1. RESEARCH ACHIEVEMENTS

Indica Rice Improvement

In order to improve the resistance to bacterial leaf blight disease of Taichung-Sen 10 and Taisen 1, they were crossed with other parental varieties. Altogether 280 crosses were obtained this year. The F_1's will be grown in the next trial. The previously selected breeding lines of *indica* type rice were at the different stages of breeding program i.e. pedigree selection (3311 lines), observational trial (297 lines), primary yield trial (78 lines) and advanced yield trial (20 lines). Four promising lines, Tai-Sen yu 367, 368, 369, and Tai-Sen waxy yu 14 were selected for further regional yield trial Tai-Sen 367, 368 and 369 are low in amylose content, resistant to rice blast, bacterial leaf blight disease and brown planthopper. Tai-Sen waxy yu 14 is resistant to rice blast and bacterial leaf blight diseases and to brown planthopper with 5% increase in yield than that of Taichung-Sen waxy 1.

Fig. 1. Taichung-Sen yu 365 at the maturing stage.

Japonica Rice Improvement

The selection for high quality is the main objective of breeding in *japonica* rice. The previously selected breeding lines of *japonica* rice were at the different stages of yield trial this year. A total of 1,937 selected lines were subjected for observational trial, 83 lines at the yield trial and 17 lines were at the advanced yield trial. Taikeng yu 3861 and Taikeng yu 135 were the highest in yield in early maturity group, which gave 47.4% and 36.1% higher in yield than that of the check variety "Taichung 190", respectively. Taikeng yu 235 and Taikeng yu 145 were the highest in yield in mid-late maturity group, which were 20.3% and 10.2% higher in yield than that of the check variety " Tainung 67 ", respectively. All four lines mentioned above have been selected for further regional yield trial.

Fig. 2. Regional yield trial of *japonica* rice breeding lines.

Effect of Yield Components on the Yield of Rice in Central Taiwan.

Twenty *japonica* and *indica* varieties of rice were planted in both lst and 2nd crops in central Taiwan. Various yield components were recorded and analyzed by the method of path analysis. Number of grains per panicle and panicle number per unit area were identified to be the most important component affecting the grain yield. Both characters contributed greatly to grain yield as revealed by the result of path analysis. The degree of contribution of percentage of filled grains to yield was rather small. It is inferred from this result that the plant type of heavy panicle weight with high tillering capacity and short stature should be adopted in the central Taiwan (Table 1).

Table 1. Path coefficient and standardized regression coefficient among yield components and yield in rice

Traits	Planting season	Path coefficients	Partial regression coefficients (SD)
Panicle number	I	1.052	1.035**
	II	0.605	0.570**
Grain per panicle	I	1.329	1.337**
	II	0.677	0.575**
% of filled grains	I	0.317	0.332**
	II	0.224	0.216
1000 — grains weight	I	0.474	0.451**
	II	0.237	0.225
Uncorrelated residual	I	0.272	
	II	0.365	

WEED RESEARCH

The Growth Pattern of Bulrush (*Scirpus maritimus* L.) at First-Crop Season in Taiwan

Bulrush (*Scirpus maritimus* L.) is a new species of perennial weed in paddy-field and generally found in Pingtung, Tainan, Yunlin, Changhua and Taichung counties. The high weed population density caused a severe effect on rice growth along the coastal areas of Changhua county. It is difficult to control due to the fast growing habit and multiplication rate, reproduce mainly by bulbs. It is highly tolerant to herbicide. The growth pattern of bulrush at first-crop season is described as follows :

1. It grows rapidly after germination, the plant height could reach to 85cm within 48 days after emergence (DAE), then maintain at 90 — 100cm in height. The total number of leaves is about 9 — 10. The leaves gradually turn yellow after 55 DAE.
2. The highest tillers (130 tillers per plant) were found at the stage of 48 DAE.

3. The maximum leaf areas of bulrush are 3650.9cm^2 at 55 DAE.
4. Few flower stalks begin to appear at 20 DAE, the full blooming stage is at 41 DAE.
5. The highest dry weight was found to be at the stage of 69 DAE. The plant dry weight of aboveground increased faster than that of underground at the early growth stage, but it was reversed at about 41 DAE.
6. The underground bulblike tissues appeared at the stage of 41 DAE, and 266 small bulbs have been found at 90 DAE. The small bulbs number could continuously increase up to 457 at 120 DAE.
7. It is highly competitive with paddy rice due to its fast vegetative growing habit.

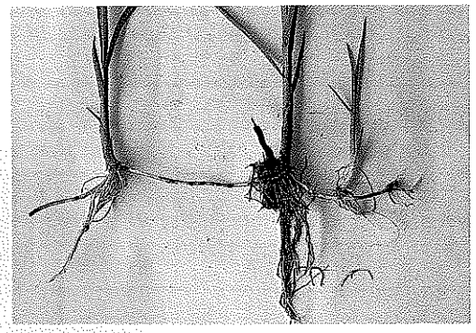

Fig. 3. The tiller and bulblet of *Scirpus maritimus.*

RICE QUALITY

Effect of Storage Temperature on the Embryoed Rice Quality

Two varieties of rice, Taichung 189 and Kaohsiung 142, were processed into embryoed rice, then were stored at different temperatures. The stored embryoed rice were sampled to study the effect of storage temperature on the grain qualities. The results showed that pH value of embryoed rice decreased in parallel with the length of storage time. The smallest value of pH value was found when the embryoed rice was stored at low temperatures of 5°C to 10°C. The opposite was true when they were stored at high temperature of 35°C to 38 °C. However, the fat acidity of embryoed rice increased in parallel with the length of storage period. Those stored at low temperature had the lower fat acidity than those stored at high temperature. Texturometer was used to measure the physical properties of cooked embryoed rice. The results indicated that hardness and cohesiveness increased during storage, but viscousness, adhesiveness and balance decreased during storage. Those stored at low temperature showed better physical properties than those stored at high temperature after the similar length of storage. The summer's temperature in Taiwan was usually over 30°C. So, if the consumers want to buy embryoed rice, they should buy the small packed form and to eat out within one month. If can't use it out at one time, it should be kept in refrigerator.

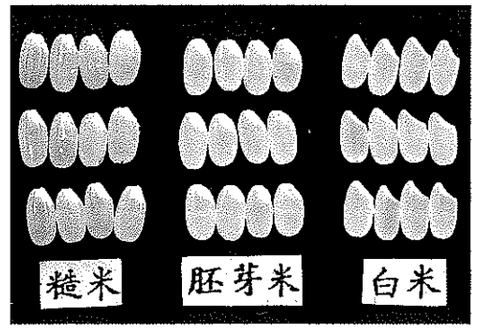

Fig. 4. Grain appearance of different types of milled rice : brown rice (*left*); embryoed rice (*center*); white rice (*right*).

The Effect of Different Milling Machines on the Quality of Embryoed Rice

The effect of different models of milling machine on the quality of embryoed rice (embryo-intact rice) was evaluated. The experiments were conducted at Taichung DAIS with the samples harvested in the 2nd crop of 1987 and lst crop of 1988. The result showed that the highest percentage of embryoed grains was obtained when the moisture content of rice grain was adjusted at 12% level. While the lowest percentage of that was obtained at the grain moisture level of 16%. The milling machine " Yamamoto VP — 30T " resulted in a better milling quality in terms of embryoed rice than that of Mcgill No.2 regardless of grain moisture content. The former was found to be much easier to control and operate than the latter. In addition, there is a positive correlation between the theoretical rate of embryoed grains (at 27° of milling whiteness) and the actual rate of embryoed grains after the circulation of rice grains 2 — 4 times. Therefore, using Yamamoto VP — 30T miller at 2 — 4 times circulation is considered to be a standard method for testing the percentage of embryoed grains (Table 2).

Table 2. The theoretical percentage of embroyed rice for different rice varieties prepared by different models of milling machine.

Variety	McGill No.2	Yamamoto VP — 30T
Toyonishiki	75.6	80.2
Tainung 67	73.9	79.8
Tainung 70	63.0	69.4
Tainan 9	65.7	75.0
Taichung 189	74.0	79.0
Average	70.4	76.7

Effect of Maturity and Drying Techniques on Grain Cracking and Eating Quality of Rice

The effects of grain maturity, drying methods and grain moisture on the grain cracking and eating quality of rice were evaluated. The result indicated that the rate of cracked grain increased in parallel with the degree of grain maturity. The over-dried grains (12% W. B.) showed a higher rate of cracking than optimally dried grains (14 — 15% W.B.). No significant difference in the rate of cracked grains and eating quality was observed between the materials dried by 2 — step (45 — 40 ℃) and 3 — step (50 — 45 — 42 ℃) methods of drying, when the similar degree of maturity of samples were used. In general, the rate of cracked grains was much higher in over-dried grains than that of optimally dried grains. This was due to the absorption of air moisture by the over-dried grain during the storage period.

