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REPORT OF TAICHUNG DISTRICT AGRICULTURAL IMPROVEMENT STATION FOR THE YEARS 1976-1986

CONTENTS

PREFACE

The results of the research activities conducted in this Station in the past ten years are briefly reviewed in this report. In the past years, our effort had been mainly directed toward researches in the field of improvement of rice, sorghum, wheat, buck wheat, barley, vegetables, fruit trees and other crops. Other fields of studies such as plant protection, soil, fertilizer, plant nutrition, agricultural machinery, agricultural extension education and home economics etc. had also been carried out.

Since many old problems solved in the past always lead us to many new ones, our research activities in these fields have gained plain sailing in recent years. A number of original papers, mostly written in Chinese, had been successively published either in the research bulletin of this Station or other scientific journals both at home and abroad. The contents of these papers are hereby presented in abstract form for the reference of people who may be interested in them.

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Sung-Ching Hsieh
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AN INTRODUCTION TO TAICHUNG DISTRICT AGRICULTURAL IMPROVEMENT STATION

Agricultural Environment in Taichung District

Taichung district including the areas of Taichung, Changhua and Nantou prefectures and Taichung city covers a total acreage of 738,700 hectares. Of which 197,922 hectares are crop lands. The ratio of paddy field to upland field is approximately 6:4. However, this ratio is changing yearly because of the recent governmental policy to increase the acreage of upland crops and reduce the acreage of paddy field.

The favorable climate in this district is suitable to grow different crops the year round. The mean annual temperature of this district is 22.4°C. July and August are the hottest months with a mean temperature of 28°C, while February is the coldest month with a mean temperature of 16°C. The mean annual rainfall of this district in the past ten years was 1,740 mm. The distribution of rainfall is rather uneven around the year.

There are five major types of soils in this district. Slate alluvial soils cover the whole Changhua prefecture where rice yield is the highest in Taichung district. Sandstone and shale alluvial soils are found mostly in Taichung and Nantou prefectures. Soil reaction in these areas ranges from slightly to strongly acid, and hence the yield of rice is usually lower than that in Changhua prefecture. Lateritic soils which are very strongly acid and very poor in fertility are scattered in the highland areas. Mixed alluvial soils of sandstone, shale and slate are located in the west coast of Taichung prefecture. Because of its high sulfur content and poor drainage condition, rice yield in this type of soil is generally low. Red-yellow podzolic soils are mainly distributed in the mountainous areas where the soils are generally strongly acid.

History

Taichung, Changhua and Nantou Farmers' Associations established their own respective experimental stations in 1920. In 1924, all three stations were merged into one station and renamed as "Taichung Agricultural Experiment Station". The status of the station had been changed several times since then. It was given the present name and was placed under the Department of Agriculture and Forestry, Taiwan Provincial Government in 1960.

This station was formerly located in Taichung city. However, the experimental field was no longer suitable for the purposes of agricultural research due to the rapid urbanization of the city. A plan to move the station to rural area was therefore laid out in 1979. After 5 years of planning and construction, the movement was finally completed in March, 1984 at a total cost of NT$500,000,000. The new site of the station, located at Tatsuen, Changhua, covers approximately fifty hectares of land. The construction of the branch station at Puli, Nantou with an acreage of 17 hectares of slope land was also completed at the same time.

Equipment and Facilities

The experimental farm of the station is properly equipped with irrigation and drainage systems. The main building consists of laboratories, offices, an auditorium, and some conference rooms, etc. The agricultural extension building consists of an exhibition hall, offices, mass communication room and a training center.

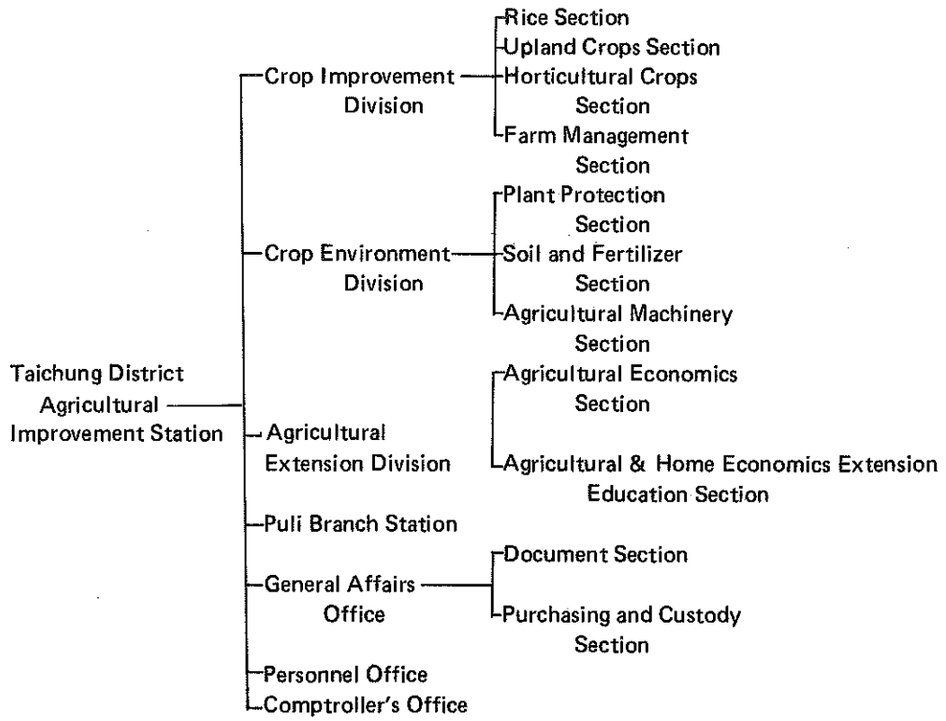
The training center may accommodate 50 trainees at the same time. It includes an audiovisual classroom, teaching material room, home economics classroom, dining room, recreation room and bedrooms.

