, and typhoon damage. The major criterion sought by farmers was short duration to fit into intensive land use systems. Because cultivars improved through crossing often lacked short duration, they were not acceptable to farmers.

Relative prices of inputs changed dramatically over the three-year period. Combined with increasing yield potential these prices induced farmers to modify the level and balance of production inputs. Output price also had a great effect on soybean profitability. In general, the higher the production inputs, including fertilizer, pesticide, and weeding labor, the lower the net return. Only at low input levels of labor, the input whose relative costs increased most, was it profitable to increase capital costs. Most farmers were over-investing.

The major alternative crops to soybean differed for each season and changed in relative importance in 1974-77. The most important was adzuki bean in winter. There was startling similarity in production costs and yield of the two crops, and price alone determined profitability.

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[a] Probably erroneously identified by farmers as powdery mildew.

In recent years, adzuki bean has been most profitable because of rising demand from Japan. This is one main reason for the decline of soybean area.

The major motive for growing soybean in winter was lack of alternatives, in spring to save labor, and in summer to fully use land. Profitability was never a major reason mentioned by farmers. Other than rain damage at planting time, the chief problem was low price and profit. Farmers in all seasons were eager for higher-yielding and early maturing varieties. Investment in crop improvement through plant breeding should continue.

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