UPLAND CROPS

Breeding of Hybrid Sorghum

Grain sorghum is one of the most important feed crops in Taiwan. The objective of breeding program is to develop a hybrid grain sorghum variety having the following characteristics: high-yielding, good quality, resistant to aphid and sheath blight disease. Easy to produce the F_1 seeds is another requirement for hybrid grain sorghum.

In order to improve the parental line of hybrid sorghum, we made crosses between 80B (maintainer line of 80A, the cytoplasmic male-sterile line of the cultivated hybrid sorghum variety "Taichung No. 5") and other three B lines, which have longer heading days, and more resistant to sheath blight and aphid than 80B. We also produced F_2 seeds of six crosses of B lines that made by 80B and other six B lines. Meanwhile, we generated the seeds of eight R lines (restoring line) crosses that were made by 2R (male parent of Taichung No. 5) and other eight R lines with characteristics of the panicle exersion, semi-compact panicle shape, larger kernel and other aphid resistant genetic sources.

Forty-nine new hybrid entries were evaluated in combining ability test, the result showed that nine hybrid lines were superior in grain yield and aphid resistance, having semi-compact panicle and short plant height, these lines were selected for further advance yield trial.

The regional yield trial was conducted at eight areas in 1989. The trial consisted of seven new hybrid lines and a check variety " Taichung No.5 ". The resulted indicated that the grain yield of Tainan-yu 76 — 12, 75 — 23 and 74 — 29 get the higher yield than the check variety by 4% to 6%. These three lines were taller than the check variety, especially of the Tainan-yu 74 — 29 (179cm). All three lines resistant to the aphid and other leaf diseases.

Fig. 5. The parental lines of hybrid sorghum " Taichung 5 ", center: 2R; two sides: 80B.

Genetical Studies on Tannin Content and Other Characters in Grain Sorghum

Four sorghum strains of different tannin content were crossed with the parental strains of hybrid sorghum " Taichung No. 5 ", that is, 2R (restoring line) and 80B (maintainer line). F_1's and F_2's were studied with regard to the genes that controlling grain tannin content and other agronomic characters. Genetic and phenotypic correlation between different characters were also studied. Results indicated that high tannin content was found to be partial dominant over the low tannin content. The tannin content was controlled by two

pairs of complementary genes as it is expressed by F_2 segregation ratios of 9:7 and 9:3:4. The heritability values of grain tannin content in three cross combinations were estimated to be as high as 97%, 97% and 93%, respectively, indicating that selection efficiency for tannin content is very high.

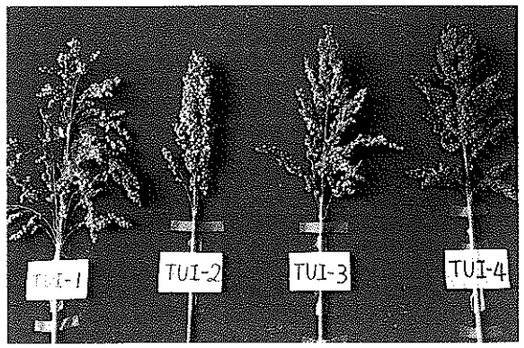

Fig. 6. Panicles of four sorghum strains composed of different tannin content.

Experiment on the Upland Crop Rotation System in Paddy Field

With the objective of evaluating the optimum rotation systems of upland crops in paddy field, this experiment was conducted at Taichung DAIS in lst and 2nd crop of 1989. Four cropping patterns were studied as follows: pattern A was rice after rice which was treated as check; pattern B was rice after corn; pattern C was peanut after rice; and pattern D was sorghum after sorghum. The pest management, diseases incidence, weed amount and the soil physicochemical properties were also investigated.

The results showed that the pattern C had the highest net profit than the other three patterns, the lst crop of rice was NT$31,479/ha and the 2nd crop of peanut was NT$30,994. The highest profit was due to the high-yielding of lst crop rice and the high price of peanut, even the peanut yield was low. The pattern of ratooned sorghum after sorghum got NT$47,723 net profit, which was also higher than the check, the net profit of check, was NT$33,854. The pattern of rice after feed corn only got NT$8,821/ha, that was due to the lowest yielding of lst crop of feed corn and 2nd crop of rice.

The results of the soil physicochemical analysis indicated that the pattern of rice after rice was the highest in total density values, while the peanut after rice decreased the values. The pH-value of soil after rice was higher than after upland crops. The organic matter of the soil after crop rotation was not significantly different from each treatment due to only one year study. The effect of cropping patterns on the soil texture needs the repeated long period of experiment before it can be evaluated.

Fig. 7. Experimental fields of upland crop rotation system in paddy field.

Experiment of Planting Date for Large-Grain Buckwheat

The purpose of this experiment was to find out the optimun planting date for large-grain buckwheat. Three varieties were used for this testing by sowing the seeds every ten days, starting from Oct. 5 to Dec. 25. The results indicated that the proper sowing time of large-grain buckwheat was from mid-October to early-November. The suitable sowing time of check variety " Hitachiakisoba " was from late-October to late-November. The yield was significantly decreased from 11.9 to 4%, when sowing time was conducted after early-November, Miyazakiootsubu showed the highest yield (1567 kg/ha) among the large-grain varieties, but it was 5.4% lower than check variety.

Yield Performance of Buckwheat under Different Conditions

The yield performance of buckwheat was evaluated in the fall and winter seasons in 1988/89, with regard to seeding time, seeding rate and seeding methods. The results of the experiment indicated that the suitable seeding time is in early October to early November for large-grain varieties and in late October to early November for medium-grain varieties, and late October is considered to be the most suitable seeding time for most varieties. The large-grain varieties are suitable for sowing either by drilling or by broadcasting under the seeding rate of 80 — 100 kg/ha (Table 3).

Fig. 8. Buckwheat at the full blooming stage.

Screening of Pesticides for Leaf Blight Disease in Job's Tears

The leaf blight disease caused by *Bipolaris coicis* is usually serious in Job's tears (*Coix lacryma-jobi*). This experiment was aimed to identify the occurrence and resistance of Job's tears varieties to this disease. Twenty-seven Job's tears varieties were used to test fungicides, Roval, Benlate and M — 45, in this study. The result indicated that none of tested varieties showed 100% resistant to this disease, while the three local varieties, Bead No. 2, White Shell and Wild No. 2, were measured to be slightly sensitive to this disease. The commercial variety, Taichung Yu No. 5, showed a moderate resistance to this disease with 11.3%~19.5% of infection. The leaf blight in Job's tears usually started from lower developed leaf and then extended to upper young leaf blade.

The significant symptom of leaf blight disease was measured at 104.2 days after the sowing in spring crop and 76.8 days in summer crop. Roval was shown to be better than other two fungicides. It inhibited 4.3~31.1% of the epidemics of the disease resulted in 0.38~0.5 ton/ha of grain yield (Table 4).

Table 3. Effects of sowing time on the agronomic characters and yield of large-grain buckwheat in the fall season of 1988.

Sowing time	Varieties[1]	Growing period (days)	Plant height (cm)	Number of branch	Flower cluster	1000 grain weight (g)	Grain yield (kg/ha)
	M. O.	71	50.7	3.9	21.1	47.3	1819
Oct. 5	S. O.	70	42.5	3.7	14.6	54.5	958
	H. A.	72	59.5	4.4	25.9	32.1	1625
	M. O.	72	55.0	3.2	23.9	47.6	1952
Oct. 15	S. O.	72	39.3	3.2	18.1	57.1	1098
	H. A.	72	50.0	3.4	27.1	33.5	1735
	M. O.	73	60.4	2.7	31.3	47.8	2402
Oct. 25	S. O.	73	56.5	2.7	20.7	57.5	1854
	H. A.	73	68.6	3.0	32.9	34.8	2590
	M. O.	83	42.3	3.3	15.8	48.6	1833
Nov. 5	S. O.	82	30.6	3.3	11.9	58.6	1000
	H. A.	81	46.3	3.4	21.9	35.6	2083
	M. O.	97	30.6	3.1	14.7	49.1	1610
Nov. 15	S. O.	94	25.5	3.3	9.7	63.6	881
	H. A.	97	35.5	3.7	18.4	37.3	1840
	M. O.	94	47.3	2.9	13.2	50.7	1563
Nov. 25	S. O.	88	37.2	2.9	8.2	63.0	792
	H. A.	94	55.8	2.8	17.9	36.6	1819
	M. O.	93	40.3	3.8	12.4	48.2	1292
Dec. 5	S. O.	86	37.0	3.5	7.4	59.1	756
	H. A.	93	45.3	3.9	15.2	35.9	1667
	M. O.	90	31.4	3.1	10.2	45.8	1027
Dec. 15	S. O.	85	26.9	3.2	6.1	56.1	485
	H. A.	90	27.8	3.6	9.7	34.7	845
	M. O.	81	27.4	3.2	8.1	44.3	604
Dec. 25	S. O.	76	24.4	3.1	5.7	55.0	327
	H. A.	81	31.9	3.6	8.5	30.5	723