The main facilities of the station are insectary, agricultural engineering workshop, cold storage room, agricultural weather observatory, greenhouses, warehouses, etc. Dormitories are also available for single and married staff members.

Main laboratory equipments include scanning electron microscope, atomic absorption spectrophotometer, automatic analyzer, gas chromatographer, liquid chromatographer, UV spectrophotometer, microprocessors, ion analyzer, flame photometer, growth chambers, incubators, mini computer and others.

Organization

This station consists of 1 branch station (located at Puli, Nantou prefecture), 3 technical divisions and 3 administrative offices. Each technical division is subdivided into several sections as shown in the following scheme:



Staff Members

There are 82 staff members, including 68 technical (13 senior and associate research fellows, 25 assistant research fellows and 30 research assistants) and 14 administrative personnels in this station. In addition, the station has 28 project employees, 69 skilled labors and 85 temporary field labors.

Functions

1. To conduct plant breeding work for the major crops of economic importance.
2. To improve the cultural methods of various crops.
3. To propagate and maintain the improved varieties of crops and other germplasms.
4. To study the problems of soils, fertilizers and plant nutrition.
5. To solve the problems of pest control, including forecasting the insect and disease epidemics.
6. To improve and design the farm machinery and implements.
7. To study the economy of farming systems in rural areas.
8. To carry out agricultural extension education, through providing technical service, training classes, field demonstrations and other measures to the farmers.
9. To carry out home economics education through training courses and other measures.

RICE

The main purpose is breeding rice varieties for high grain quality and yield as well as resistances to disease and insect pests. The first japonica rice Taichung 65 and the first indica rice Taichung (N) 1 developed through hybridization in Taiwan were released, respectively, in the early years of 1929 and 1956. The new variety Taichung 189 (japonica type), characterized by its good eating quality, high grain yield and resistance to blast disease, was released in 1984. The short-grain japonica type glutinous variety Taichung (gl) 70 and the long (indica) type glutinous variety Taichung Sen (gl) 1 were also released in 1984. Because of their good grain quality and high yielding potential, the acreage cultivated to these varieties is increasing rapidly. As for the non-glutinous indica varieties, Taichung Sen 3, Taichung Sen 10 and Taichung Sen 17 are the popular varieties released by this station.

In the past, experiments on cultural practices were mainly directed to spacing, fertilization methods, irrigation practices, ratoon techniques, etc. Recently, more emphasis has been laid on weed control, mechanized system of rice culture and the improved cultural techniques to raise the grain quality of rice.

1. Development of Rice Variety

Taichung No. 189 is developed by crossing Tainung No. 67 with Taichung No. 187. With the characteristics of strong culm, blast resistance, good rice quality, and stability in grain yield, it was named and released to the farmers on June 17, 1983.

Taichung Sen 3 is an indica rice developed in Taichung DAIS. A selection derived from the cross of Mean-don-chieh with IR-24. It was named and released in 1976. It was resistant to rice leaf blast and neck blast but susceptible to bacterial leaf blight.

Taichung Sen 17 is a newly developed indica rice from the crossing of Taichung Sen Yu 223 (♀) x IR 17488-2-2-1 (♂) and officially registered and released in 1984. This new variety possesses the characters of semi-dwarf type, erect leaves, resistance to lodging and high responses to N-fertilizer. It is a medium grain size and wider grain variety, with 33 gm of 1000-grain weight and 25.6 gm of 1000-total-milled-rice-weight that are heavier than those extension varieties such as Taichung Sen 3, Taichung Sen 10 and other varieties.

The provincial district yield trials conducted at 10 locations in 1983, showed that Taichung Sen 17 yielded 7058 kg/ha in the first crop and 6864 kg/ha in the second crop. The advanced yield trial of 1982 and 1983 showed an average yield of 7711 kg/ha in the first crop and 7587 kg/ha in the second crop. This variety is moderately resistant to leaf and panicle blast and bacterial leaf blight. It is highly resistant to brown planthopper. The degree of expansion, low gelatinization, high

amylose and hard gel consistency are the same as Taichung (N) 1.

Taichung Sen 10 is an indica variety with medium long grain. This variety was named in the 1st crop in 1979. It was resistant to rice blast and brown planthopper. Besides it showed very high yield performance, especially in the 2nd crop.

Taichung Sen 5 was an indica rice developed in Taichung District Agricultural Improvement Station by crossing Kaohsiung Sen-yu 12 (female parent) with IR 22 (male parent). It was named and released in 1977. It was resistant to rice blast and bacterial leaf blight.

Toyonishiki was a high and stable yielding japonica rice with several favorable characteristics such as early maturity, cold tolerance and good grain quality. It was suitable for rotational cultivation with some summer and winter catch crops, such as cantaloupes, pickling cucumber, vegetables, peas as well as various upland crops. It was also suitable for cultivation in the coastal areas for reducing the injury of monsoon.

2. Comparison of Rice Breeding Methods Between Pedigree and Single Seed Descent

The differences of grain yield among F_6 and F_7 lines were not significant when three methods were applied in both crosses. Grain yields of F_5 selected lines were similar between pd1 and pd2 methods, even with pd1 method, the F_5 lines were selected from the high yield lines of F_3. Therefore no significant effect of selection was found in F_3 generation. This result concluded that there were no significant difference among the three selection methods. However, the SSD method saved labors and was found more efficient in the utilization of land.

3. Growth and Yield Components of High-Yielding Rices

Rice plant in the first crop was profited by its longer duration of growth and optimum temperature. So it has abundant number of tillers. However, the rice in the second crop was transplanted by the end of summer, thus its vegetative growth period from transplanting to panicle formation stage was just under the high temperature. The growth period of the second crop was hence shortened 29 days in Tainan 5 and 25 days in Taichung (N) 1. In the second crop, the elongation of stalk and leaf caused the reduction in the tiller per unit area for about 40%, and the reduction in panicles per unit area by 36% as compared with the first crop. The number of spikelets per panicle, percentage of ripened grains and weight of 1,000 grains in the first crop did not show better than in the second crop. These

phenomena suggested that 30% yield reduction in the second crop was mainly due to the less number of panicle per unit area. On the other hand, the plant morphological characters between the two crops also varied. The percentage of stalk weight to total dry weight of the second crop at ripening stage was higher than that of the first crop. Especially Taichung (N) 1 was highly significant. Moreover, the ratio of grain-straw of the second crop was lower than that of the first crop.

The net assimilative rate in the second crop was higher than the first crop before rice booting. Beyond the booting stage the first crop exceeded the second crop. On the other hand, the nutritional translocation of starch and nitrogen in the straw of the first crop and second crop was similar. The analysis of starch and nitrogen contents in straw at ripening stage revealed that the first crop was 8% and 21% higher than the second crop respectively. The grain starch of the first crop was 2% higher than that of the second. But the nitrogen content of the grain in the first crop was 2% lower than that of the second. The nutritional translocation in the second crop was very similar to the first crop.

4. Several Agronomic Traits and Adaptability of New Indica Rice.

To evaluate the agronomic traits and the adaptability of the new indica varieties of rice, 5 varieties were tested at 10 locations in 1983.

The result showed that Taichung Sen 17, Tainung Sen 19, Tainung Sen Waxy 2 and Taichung Sen Waxy 1 yielded higher than the check variety Taichung Sen 3 in the 2nd crop, and also in the 1st crop except Taichung Sen Waxy 1. A stability test indicated that the highest yielder Taichung Sen 17 showed a wide adaptability in the 10 sites tested.

Recently, the agronomic characters and pests resistance of the indica varieties have been improved in Taiwan. However the cold tolerance still need to be enhanced.

5. Use of Genetic Diversity in Rice Production with Special Emphasis on Pest Management

The present study was aimed to evaluate whether the disease epidemics of rice could be controlled or reduced by the method of "multi-variety" culture. The seeds from the three varieties, Tainung 67, Tainung 69 and Taichung 189 were mixed in different proportions to form several multi-variety blends and then planted in an experimental field. The degree of blast disease epidemics and grain yield etc. from

the mix-varieties were compared with the single-variety plantings. The competition of plant growth in terms of agronomic characters and grain yield, as well as blast disease infection was also studied.

The results of the multi-variety experiment indicated that the mixture of 1 part of Tainung 67 with 3 parts of Taichung 189 showed the best performance with respect to blast disease resistance and grain yield. The grain yield of mix-variety was 26-27% higher than that of single-variety culture. The results of the competition experiment also indicated that the plant height and the degree of blast disease infection were reduced when the varieties Tainung 67 and Taichung 189 were alternatively planted. The "cooperative effect" enhanced the number of tillers and grain yield in the blend of Tainung 67 with Taichung 189.