(1) M. O. — Miyazaki Ootsubu
S. O. — Shinshu Oosoba
H. A. — Hitachi Arisoba

Table 4. The occurrence of *Bipolaris coicis* on different Job's tears varieties

Ranking of disease	Degree of disease infection (%)	Job's tears varieties	
		Spring crop	Summer crop
0	0 — 10	Okayama	
1	11 — 20	Aimei, Kuanchou, Taiwan Local, Taichung Yu No.5 White Shell. Bead No.2 No.1	Aimei, Okayama
2	21 — 30	Shaihai, Brazil No.1, Taichung Yu No.5, Wild No.1	Kuanchou, Brazil No.1, Taiwan Local, Taichung Yu No.5, Brazil No.2
3	31 — 40	Kuroishi, Nakazado Miagi, Kimyan, Kimatea Brazil No.2, Taichung Yu No.2, Bead No.1	Nakazado, Miagi, Shaihai Kimyan, Taichung Yu No.2
4	41 — 50	Tocuda, Gainobukei Talein, Taichung Yu No.1, Taichung No.4	Kuroishi, Gainobukei Talein, Taichung Yu No.3 Taichung Yu No.4
5	51 —	Mato Grosso Rio Grande	Tokuda, Mato Grosso Rio Grande, Taichung Yu No.1

Fig. 9. Job's tears (*Coix lacryma-jobi*) at fruit-setting stage.

HORTICULTURAL CROPS

Studies on Flower and Pod Distribution Patterns in Bush Bean (*Phaseolus vulgaris* L.)

This study was to determine the spatial and temporal distribution patterns of flowers and pods among five bush bean varieties. In bush beans, the growth habit is determinate when the inflorescene appears, the plant stops growing. On the terminal inflorescence, the first flower opening starts at the bottom of the axis and progresses randomly among each branch nodes. Red Kindey and OSU 5105 had a short and highly concentrated flowering period reaching its

peak of flower production and pod retention in 5 days from the beginning of first flower. PI 101830 and Gold Rush have two peaks of flower production. Black Valentine had a longer and less concentrated flowering period. At 5 or 6 days after blooming, Red Kidney, OSU 5105 and Gold Rush have reached approximately 90% of the accumulated total pod yield, while Black Valentine and PI 101830 were at 9 days after blooming. The pod setting rate for five bush bean varieties was ranged from 24 to 36%. Comparison of pod number and yield at each node, in general, the upper and lowest branch nodes were the prime yield component areas.

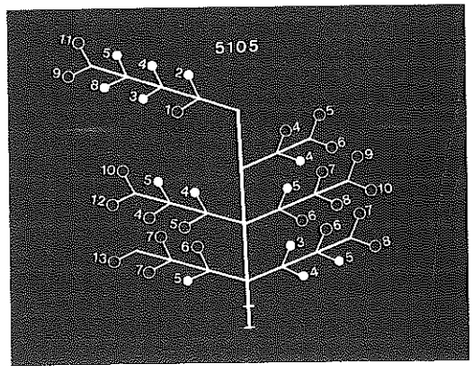

Fig. 10. Diagram of patterns of inflorescence diposition and pod retention of OSU 5105, numerals represent days after anthesis.

Development of New Summer Tomato Variety-Taichung Asveg No. 4

Taichung Asveg No. 4 (TA 4) was tested as "FMTT 22" which was selected by this Station from AVRDC fresh tomato breeding lines, after regional and local yield trials. It was registered and released in July 1989. TA 4 is an indeterminate, very vigorous and moderate spreading fresh tomato variety. Complex in florescence bearing fruit cluster every 3 nodes, each cluster have 8 to 12 flowers. Average fruit-setting rate for fall crop is 84%; for summer crop is 28% and 80 — 89% at lowland and highland areas, respectively. The fruits are deep oblate in shape, with 4 — 5 locules, fruit weight varies between 70 and 150g, fruit wall is 9mm in width. The fruit are medium firmness, sugar content is 5.7 Brix, immature fruit has light green shoulder and ripe fruit is bright red with slight wrinkle on top. Fruits may be cracked in summer crop.

Fruits begin to harvest at 54 — 79 days after transplanting. The harvest period is about 32 — 70 days. Full growth period is 107 — 145 days. The average yield at lowland area for summer and late summer crops are 10 — 24 and 65 t/ha, respectively; for fall crop is 110 t/ha, at highland area for summer crop is 51 — 63.7 t/ha. TA 4 is an F_1 hybrid, heat tolerant, good fruit-setting under high temperature. The planting date at lowland area is from mid-June to March; at highland area is from mid-May to early July. TA 4 is slightly resistant to Fusarium wilt and highly resistant to tomato mosaic virus, high yielding, and is specially adapted for summer production.

Fig. 11. Heat tolerance and tomato mosaic virus resistant fresh tomato variety " Taichung Asveg No. 4 ".

The Effects of Plant Growth Regulators on Budbreak, Flower Development and Fruitset of Grape

The plant growth regulators, plant organic extracts and foliar fertilizers were added to bud forcing agents (such as ethylene chlorohydrin, hydrogen cyanamide and calcium cyanamide), and the observation on the effects of budbreak and primary growth of flower cluster was conducted. The preliminary results showed that cytokinins could promote the development and growth of flower cluster, whereas IBA promoted the elongation of the main and branched axis of the cluster which will save the task on flower and cluster thinning. The addition of both cytokinin and IBA to bud forcing agents could gave an synergetic effect. The addition of plant organic extracts also have budbreak and cluster-growth promotion effects. Many kinds of nutrition compounds, synthetic or natural plant growth regulators were treated to the clusters before and during full bloom, the results are being evaluated.

Fig. 12. Cytokinin and IBA could promote the development and elongation of flower cluster of grape.

Rooting and Propagation of Oriental Pears

This study was conducted to look into the possibility of mass propagation of oriental pears by means of semi-hardwood cuttings.

The results showed that the highest rooting percentage of semi-hardwood cutting in Hengshan pear was those sampled on June and at 4th to 6th nodes, a 60% rooting was reached for those treated with 2000ppm IBA after transplanting in a medium of vermiculite/perlite (1:1). For the hardwood cuttings of Hengshan pear sampled in January, basal dipping with 2500ppm

IBA and then transplanted in vermiculite, a 62% rooting was reached.

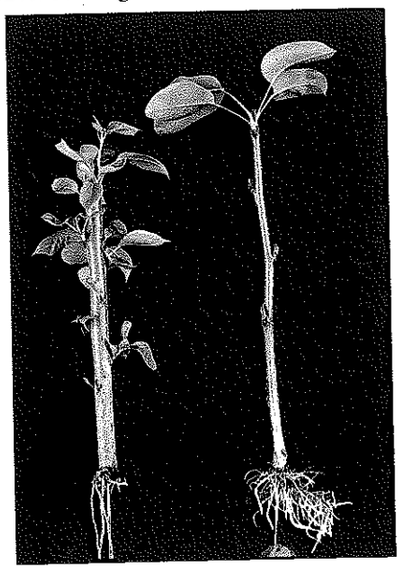

Fig. 13. Rooting of semi-hardwood cutting of Hengshan pear (left) and Liauli (right).

Enhancement of Budbreaking and Germination of Pear by Application of Chemicals

The germination of Liauli (*Pyrus kawakamii* Hay.) seeds was promoted by the treatment of thidiazuron (TDZ), it was increased with the concentration. Seeds treated with 400uM 58% germination is reached after 26 days, while those treated with a mixture of 200uM TDZ and 0.05% hydrogen cyanamide, the germination rate was increased to 69%.

In the other study, 0.5% of hydrogen cyanamide was sprayed on the cuttings of Shinseiki pear at two days interval for 25 days period. The result showed that the highest budbreak rate of 74% was found at 25 days after treatment in those sprayed 3 times.

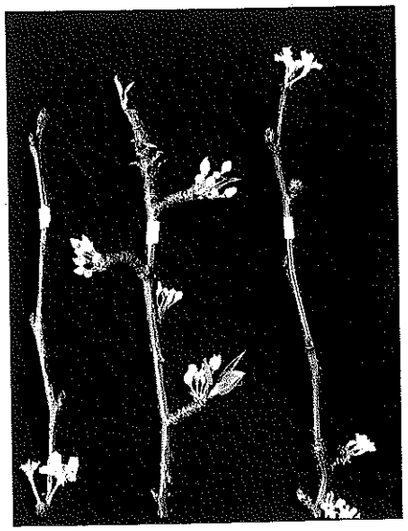

Fig. 14. Application of 0.5% hydrogen cyanamide on cutting of Shinseiki pear could promote the percentage of budbreaking.

Effect of Enclosed Vinyl Tunnel on the Growth of Chrysanthemum Cutting

The growth of chrysanthemum cuttings was compared under the enclosed vinyl tunnel (40 – 60cm in height, 80 – 100cm in width) and the open field condition. Sand bed was used in both condition of this experiment, and the light was adjusted to be 40% of light intensity by shading in the winter.

The temperature was 10 – 26 °C in the vinyl tunnel, and 10 – 24 °C in the open field. The relative humidity increased to 85 – 97% and very stable in enclosed vinyl tunnel. But, it was very unstable under open field, that was 40% at noon and 90% in the night.

It was observed that water content of cutting's leaves was 90% or more in the tunnel, but only 88% or less in the field. Wilting phenomenon occurred in the early stage in the field, especially in the afternoon when RH was low. Enclosed vinyl tunnel method was found to enhance rooting ability in the winter. Rooting percentage was as high as 98% 15 days after planting in tunnel, but only 50% in the field. The rooting initiation was promoted 2 days earlier under the vinyl tunnel condition in comparison with that in the open field.

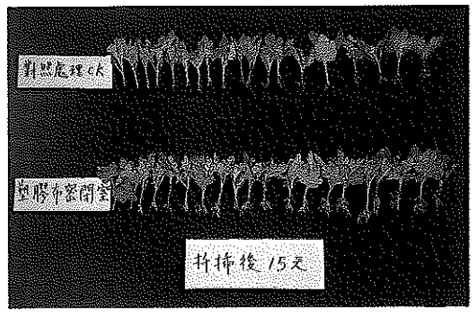

Fig. 15. Comparison of rooting at different environment for chrysanthemum cutting in the winter. Outdoors (above); Vinyl tunnel (bottom).

A Study on Raising Chrysanthemum Seedlings by Hydroponic Culture

The feasibility of raising seedlings of chrysanthemum by hydroponic method was studied. Under the greenhouse hydroponic culture condition, the number of seedlings per 1 m^2 could be increased as many as 200. The survival rate of seedlings reached 100% and days to rooting was significantly reduced. Under the hydroponic condition very few incidence of basal stem rots and aphid infections occurred. It was observed that the seedlings raised by this method sustained less injury after the transplantation, and showed a large growth vigour. The establishment of seedlings by hydroponic method is more stable and quicker than sand culture. Therefore, it is considered to have a practical value for application.

Fig. 16. Vigorous rooting system of chrysanthemum cutting by hydroponic culture.

PROTECTED HORTICULTURE

Effects of Wave-length Selective Plastic Film on Protected Vege -table Culture

The different light wavelength selective plastic films were used as the roof covering material of pipehouse to study their effect on vegetable growth and insect pest population inside the house. A significant increase in plant height, fresh weight, leaf number, fruit number and fruit weight occurred in UV-light cut film treatment. A significant decline in insect pest population of cabbage webworm (*Hellula undalis* Fabricius), diamond back moth (*Plutalla xylostella*

Linne), stripped flea beetle (*Phyllotreta striolata* Fab.) or turnip aphid (*Brevicoryne brassicae* Linne) occurred under UV-light cut film covered house on edible herb vegetables. The population of thrips (*Thrips palmi* Karny), tea mite (*Polyphago tarsonemus* latus (Bank)) and tomato fruit moth (*Spodoptera litura* (Fabricius)) was also decreased on sweet pepper plant. As for strawberry, the plant growth vigor was not affected by the cover of UV-light cut film. The occurrence of two spotted mite (*Tetranychus urticae* Kock), spider mite (*Tetranychus kanzawai* Kiskida), cotton aphid (*Aphis gossypii* Glover) and white fly (*Trialeurodes vaporariorum* (Westwood)) decreased considerably.

Fig. 17. The insect pest population declined inside the pipehouse covered with wave-length selective plastic film.

Studies on the Year-round Production of Tomato Using DRF Hydroponic Culture System

The possibility of year-round production of tomato was evaluated by using self-designed dynamic root floating (DRF) hydroponic culture system. Eight tomato cultivars with four kinds of cultural method were involved in this study. Eight tomato cultivars were KY2301, KY658, Sen-Li, Lien-Duo, FMTT-22, TN-3, FL-8452 and FL-TV274. The yield responses were compared to tomato plants receiving: (a) pinched to be one major vine and without pruning, (b) pinched to be two major branch vines and without pruning, (c) pruned to be three clusters, (d) pruned to be one major vine and without pruning and grown in rockwool. The greatest fruit yield performance occurred in treatment (a), and the lowest was in treatment (d). The drastical decrease in numbers of fruit set and fruit yield were generally occurred as the growth period approached to the hot summer. The pollination efficiency of the early 3-cluster flowers in TN-3 seemed insensitive to the high temperature, then obtained 2-crop yield potential during the hot summer. Therefore, a 3-crop of year-round tomato production pattern is suggested to grow tomato by treatment (a) from November to the next April and following by 2 successive croppings with treatment (d) during the hot summer.

Fig. 18. Year-round production of tomato using DRF hydroponic culture system.

Studies on Year-round Production of Lettuce Using DRF Hydroponic Culture System

The possibility of year-round production of lettuce was evaluated by using hydroponic culture method. Two lettuce cultivars with two hydroponic culture systems were involved in a 2-year experiment. The two lettuce cultivars were crisp lettuce and butterhead lettuce. The efficiency of self-designed dynamic root floating (DRF) system was compared with the Japanese Shinwa equivalent exchange (SEE) system. Seedlings were transplanted at every first day of each month. The results indicated that the horticultural characters such as the fresh head weight, plant height, leaf number and heading rate were superior in DRF system to those in SEE system. The 100% heading rate in crisp lettuce was obtained from October to March, then was dramatically decreased from September to April to 60% in DRF system and 30 — 40% in SEE system, and 0% in these two system from May to August. The seasonal performance of butterhead lettuce was also fluctuated. The better yield performance was observed from September to April. The high night temperature related to the less heading performance was proved to be the limiting factor in this experiment.

Fig. 19. Year-round production of lettuce by hydroponic culture.

PLANT PROTECTION

Investigation on the Population Fluctuations of Pea Thrips

There are two species of pea thrips which feed on peas, i.e., *Frankliniella intonsa T.* and *Gynaihothips ficorum* (Marchal). Population density ratio of these two thrips in the field was 2.71:1. Damage of pea plants by *F. intonsa* started to appear at 20 and 40 days after sowing for summer and winter crops, respectively. The population of this thrip reached its peak at 55 — 60 days after sowing when the pea plants were ready for the first harvesting. Among the cultivars tested, Taichung 11 had the highest population of *F. intonsa* while Taichung 13 had the lowest. More thrips were found on the pods than on

other parts of the plant. *G. ficorum* occurrence on pea plants began at 40～50 days after sowing for both summer and winter crops. Its population density reached its peak at the beginning of harvest. The population of *G. ficorum* was the highest on cultivar Taichung 12 and lowest on Taichung 13. And more thrips were found on the young leaves and flowers than other parts of the plant. Higher population density of these thrips was observed on winter crop than on summer crop. Cultural methods did not result in different infestation of pea plants by these thrips.

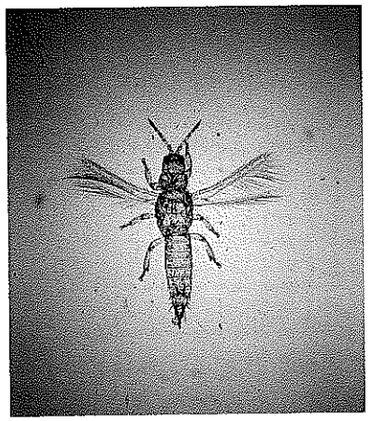

Fig. 20. Pea thrips (*Frankliniella intonsa*), a major insect pests in winter pea production.

Studies on Pathogenic Specialization of *Uromyces phaseoli* and Evaluation of Rust Resistance in Snap Bean

The purpose of this study is to identify the pathogenic specialization of *Uromyces phaseoli* in snap beans in Taiwan. Nineteen rust differential varieties from USDA identical to those from the International Snap Bean Rust Nursery have been used. Cultivar Taichung 1, Black creaseback, Thailand and Kentucky Wonder (local) were also used.