6. Breeding for Resistance to Several Biotypes of Brown Planthopper

The preliminary results indicated that Taichung Sen Shih 346, 348, 353, 356 and 358 were resistant to multi-biotypes of planthoppers and blast disease. The yields of the above selections were 6.3-16.2% higher than that of check variety, Taichung Sen 10, and 55.3-69.7% higher than that of Tainung 67. In addition, Taichung Sen Shih 353, 356 and 358 have good head rice (over 60%), low amylose, low gelatinization temperature, soft gel consistency, and good quality. Taichung Sen Shih 346 and 348 have high amylose (26-27%), intermediate to low gelatinization temperatures, hard gel consistency. It is good for rice products.

Taichung Sen Shih 329 has carried a recessive resistance gene bph4. Taichung Sen Shih 339 and 338 carried a dominant resistance gene Bph 3. The yields of these selections were higher than the control Taichung Sen 10. In addition, they have several good agronomic characters, such as good rice quality, high head rice and cold tolerance. The elites of these strains showed the characters of high yielding, good grain quality, and resistant to several biotypes of brown planthopper.

7. Resistance to Brown Planthopper in Rice

Five indica varieties including two breeding lines, IR13539-11-1 and IR17488-2-2-1, introduced from the International Rice Research Institute and three local varieties, Taichung Sen 3, Taichung Sen 10 and Taichung Sen-yu 223, were tested for the degree of resistance to 5 biotypes of the brown planthopper. IR 13539-11-1 was found resistant to biotypes 1,2, 3 and 5, but susceptible to biotype 4. IR17488-2-2-1 was susceptible to biotype 5, but resistant to the other 4 biotypes. Taichung Sen-yu 223 was resistant to biotypes 1 and 3 and Taichung Sen 10 moderately resistant to biotype 1 and resistant to biotype 2. Taichung Sen 3 was found highly

susceptible to all biotypes. These results coincided with the reactions of brown planthopper occurrence density under field conditions in Changhua county where biotype 1 prevailed.

The results from the F_1 and F_2 generations of the crosses between susceptible variety Taichung Sen 3 and resistant varieties/lines Taichung Sen-yu 223, Taichung Sen 10, IR13539-11-1 and IR17488-2-2-1 showed that the resistance to brown planthopper of Taichung Sen-yu 223 was attributable to a single dominant gene $Bph_1{}^a$, which exerted its effect of resistance to biotypes 1 and 3. Taichung Sen 10 was resistant to biotypes 1 and 2 because of the recessive gene $bph_1{}^b$. The IR13539-11-1 carries a dominant gene $Bph_2{}^a$, resistant to biotypes 1, 2, 3 and 5. IR17488-2-2-1 carries a single recessive gene $bph_2{}^b$, resistant to biotypes 1, 2, 3 and 4.

$Bph_1{}^a$ and $bph_1{}^b$, also $Bph_2{}^a$ and $bph_2{}^b$ were respectively alleles.

8. Attributes of Hopper-Predator Community in Rice Field

A hopper-predator community in an experimental rice field was observed weekly with regard to information content (H'), formation of a geometric series or the grade of orderly distribution of component taxa (R^2), and clumping index (I). These community attributes changed with time in close association with one another, and attained the highest values around the heading time of the rice. Significant correlations were found between the density of prey and that of predators when a certain time-lag was assumed for the increase of predators.

9. Comparison of Four Brown Planthopper Biotypes and the Reaction of Several Rice Varieties

Studies were designed to compare the morphology, the ecology and the host preference of 4 biotypes of brown planthopper as well as the blast resistance of 10 rice cultivars.

Biotype 1 (reared on T (N) 1) plant hopper has the heaviest body weight and the longest body length. It gave symptoms on various rice cultivars. Biotype 2 (reared on Mudgo) was the most destructive colony although the hopper was the smallest and lightest among the 4 biotypes. Biotypes 3A and 3B (reared on H 105 and Samba, respectively) were the same colony. They showed the same reactions to selected rice cultivars and had similar ecology and morphology. The 3A and 3B showed the extension of nymphal duration, reduction of nymphal survival, as well as the nonpreference while they were reared on resistant varieties.

The reaction of resistance to 4 biotypes of brown planthopper in 10 rice cultivars was studied in green house with bulk seedling test. T(N) 1 and TKM 6 showed high susceptibility to all biotypes, while ASD7 and IR1541 were susceptible to 3 of them, except biotype 1. CNS X1, CNS XIII and Hsinchu-I-Geo-Gen were resistant to biotype 1 and biotype 2; nevertheless they were susceptible to biotypes 3A and 3B. Rice varieties derived from IR9-60, JP 5 and Mudgo were highly resistant to biotype 1, 3A, and 3B but susceptible to biotype 2.

10. Quality Classification of Taiwan Rice

Usually, rice grains were classified into three grades depending on the percentage of milled rice, grain appearance, cooking and eating qualities. However, so far the USDA standard was found not to be applicable in Taiwan. We, therefore, suggested that the category should include the percentage of head rice, translucency, white center, white belly, white back, amylose content and gel consistency. According to the suggested system, a total of five grades, has been developed. For the consideration of market, and price, however, a 5-10% difference for each grade seem to be needed.