Rust urediospores of 8, 6 and 9 races were respectively collected from snap bean plants in the field of Shinshe, Shanhua and Pingtung. The races isolated from Shinshe and Pingtung were proved to be immune to the new cultivar "Taichung 1" with the exception of the race T－17 from Pingtung which caused the moderately susceptible. The various races gave cultivar "Black creaseback" a broad range of susceptibility. The cultivar "Thailand" showed nearly identical reaction to the rust race of "Kentucky wonder". It showed the same reaction to all isolates indicating that this local variety is very susceptible to rust disease.

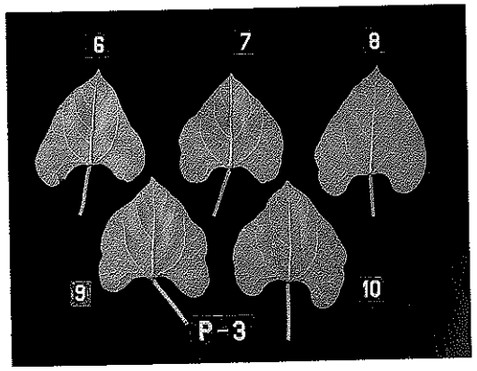

Fig. 21. Reactions of differential snap bean cultivars to specific race of *Uromyces phaseoli* "P－3".

The Control Threshold and Damage of Rice Borer

Three rice borers increased gradually in recent years in central Taiwan.

Scirpophaga incertulas occurred only along the Tachia river. Control is negligent and cause 5－8% yield lost. The occurrence of *Sesamia infereus* is very popular, but the population density is not very high. *S. inferus* can damage the mid-crop and late crop with the *Chilo suppresalis* and cause the white heart and white head. There are significant differences between rice varieties, but Tainung 67 is the most seriously damaged. The control threshold is determinted when the dead heart rate has reached 6% and control is needed. The yellowish rate of leaf sheath is 10－15% can cause about 6% dead heart. The chemical spraying at 15－20 days after transplanting, and 2－3 instar larvae stage have effective control. The utilization of the sex pheromone to attract male *Chilo suppresalis*, had good effectiveness and attract more insects than those of light trap.

Fig. 22. Yellowish symptoms of rice leaf sheath caused by *Chilo suppresalis.*

Studies on the Zucchini Yellow Mosaic Virus Transmitted by Aphids

The objectives of this experiment was to determine the aphid species and their efficiency to transmit ZYMV on cucurbita crops. Aphids that occurred in the field were collected and reared on their original host plants under control conditions (24 ± 1 ℃). The tested aphids species including *Myzus persicae* Sulzer, *Aphis gossypii* Glover, *Rhopalosiphum maidis* Fitch, *R. padi* Linnaeus, *Lipaphis erysimi* Laltenbach, *Hysteroneura setariae* Thomas, *A. craccivora* Koch, *Schizaphis rotundiventris* Signoret, *A. citricola* (van der goot) were reared on the healthy tobacco, pumpkin, barn yard grass, sorghum, cabbage, goosegrass, asparagus bean and nut grass, respectively, for several generations and the apterous adults were used as experimental source. The tested aphids were pre-starved 2 hr and then allowed to feed on the infected zucchini plants for another 2 hr. After acquisition, aphids were confined singly or in a certain number with clip-on cages on the 3th to 4th leaf stage of healthy zucchini plant for 2 hr and then eliminated. Each aphid species applied to transimission test were 1, 5, 10 and 20 individuals and each number treatment was confined to 20 test plants, and with 5 plants feeding by non-acquisition aphids were served as control. The results indicated 5 of 9 species of the test aphids could transmit ZYMV. They were *M. persicae, A. gossypii, H. setariae, A. craccivora* and *A. citricota.* Whereas, *R. maidis, R. padi, L. erysimi, S. rotundiventris* failed to transmit ZYMV. When 1, 5, 10 and 20 individuals of *M. persicae* for inoculation, the infection rate were 20, 55, 85 and 100%, respectively. When the inoculated number of *H. setarive* were 1, 5, 10 individuals, the infection rate were 12.5, 26 and 25%, respectively.

The inoculated number of *A. gossypii* were 1, 5, 10 or 20 individuals, the infection rate were 0, 0, 25 and 100%, respecitvely. The inoculated number of *A. craccivora* were 1, 5, 10 and 20, the infection rate were 0, 20, 50 and 70%, respectively. When the *A. citricola* inoculated with 1 insect, the infection rate was 30%. All control had no symptom expressed.

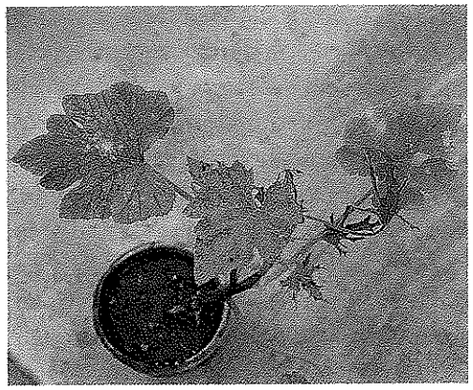

Fig. 23. Chlorotic symptoms caused by zucchini yellow mosaic virus.

Investigation of Leguminous Vegetables Damaged by *Ostrinia furnacalis* in Taichung Area

Results of field survey showed asparagus bean was the most seriously attacked by *O. furnacalis* with an average density of 5.25 insects/m^2, light infection in lima bean, vegetable soybean and peas with a density of 0.21, 0.06 and 0.12 insects/m^2, respectively. However, snap bean and hyacinth bean were not found to be attacked. In different locations, *O. furnacalis* was damaged asparagus bean with higher density in Changhua county with 3.4 to 9.6 insects/m^2 (13.8 to 56.8% infected plants) higher than in cool area, e. g. Hsinshe and Hsinyi with density of 0.6 and 0.3 insect/m^2, respectively. A further investigation carried out to evaluate the servity of infection caused by *O. furnacalis* at 80 to 100 days after planting (podding stage) in different parts of the asparagus bean shown the infected percentage of main stem, branch stem, offspring stem and offspring branch stem, fruit pedicel and bean pod were 5.0, 3.7, 15.8, 11.2, 1.2 and 0.3%, respectively. Apparently, the offspring and offspring stem were being highly attacked and that might contribute to it just at suitable stage for infection of the leaves during the survey period. The *O. furnacalis* usually penetrated the young bud of stem with the 2nd to 4th instar larvae and then fed along the inner stem with a length about 6 — 10 cm, and then pupated or transfered to feed other stem. In general, only one larva could be found in one stem, some of the infected stem recover their growth about 10 — 15 days after infection and regrowth gall were formed around the infected hole. Primary survey showed that *O. furnacalis* attacked the legume vegetables has no relation to the culture of corn at adjacent area. The *O. furnacalis* collected from corn could complete their life cycle in asparagus bean. But, the insect collected from corn were larger than collected from the asparagus bean. Using the pheromone of *O. furnacallis* which adapted in corn culture area were available for collecting the adults of the same insect in bean field. All these primary evidences suggested that the *O. furnacalis* attacked to both legume crops and corn are a unique species.

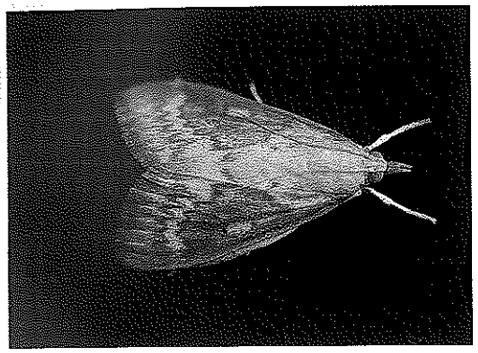

Fig. 24. Adult of *Ostrinia furnacalis,* a major pest on legume crops.

Ecology and Chemical Control of *Oebia undalis* Fab.

Oebia undalis, a major pest of cruciferous vegetables, mainly radish, paitsai, cabbage, cauliflower and mustard, attacks at the early stage of these plants. The larvae feed on seedlings and may destroyed the plants. In the summer, such a damage often results in the infection of radish by soft rot. Damage of plants by the larvae in the field peaked in July/August and October, and up to 90% of the plants were damaged in one way or another. Egg stage lasted for 3 ~ 4 days, larval stage 11 ~ 14 days, pupal stage 5 ~ 6 days, and adult stage 4 ~ 5 days with a generation time of 24 ~ 29 days when *O. undalis* was reared on radish leaves in the laboratory at 28 ~ 30°C. The sex ratio (female/male) was 2: 1 and each female could lay 76 ~ 227 eggs. The eggs were either laid singly or in mass near the veins on both sides of the young leaves or on petioles. The young larvae bored into the underside of the leaves and after the second moulting, the larvae left the leaves and got into and stayed at the growing point of the plant. Mature larvae then migrated to the ground and pupated in the soil 0.5 ~ 1.5 cm near the surface. Dursban, Pada and Cidial were found effective against *O. undalis.*

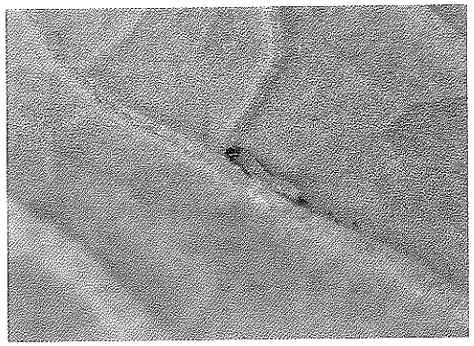

Fig. 25. Larva of *Oebia undalis* Fab. feeding on cabbage leaf.

Distribution of *Liriomyza trifolii* in Taichung Area

Liriomyza trifolii was first found on gerbera at Takung, Taichung city. This Station make the follow-up investigation on gerbera, chrysanthemum, leguminous, solanaceae and cucurbita vegetable crops, which is growing at Taichung district. The yellow sticky plate was used to trap the distribution of field population of *L. trifolii.* The first survey at June, 1988 found that there was 1.6% of sticky plate have adult insects. Infected crops included gerbera, chrysanthemum, tomato, asparagus bean and pumpkin. Infected areas included: Shinshe, Tungshi, Peitun. The second survey at January, 1989 found that there was 4.8% ofsticky plate

had adult insects. The new infected crops are eggplant, pea, dahlia and potato. The new infected areas are Tantzu, Taipin, Houli, Tanwei, Yangchin, Hsichou and Shetou. An emergency control program was initiated by PDAF that using the chemicals spraying, as Taizophos, Trigard and remove the infected leaves. The average number of insects on each plate have reduced from 303 to 50 in Changhua, and from 747 to 7.4 in Taichung city. The third survey in June, 1989 found that 1.5% of gerbera have infected by *L. trifolii.* The new infected location was Peitou and extented to Puli. The total infected areas are from the initial 2 ha. to all around the Taichung district.

Fig. 26. Gerbera leaf, showing serpentine tunnels made by larvae of *Liriomyza trifolii.*

SOIL AND FERTILIZER

Effects of Green Manure on the Growth of Spring Sorghum

The field experiments of various treatments of green manures, milk vetch (*Astragalus sinecus* L.), Berseem clover (*Trifolium alexandrinum*), rape (*Brassica campestris* L.), and Berseem clover with lime were conducted to study the effects of green manures on the growth and grain yield of spring sorghum "Taichung 5" and soil fertility. The results were summarized as following: In both acid and alkaline soils, the average fresh weight of incorporated Berseem clover was 16.8 t/ha, which was higher than that of milk vetch and rape. The grain yield of sorghum in the treatment of incorporated Berseem clover was the highest, and the mean increased rate was 16.4% in two years' results. In the treatment of Berseem clover with lime (applying lime two weeks before planting Berseem clover) in acid soil, the average fresh weight of Berseem clover was 22.5 t/ha, which was 43.3% higher than that of check. This treatment also had the highest grain yield of sorghum, and its mean increased rate was 24.2%. By multiple regression analysis, the relation between the grain yield of sorghum and the fresh weight of Berseem clover was statistically significant. The application of green manure could increase the soil organic matter slightly and could alleviate the soil pH decreasing rate.

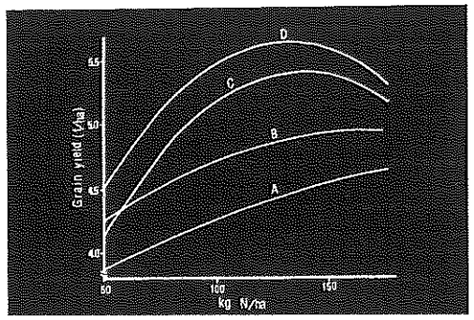

Fig. 27. Relationship between the grain yield of spring sorghum and amount of nitrogen from different green manures.
A: check, B: Berseem clover,
C: lime,
D: Berseem clover + lime.

Effects of Different Organic Manures on the Yield and Quality of Grapes

The purpose of this study was to compare the effects of organic manures on the yield and qualities of Kyoho grapes. Nine treatments including chicken manure, hog manure, rice bran, peanut cake, soybean cake, rice straw, bark compost, humic acid plus chemical fertilizer and chemical fertilizer, which used as a control were layed out in a randomized complete block design. The result indicated that the hog manure treatment showed a little higher grape yield, where soybean cake, bark compost and rice straw compost treatments were the next. Rice straw compost treatment showed the highest sugar content of fruit juice, and chicken manure, rice bran and humic acid plus chemical fertilizer treatments followed, and there were very significant difference between rice straw compost treatment and peanut cake and soybean cake treatment.

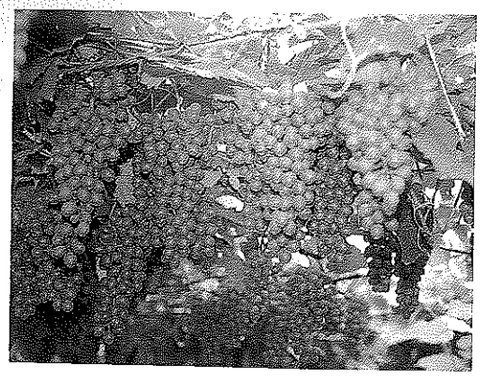

Fig. 28. Yield and quality of grape is increased by the application of organic manures.

A Survey on the Inorganic Nutrient Contents in the Different Kinds of Organic Wastes in Taiwan

This survey was to study the inorganic nutrient contents in the different kinds of organic wastes commonly used or available in Taiwan. The results showed that the nutrient elements in the straws or stalks of the gramineous plants were low. Generally, it had 0.5 – 1.0% of nitrogen, 0.1 – 0.3% of phosphorus, 0.6 – 1.0% of potassium, 0.2 – 0.4% of calcium, 0.1 – 0.2% of magnesium, and 3 – 14% of silica.

Most of the mushroom compost had very low potassium, but they still had 0.5 – 1% of nitrogen, 0.3 – 0.9% of phosphorus, 1 – 4% of calcium, and 0.2 – 0.5% of magnesium. Common compost with 1 – 1.8% of nitrogen, 0.2 – 0.5% of phosphorus, 1 – 2% of potassium, and high fibrous material and low heavy metal contents is the most ideal manure for the improvement of soil physical, chemical and biological properties. The leguminous manure crops usually containing 1.5 – 3% of nitrogen is an important source of natural nitrogen.

With 0.1 – 0.4% of nitrogen, 0.05 – 0.2% of phosphorus, 0.3 – 0.5% of potassium, 0.5 – 3.0% of calcium, 0.2 – 0.5% of magnesium, and some trace elements and fibrous material, gabage compost is still useful for the improvement of the soil, however one should be careful to its higher content of heavy metal such as copper, nickel, chromium,

cadmium, and lead etc. in some samples.

The manure of milk cow with 1.0 — 1.7% of nitrogen, 0.5 — 0.6% of phosphorus, 1.0 — 1.5% of potassium, 1.3 — 1.5% of calcium, and 0.6 — 0.7% of magnesium, and lower heavy metal, was similar to common compost in its nutrient content, and therefore is considerable to be a good compost, however proper addition of phosphorus from other sources is necessary due to the insufficient content of phosphorus in this compost. Hog manure was slightly higher than cattle manure in nutrient contents. Generally, it had 1.0 — 2.5% of nitrogen, 1.0 — 2.5% of phosphorus, 0.7 — 1.3% of potassium, 3.0 — 7.0% of calcium, and 0.6 — 1.0% of magnesium, with especially higher concentration on copper that is easy to cause toxicity to the plants. Chicken (leghorn) manure, with 2.0 — 2.8% of nitrogen, 2.0 — 3.5% of phosphorus, 2.0 — 3.0% of potassium, 1.4 — 17% of calcium, and 0.8 — 1.2% of magnesium, had the highest nutrient contents among the three animal wastes investigated. However it had the disadvantages of low fibrous material and possible contamination by antibiotics.

Rice bran with 1.9% of phosphorus is an important source of organic phosphorus. Peanut, soybean and most other oil cakes usually having more than 4% of nitrogen are an important source of organic nitrogen. However, applying excessive rate on these material to the soil should be discouraged due to their low carbon or fibrous material.

Fig. 29. The composition of organic manure, sorghum straws, chicken manure and rice straws.