11. Effects of Environmental Factors on Rice Quality

Rice quality is determined by the physicochemical properties of rice grain. The quality usually depends on grain appearance, milling rate, amylose, and protein content etc. These characteristics of rice are also influenced by the practices as well as the environmental factors during grain filling and storage. The relationship among environmental factors and the physicochemical properties of rice grain are discussed.

The percentage of rice grains invaded by insects and the discolored grains increased with the advancement of storage period, but the translucency of grain decreased. More rice grains were invaded by insects in pack than without it. The percentage of discolored grains was lower under non-packed than packed. Among the different types of grains, the highest percentage of grains invaded by insects and the discolored were found from japonica rice. But no significant difference of insect invaded grains was found between the two indica types. The least number of discolored grains was obtained from the long grain indica rice. The poor grain appearence and eating quality were found from short indica grain. And no significant difference was found between japonica and long grain indica. The percentage of milled rice was found slightly higher from japonica grain than indica grain. The results indicated that, except the percentage of milled rice, the rice quality of newly improved long grain indica variety can be kept as good as japonica variety.

12. Quality of Long Grain Rice

Since volume weight is negatively correlated with grain length, it is difficult to expect the long-grain rice to perform the originally stipulated volume weight of 532 g/dcm ^{3}. Judging from its similar milling rate to short-grain rice, the reasonable volume weight of long-grain rice for marketing should be adjusted to 512 g/dcm ^{3}.

The milling rate of long-grain indica rice was lower than that of japonica rice, Tainan 5, by 2.29%. However it was similar to that of short-grain indica rice. Its bran content was respectively lower than Tainan 5 and short-grain indica rice by 2.38 and 1.2%. It has high translucency, less abdominal white and heart white, medium or low gelatinizing temperature, and high protein content (9.27% in average). Besides, some long-grain indicas have high amylose content. The general quality of long-grain rice was superior to those of short grain indica and japonica rice.

Long-grain indica rice has low and high amylose varieties. The high amylose could be marketed at the same price with short grain indicas. The low amylose could be marketed about 2.29% lower than the japonicas.

13. Improved Method of Measuring Chalkiness and Translucency of Milled Rice

The degree of grain whiteness increased with the increase of sample size and the value became stable when sample size went up to 6.5 gram. The degree of whiteness was the value of reflection of grain chalkiness. The value was converted into the five conventional rating of white belly and white core of rice grain.

Six pieces of white plastic discs, 1 mm in thickness and 6 cm in diameter were inserted into the sample dish. The value of measurement (T) was confirmed to be the same value obtained from measuring the translucent part of rice kernel.

The result further confirmed, that the values of translucency and whiteness of rice kernel estimated by the above mentioned methods were reliable because it avoided vicious values of visible inspection.

14. Hot Water Treatments on Inhibition of Germination and Quality of Harvested Wet Rough Rice

Soak seeds in 75^{o}C hot water for 30 seconds inhibited germination at three different moist levels under various piling periods. The 1000-grain weight of milled rice and the percentage of brown rice were slightly increased. However,

the percentage of head rice and broken kernels varied markedly with the rice varieties. The percentage of head rice from hot water treated Tainan 5 and Taichung Native 1 was only 50% of the nontreated, whereas no difference was observed in Kaohsiung Sen 1 and Chianung Sen 8. The cooking and eating qualities including gelatinization temperature, amylose content, and crude protein content of the tested varieties differed insignificantly when soaked in 70°C hot water and then piled for 3 days. Grain appearances, including translucency, white belly and white center, were unchanged after hot water treatments. But the color of the milled rice turned brown following the increase of water temperature or soaking time. The results indicated that the soaking of wet rough rice in 75°C hot water for 30 seconds, and piling for more than 3 days under room conditions were sufficient to inhibit germination and the rice quality maintains as good as the untreated rice.

15. Cropping Systems with Early Maturing Rice and Upland Crops

The conventional cropping frequency needs to be adjusted to two or three rice crops followed by a winter catch crop in a year in central Taiwan. The experimental results indicated that planting three crops of early maturing rice increased 33.4% and 24.3% in total production as compared with the system with two rice crops, Tainan 5 and Taichung Sen 3. The data also showed that the production value by planting two early maturing rices followed by one corn or soybean increased by 14.8% and 12.6% as compared with two crops of Tainan 5. However, if the variety Tainan 5 was replaced by Taichung Sen 3, the total production value only increased 6.9% and 4.9%. General conclusion may be made that the farm income can be increased by growing three crops of ordinary rices or two crops of early maturing rices followed by one crop of corn or soybean.