Effects of Nitrogen Fertilizers and Storage Conditions on the Inorganic Nitrogen Content of *Brassica chinensis* L.

This experiment was conducted to investigate the relationship between inorganic nitrogen content, nitrogen fertilizers and storage conditions of Pak-chai (*Brassica chinensis* L. var. Pak-chai). The results showed that under experimental soil conditions (contained 70.2 mg/100g NO_3, 2.33% organic matter), the yield of Pak-chai was not affected by the application of NO_3-N, NH_4-N, or urea-N at different rates. The nitrate content of Pak-chai significantly different in different nitrogen fertilizers at various rates. There was a tendency that the treatment of NH_4-N showed higher nitrate content in leaf, then followed by NO_3-N and urea-N. The tendency was similar for 3 types of fertilizer that nitrate content increased as rate of fertilizer increased. The peak of nitrate content reached at 624 g/g fr. wt. by NH_4-N at the rate of 160 kg/ha. The activity of nitrate reductase had similar tendency that it was increase as rate of fertilizer increased and reached to the peak at 1.231 mole NO_3/g fr. wt./hr. Comparing the nitrate content of Pak-chai storaged at lab and refrigerator showed that the treatment of Pak-chai stored by plastic bag in refrigerator had the lowest content of nitrate that was 544 g/g fr. wt. less than those stored at lab condition.

Effects of Humic Acid and P, K Fertilizers on the Quality and Yield of Loquat

This field experiment was conducted with humic acid, P and K fertilizers at a loquat orchard of red soil in Hsinshe, Taichung. The results showed that application of humic acid reduced soil bulk density and hardness, and increased the availability of P, K, Ca, Mg and nitrate contents in soil profile from 0 to 40 cm, but no difference below 40 cm. The application of humic acid also increased the yield and sugar contents of loquat. Furthermore, the sugar contents of fruit was increased significantly by the application of P-fertilizer. The yield of loquat was closely related to K-fertilizer, and no relationship between fruit quality with K-fertilizer. As far as both P and K fertilizers were concerned, the maximum yield and quality of loquat could be obtained with the treatment of 300 kg/ha of P_2O_5 and 450 kg/ha of K_2O_2.

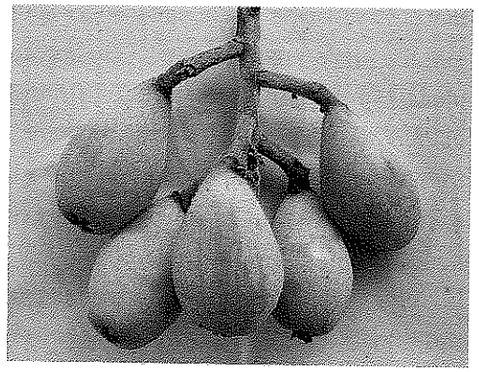

Fig. 30. The proper application of humic acid and P-fertilizer could increase the sugar content of loquat.

The Development of Hydroponic Seeders for Polyfoam Seedbed

In order to overcome the slow sowing efficiency problem, two prototype hydroponic seeders, the push-rod type and the press blade type were developed. The push-rod type uses a push-rod set to push the seeds into the sponge and deposit the seeds in an acceptable position. The press-blade type uses a plastic press-blade to force the cross-cutting of the sponge open and let the seeds drop into the holes. The results of the sowing depth experiment showed that the sowing depth should be 1/2 depth of the sponge height for big seeds and 1/3 depth for small seeds. The sowing rate of push-rod type seeder is over 85% and germination rate is about 60%. Its sowing ability is about 50 — 60 sec/pad. Since the precision problem sometimes causes the very small seeds crashed be-

tween the push-rod and the hole wall, the push-rod type is not suitable for sowing the very small seeds. The press-blade type seeder uses the same press-blade for different seed sizes but needs to change different sowing plates for each condition. Its sowing ability is about 20 — 30 sec/pad and sowing rate is about 85 — 90%. A shortcoming of this type is that the sowing depth is very hard to control.

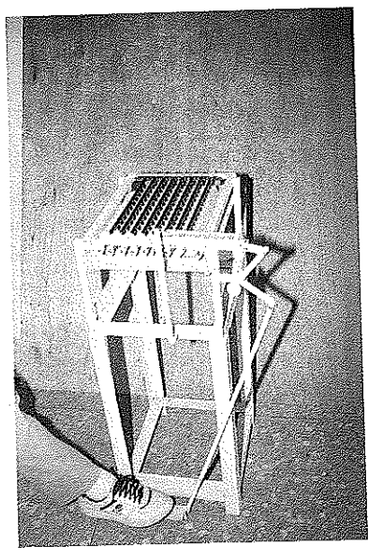

Fig. 31. Hydroponic seeder for polyfoam seedbed.

HOME ECONOMICS

A Case Study on the Farmer's Life Style and Dietary Habits of the Hyperuricemia Patients and Their Recognition on the Symptom of Grouty Arthritis

The life style and dietary habits of the hyperuricemia patients and their awareness on its relationship with the grouty arthritis disease were surveyed in a case study. A total of 59 Tungshih farmers suffering from hyperuricemia disease were chosen and interviewed according to a set of questionnaire. The physical data of the patients were based on the physical examination conducted by the Farmer's Hospital of Tungshih Farmer's Association on August 1986. Results of survey indicated that a half of the patients felt tired on their house-works, and 40% of them felt living under the high pressure and nervous conditions. It was unfortunately found from the interview that the high purine foods such as mushroom, small fishes, terapia, seaweed and gravy etc. were still very popular in the patient's daily diet. The majority of the patients did not have any idea on the relationship between the dietary habits and hyperuricemia disease. Moreover, they knew nothing about the relationship between the symptoms of grouty arthritis and hyperuricemia. The patients did not know that the symptom of grouty arthritis could be reduced by taking the controlled diet. It was concluded from this study that more education in these respects is necessary for farmers.

Studeis on the Farm Family Expenditure Status in Yuanlin Area

The annual home expenditure status of farm families was surveyed in a case study. A total of 18 farm families in Yuaniln area were chosen and interviewed according to a set of questionnaire. The results indicated that the average income of the farm families in Yuanlin area was NT$381,409, which was about 25.68% higher than the average income of farm families of Taiwan province, and about 8.38% lower than the average income of non-farm family of Taiwan province. The per capital income of farm families in Yuanlin area was NT$64,755, which was about 95.27% and 69.16% of the per capital income of farm families and non-farm families of Taiwan province, respectively. The average expenditure of farm families was NT$237,564, which was about 107.29% in comparison with the average expenditure of farm families in Taiwan province. The per capital expenditure of farm families was NT$40,333, which was about 92.51% compared with the per capital expenditure of farm families of Taiwan province. The majorities of expenditure were spent for food, followed by the costs of social relationship, water and electricity, fuel and tuition fee etc. The high percentage of tuition fee in expenditure indicated that the education for the next generation was emphasized by rural family. It was also found that the rural families spent more money on social relationship than health care or recreation. The expenditure on those items tended to increase when the education level of the member of the families was higher.

AGRICULTURAL ECONOMICS

Analysis of Production Cost and Revenue for Cut-flowers Cultivated under Protected Structure in Taiwan

This study was aimed to analyze the production cost and revenue of cut-flowers (baby's breath, carnation, gerbera and lily) under the protected structure condition in Taiwan. The following results were obtained:

1. In average, the production cost of fall lily cultured under structure was the highest among the four cut-flowers surveyed. However, the revenue was the highest too. Gross revenue for baby's breath was the lowest, but due to the lowest production cost, its profit was higher than those of carnation and spring lily.
2. The similar production cost for baby's breath was observed in various areas. However, its revenue in Changhua county was the highest. Labour, materials, seed and facility depreciation were the four major items of production cost. For carnation flower, gross revenue and production cost in Nantou county were the highest. Profit for grown carnation flower in Changhua county was the highest among the area surveyed. The cost of seed was identified to be the major production cost, followed by the costs of labour, materials and facility depreciation. As for gerbera flower, the similar production cost and revenue were recorded in Changhua and Nan-

tou counties. The labour was found to be most costy in the production of gerbera flower, followed by seed, materials and facility depreciation.

3. Generally speaking, the pay-back period of facility investment was short for baby's breath, carnation and gerbera, which was within one or two years. Especially for gerbera, the pay-back period would be only 1.2 years, even the interest was considered.

Analysis of Production and Management Cost for Hydroponic Vegetable Farm – A Case Study

One of the very successful hydroponic vegetable farm was selected to analyze its management, achievement and the economy of investment as a case study.

It was found that the first and second production costs were estimated to be NT$39.2/Kg and NT$42.9/Kg, respectively, with a structure area of 2,000m^2. The first and second production costs were reduced to NT$32.7/Kg and NT$35.9/Kg, when the structure area enlarged from original size to 4,850m^2. Depreciation and labor costs were the major inputs among the production costs, then followed by the costs of marketing and interests. The farming incomes were fairly good regardless of the enlargement of farm scale or not. The profit/ratio was raised to 20.3% for the enlarged farm size, in comparison with 4.6% of original sized farm.

It was also found that the actual investment was higher than the investment margin under the condition of 2,000m^2 structure area, 12% annual interest rate and 5-years facilitated life time, then it became an unreasonable agricultural investment. On the other hand, the actual investment would be lower than the investment margin with 5% annual interest rate and 8-years facilitated life time. This kind of investment could be considered a reasonable one. If the structure area was enlarged from 2,000m^2 to 4,850m^2, the investment would always be reasonable regardless of both interest rate and facilitated life time. Generally speaking, the investment of studied farm was reasonable regardless of before or after enlargement on the farming scale. However, the efficiency of investment was higher and the pay-back period of investment was shorter, when the farming scale was enlarged.

Analysis on the Cultivated Patterns and Revenues of Pea Production in Taichung Area

There are two methods of pea production in Taiwan, i.e, the non-tillage and trellis cultivation. For the non-tillage cultivation, a total of 55 farm families in Fusin, Tatsuen, Puyen, Chihu and Showshui were surveyed. It was found that the average yield per hectare was 8,245 Kg; the gross revenue was NT$221,034; the production cost was NT$187,193; the profit was NT$33,841; the returns of family labor was NT$134,299; the farm earning was NT$143,765. For the type of trellis cultivation, a total of 57 farm families in Hsinyi, Hsinshe, Erhlin and Chihu were surveyed. It was found that the yield per hectare was 9,505 Kg; the gross revenue was NT$514,980; the production cost was NT$339,875; the profit was NT$175,105; the returns of family labor was NT$357,106; the farm family earnings was NT$266,029.

ACTIVITIES OF AGRICULTURAL EXTENSIONS IN 1989

Guidance of Farmer's Associations Agricultural Extension Works

For strengthening the agricultural extension activities, a total of 3,621 study groups with 37,898 participants (Table 5) had been organized by the local Farmer's Associations (FAs) through the assistance of this station. This included 1,841 agricultural study groups (with 20,206 participating farmers), 265 4-H club groups (with 2,037 rural youths), and 1,515 home economic groups (with 15,385 participating farm housewives). In cooperation with the local FAs, a total of 22,209 agricultural extension programs (Table 6) had been carried out and with 1,040,350 participating farmers. This station assisted the FAs to carry out activities of training courses, 4-H club and home economics, planning of crop production, marketing of farm products and improving living environments, etc. The amount of money (Table 7) used for extension works by 60 township level FAs and 4 county level FAs in 1989 totaled NT$461 millions with an increase of 20% compared with last year.

Table 5. The grouping for the 80,000 core farmers program in Taichung area.

County City&	Agriculture		Home economic		4 – H club		Total	
	groups	persons	groups	persons	groups	persons	groups	persons
Taichung City	48	360	44	339	13	124	105	823
Taichung County	491	5,123	323	3,158	96	730	910	9,011
Changhua County	795	8,802	720	7,668	79	715	1,603	17,185
Nantou County	507	5,921	419	4,220	77	738	1,003	10,879
Total	1,841	20,206	1,515	15,385	265	2,307	3,621	37,898

Table 6. The accomplishmemts of agricultural extension education of FAs in Taichung area for 1989.

Program	Agricultural extension	4 – H extension	Home economic extension	Total
No. of extension programs	9,833	5,843	6,583	22,209
No. of interviewed household	141,855	47,009	64,883	253,747
No. of participating trainees	100,417	63,546	90,904	254,057
No. of participants of meeting	104,577	21,514	44,015	170,106
No. of persons participated extension activities	156,445	69,685	136,310	362,440
No. of extension agents	327	80	82	489
No. of groups	4,820	1,679	693	7,192
Total members	28,238	16,420	22,564	67,220

Table 7. The amount of expense for agricultural extension and number of FA's members in Taichung areas.

County & City	Farmer's Associations	Full members	Associated members	Business profit	Expense for agri. extension
Taichung County	21	62,051	44,676	374,076	175,322
Taichung City	1	11,734	14,003	26,608	16,497
Changhua County	26	111,126	24,968	335,101	168,510
Nantou County	13	62,869	19,343	243,693	100,298
Total	61	247,780	102,989	979,478	460,627

Fig. 32. Agricultural consultant service meeting for flower growers.

Activities of Farmer's Services Center

For strengthening the farmer's services, a special telephone (04-527455) and a Fax machine (04-8525841) had been additionally installed in the Farmer's Service Center of this Station this year. A total of 476 farmer's letters had been answered. A total of 175,200 extension bulletins and 74 lots of seeds requested had been sent out. A total of 4,382 soil samples sent by the farmers were analyzed and the results of the soil analyses were sent back to the respective farmers for their use in crop production. A total of 1,919 field demonstrations were held to introduce the new production technologies and varieties to the farmers. This year, a total of six consultation meetings on grape production, rice production, floriculture etc. were organized. Each meeting was attended by about 100 farmers. The questions raised by the farmers were answered by subject matter specialists. The records of each meeting were printed as the extension bulletins and were distributed to the interested farmers. This year we had a total of 12,293 visitors including 813 foreign guests.

Agricultural Training

The "on the job training" is a program designed to promote the professional skill and to update the technological knowhow for extension workers of the farmer's associations. This year, a total of 732 extension workers received this training at the Training Center of this Station.

Subject Matter Training Course for the Rural Youth was held to transfer the new production technologies developed by the Station to the young farmers. The courses included hydroponic culture, protected horticulture, floriculture, high quality rice production etc. A certificate was given to each participant who finished their required hours of courses. With that certificate of training the young farmers were entitled to loan the money at a maximum of 3 million NT dollars from the government so that they can start their new farms. A total of 83 rural youth finished this type of training this year.

The farmer's associations in Taichung district organized the training courses at various places. A total of 578 persons (counted based on attendances) from this Station served as the teachers of these training courses.

Table 8. Activities of agricultural training center in 1989.

Training activities	Classes	Trainees
On the job training	18	732
Special subjects training	3	83
Co-organized training	578	26,311

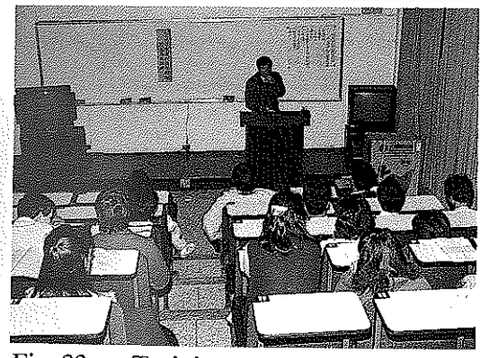

Fig. 33. Training course on protective horticulture for rural youths.

Agricultural Mass Communication

The published materials of this station had been widely distributed. A total of 100,000 copies of "Taichung Agricultural Extension Newsletters" (Quarterly), 12,000 copies of "Taichung Agricultural Extension Bulletins" (Monthly) and "Taichung DAIS Weekly News" had been published and sent directly to farmers and related persons this year. In cooperation with TV and radio stations as well as newspapers, the station delivered 65 video tapes, 61 radio tapes and 42 newspaper informations to news media for broadcasting (Table 9).

Table 9. Agricultural information delivered to news media.

Media	News released
Video	65
Radio	61
Newspaper	42

Fig. 34. Video tapes of agricultural knowledge and information are available for rent or copy.

Integrated Rural Development and Home Economic Extension

The major activities (Table 10) of home economic extension have been emphasized on both the rural community development and living environmental improvement with the cooperation of home economic specialists of FAs. A total of 556 farm families in Taichung area were chosen and guided to improve their living environment as the demonstration families. And a total of 17 villages were selected to improve the garbage handling

and instructed them to prepare home-make compost. In addition, guidance to the rural family development and the resources management were also provided to 32 farm families by helping them to keep consumption records for further data analysis. Those farm families were guided to improve their expenditure structure and to strengthen their budget management. Generally speaking, the rural family function and moral education can be strengthened through parental education, harmonious marriage and mutual communication by the programs metioned above.

Table 10. The accomplishment of home economic extension of Taichung areas in 1989.

County & City	Environmental improvement (families)	Garbage handling (villages)	Family development (families)
Taichung County	236	11	11
Changhua County	200	4	10
Nantou County	110	2	10
Taichung City	10	-	1
Total	556	17	32