16. Development of Nursery Plate for Mechanical Transplanter

Experimental results indicated that a mixture of the crushed rice husk with peat and pulp subjected to the dry condition to form as nursery plate can be used to replace soils for growing normal seedlings. The nursery plate was 1.3 cm in thickness, 550g in weight, 5.7 in pH value, and 10.2% in water content. The materials and weight of nursery plate were cheaper and lighter as compared with the original seedling plates. Better seedlings were obtained from the seeds embeded in the nursery plate under wet condition and then heated up to 70°C in 12-48 hours.

The results showed that high percentage of germination can be obtained by embedding the seed in the nursery plate and stored up to 90 days.

17. Yield Improvement for the Second Crop of Rice

The low yields in the second crop of rice in Taiwan differed with locality, variety and cultural practices. It was generally known that the improved varieties are more adaptive to the environmental conditions of the second crop season and the improved cultural technique may also help increase the grain yield in the second crop for these varieties. The varieties with high response to N-fertilization and lodge-resistance were recommended for the second crop season in Taichung district. Increasing planting density in order to obtain a higher number of panicles per unit area was also effective for increasing the grain yield in the second crop. Other practices such as proper irrigation, drainage, and disease and insect-pest control were all important to enhance the yield. Proper drainage was critical in the ill-drained area. Prevention of high reduction and accumulation of toxic substances caused by the decomposition of organic matter in the soils are also very important. Selection of semi-dwarf indica rices for the second crop were also recommended. Monsoon damage to the second crop in the west coastal area was reduced by planting early-maturing varieties. Shortening the growth duration of the second crop by ratoon culture was helpful because the monsoon damage at ripening period can be minimized. Good windbreaks was also very important for preventing monsoon damage to secure higher grain yields in the second crop.

18. Minimum and Zero Tillage in Paddy Rice Production

An average of 2.0 per cent missing hills per hectare was recorded in zero tillage plots. It was more difficult and more time consuming to transplant in the zero tillage plots than in the minimum and conventional tillage plots. Combinations of Glyphosate followed by Paraquat gave better effect in controlling weeds than a single application or mixtures of those herbicides. Among the chemical combinations, Glyphosate applied at 1.5kg/ha 7 days before planting followed by Paraquat at 1.0kg/ha 3 days before planting or Glyphosate at 1.0kg/ha 7 days before planting followed by Paraquat at 1.5kg/ha 3 days before planting were most effective in controlling weeds in both transplanted and broadcast-seeded rice. The amount of nitrogen uptake at all growth stages of transplanted and broadcast-seeded

rice was greater from minimum and conventional tillage than from zero tillage plots. In the experiment involving the substitution of herbicides for land preparation in transplanted rice, Glyphosate sprayed at 2.0kg/ha 7 days before transplanting followed by one plowing 2 days before transplanting, chemical combinations such as Glyphosate at 1.5kg/ha 7 days before transplanting followed by Paraquat 1.0kg/ha 3 days before transplanting, or Glyphosate at 1.0kg/ha 7 days before transplanting followed by Paraquat at 1.5kg/ha 3 days before transplanting, gave grain yields similar to the standard one plowing followed by two harrowing treatments. In broadcast-seeded plots, conventional tillage method gave higher grain yields than all chemical treatments.

19. Improvement and Production of Rice

Rice is the most essential crop in national agricultural development. Paddy rice always ranks first in both production value and production hectareage. The production of rice in the past 30 years has increased more than 3.5 times. The contributive factors to the improvement of rice production were as the following: 1) The success of "Rural Land Reform Program" has raised the interest of farmers, and resulted in higher crop yield and better income. 2) "Farm Land Consolidation Program" has led to highly efficient utilization of farm land. 3) A number of new rice varieties of both japonica and indica type have been developed through breeding programs. 4) The improvement of rice cultural methods to increase yield were practical and fruitful. 5) The proper application of chemical fertilizers and pesticides are the two major factors that has helped increase the rice yield. 6) The rapid development of rice mechanization has led to a new phase which has ended the era of labor slack production. 7) Proper flood prevention and adequate irrigation/drainage systems has provided a good guarantee to the success of rice. 8) The expansion of agricultural extension service has led to the efficient utilization of natural resource and modern technology.

20. Possibility of Non-Tillage Rice Cultivation

Application of Paraquat at the rate of 2.0 kg/ha as a substitute for land preparation resulted in more missing hills than in ordinary tillage plots. Experimental results also indicated that there were many missing hills in the continued non-tillage plots. The highest percentage of missing hills per hectare in the non-tillage treatment were 12.9% in the second crop. The transplanting depth of seedling and

number of seedlings per hill was not affected by the transplanter in the non-tillage treatment. In zero tillage plots, perennial weeds can be controlled thoroughly by land preparation in the previous crop. In the first crop high grain yields were obtained from the zero tillage plot applied with 20% additional nitrogen fertilizer. In the second crop grain yields in the ordinary plots were significantly different from other treatments. However, grain yields were not significantly different among non-tillage treatments. Lower grain yield in the plots of continued non-tillage was rather frequent due to missing hills.

These results suggested that non-tillage technique might become an alternative to conventional land preparation. However, the problem of missing hills in the non-tillage plots should be improved.

21. Tillage and Non-Tillage Cultivation on Crop Yields and Soil Fertility in Paddy Field

The pH values in the 0-5 cm and 15-30 cm soil layers and the available K in the 0-5 cm soil layer were not different among the 9 rice cultivation methods. No significant difference in available P content of the soil layers of 5-15 cm and 15-30 cm among the treatments were observed. However, the amounts of organic matter in the 0-5, 5-15 and 15-30 cm soil layers and the available P content in the 0-5 cm soil layers were significantly higher in the treatments where the 1st crop of rice was directly seeded. The pH values in all three layers were significantly lower in the treatment where corn was planted as winter crop. The amount of available K were significantly higher in the plots planted to corn than planted to wheat or lying fallow, however. The total grain yields of the 1st and 2nd crops were significantly higher in the treatments where the 1st crop of rice was transplanted after tillage with any kind of cultivation methods adopted in the 2nd crop. The total grain yield was the lowest in the treatment where two crops of rice were all directly seeded without tillage. The rice yield was also significantly lower in the treatment where wheat was planted as winter crop. The grain yields of wheat and corn differed significantly among 9 different cultivations. In other words, the grain yields of wheat and corn were not affected by the cultivation methods of the two preceding rice crops.

22. Improving the Efficiency of Nitrogen Fertilizer in the Flooded Paddy Soil

The efficiency of nitrogen fertilizer (urea) was significantly increased by

wrapping the fertilizer in mudball or tissue paper and then applying to the reduced layer of the soil between two hills of rice plants. The grain yields of the treatments applied 60% of standard rate of nitrogen fertilizer in mudball or tissue paper were as high as control. Higher number of panicles per hill resulted in the high grain yields of the mudball or tissue paper treatmennts notwithstanding the decreases of other yield components. The surface broadcasting of nitrogen fertilizer caused much loss and thus needed more nitrogen fertilizer to achieve good yield as compared to the mudball or tissue paper treatment. One split of nitrogen fertilizer applied at panicle initiation stage was the key factor for this treatment to obtain more grains per panicle. The grain yield of SCU treatment was only similar to that of urea broadcast at the same rate in 4 splits, and that of IBDU treatment was significantly lower.

23. Effects of Nitrogen Application on Rice Milling Quality

Nitrogen treatment had significant effect on milling quality, especially affected the head rice percentage. Harvest moisture which related to head rice percentage was affected by nitrogen application. The 100 kernel weight tended to be negatively correlated with head rice. However the percentage of head rice was more affected by nitrogen dose than by 100 kernel weight. The difference of milling quality between varieties Earlirose and M101 was nonsignificant.

24. Effects of Nitrogen Fertilizer and Delaying Harvest on Recovery Rate of Ratoon Rice

Applying 25% additional nitrogen fertilizer at the yellow maturing stage of Taichung 67, a japonica rice, helped induce enough ratoon tillers at harvest. Without applying the nitrogen fertilizer, the plant extended at least 10 days later to obtain the same number of ratoon tillers. Before the emergence of the ratoon tillers, the new roots did not well generate. If rice was harvested at this stage, the stubbles would easily die. However, those plants harvested after the emergence of ratoon tillers, new roots developed simultaneously. Therefore, the stubbles regrew easily and a high recovery rate was obtained.

Application of 50% additional nitrogen fertilizer for the ratoon rice, was helpful to get higher grain yield as compared to the conventional transplanted method in the first crop. Since ratoon rice is easily susceptible to transitory yellowing and yellow dwarf, virus vector control of leaf hopper should be started from the previous rice crop.

25. Principles and Methods of Seed Test

Purity analysis: The object of the analysis was to determine the composition by weight of the sample being tested. Therefore the sample should be separated into the following components: pure seed, other crop seed, weed seed and inert matter. The definition of each component was strictly defined in the International Rules for Seed Testing.

The germination test: The objective of germination test was to obtain information to field planting. Test undertaken in field conditions was usually unsatisfactory, as the results was not reliable. Laboratory methods have, therefore, been evolved and the out door conditions were imitated to give a normal, rapid and complete germination. The definitions of germination, and normal seedling were prescribed in International Rules for Seed Testing.

Methods for breaking seed dormancy: When fresh ungerminated seeds remain at the end of the test period, requested tests would be carried out by applying one or several of the following treatments: (1) Prechilling (5-10^{o}C) (2) Predrying (40^{o}C) (3) Potassium Nitrate (0.2% KNO_3) (4) Low temperature germination (5) Prewashing and (6) Plant hormone (GA).

Test duration: Time varied from 6 days to 70 days (tree seed) depending on species. Tests may be terminated prior to the prescribed time when the result was satisfactory.

Biochemical test: Species normally germinated slowly or dormant in the test. Biochemical tests (Tetrazolium test) shall be applied to determine the quick viability of seed samples (especially tree seed).

26. Grain Yield and Growth Behavior Affected by Seedling Age and Plant Spaces

Rice seedlings that had been seeded at the same date but transplanted at different time significantly affected the grain yield. Transplanting with 65 day-old seedlings in the first crop resulted in grain yield decreasing by 17-34% as compared to the traditional 25 day-old seedling treatment. Seedlings of 45-day-old transplanted in the second crop reduced grain yield by 10-20% than 15 day-old seedlings. In the first crop, grain yield reduced 2-12% by planting 65 day-old seedlings as compared with conventional 25 day-old seedling seeded at different date but transplanted at the same age. The highest grain yields were obtained from the plots transplanted with 45 day-old seedlings in the first crop, and with 30 day-old seedlings in the second. Grain yields were significantly affected among rice varieties subjeced to the various seedling ages. In the transplanting with old seedlings of

indica variety, the grain yields were slightly decreased. However, the early maturity varieties were significantly decreased in grain yield while the old seedlings were grown. The low grain yield of early maturity variety by using old seedlings was attributed to the abnormal heading of rice resulted in low grain number per panicle. The grain yield of old seedlings can be improved with close plant spacings.

Growth duration was greatly affected by seedling age. In the second crop, irrespective of seeded date and transplanted time, the growth duration of rice crop shortened 8-11 days with old seedlings. In the first crop, old seedling transplanting at the same time shortened the growth duration for 6-9 days. However, if the old seedlings were transplanted at the growth period it shortened 9-30 days as compared to the young seedlings.

These results suggest that transplanting healthy old seedling of indica variety at close spacing may be considered as an alternative of using young seedlings.

27. Agronomic Practices Related to Bud Sprouting, Growth and Grain Yield of Ratoon Rice

Grain yields of ratoon crop were significantly different among tested varieties. The yield performance was mainly dependent on the ratooning ability, and also water management. Drained surface water from milky stage to harvest of the main crop inhibited ratoon bud sprouting. On the other hand, continuous flooding at late stage favored ratooning. Hence, the yield from flooded plots were significantly higher than that of surface drainage plots. The required labor for ratoon crop was 38 percent less than that of transplanting. The labor was mainly saved from raising seedlings, land preparation, and transplanting to paddy field. The ratoon rice saved 22 percent production cost and increased the net profit by 16.5%. The ratoon ability was affected by the harvest time of main crop. However, it varied with varieties. For good bud sprouting, variety Taichung Sen 3 should be harvested at 33 days after heading (DAH), and Tainan 5 at 38 DAH. The height of main crop stubbles significantly influenced the grain yield of ratoon rice. The highest grain yield was obtained from the stubbles of 15 cm and cut back to 3 cm, while newly grown ratoon tillers were 15 cm tall. This treatment gave uniform sprouting and heading. The grain yield increased by 13.6 percent, while the rate of nitrogen increased from 80 to 110 kg/ha. Deeply buried nitrogen at 10 cm under field surface increased ratoon yield by 16.7 percent. The plant leaves in these plots remained dark green until maturity. Ratoon ability were found significantly correlated with carbohydrate content in the basal part of culm during maturity.

28. Improvement of Second Rice Crop in Southern and Central Taiwan – Methods for raising rice yields in the ill-drained area in the west coast of Changhua Hsien

This project was aimed to elucidate the possibility of increasing the rice yield of the second crop through various experiments and demonstration of varietal adaptability and cultural practice. The results are as follows:

1. Varietal adaptability in ill-drained areas: eighteen rice varieties/lines were tested in the first and second crops of 1975. On the average the well-drained yielded 6.5% more than that ill-drained in the first crop and 3.4% more in the second. The high yielding varieties/lines which exceeded Tainan 5 were Taichung Sen 3, Taichung Sen-yu 193 and Chianung Sen Selection 8 in the 1st crop and Taichung Sen 3, Taichung Sen-yu 191, and Chianung Selection 8 in the second crop. Indica rice adapted better than japonica to ill-drained soil.

2. Effects of percolation, drainage, and organic matter: broke hard-pan by subsoiler increased the rate of percolation from 1.5 mm/day to 4.0 mm/day in Homei silt-clay soil. Timely drainage tended to accelerate rooting and tillers but inhibited plant height, thus minimized lodging. Finally, the timely drainage yielded markedly more than continuous flooding. Incorporation of rice straw gave poor growth and yielded less than compost.

3. Effects of deep plowing, fertilizer response and drainage: plowing to 18 cm deep and corporating optimum rate of N-P-K fertilizers with timely drainage gave the best yield as compared with those plots plowed to 12 cm and 24 cm deep with 25% more N-P-K fertilizers.

4. Varietal adaptability in the west coast: long-grain indica varieties/lines gave higher yield than early and ordinarily maturing rices of japonica type in both crops. Among them Taichung Sen 3 (Taichung Sen-yu 195), Chianung Sen Selection 8, Chianung Sen 11, Taichung Sen-yu 191 and 194 showed better in the first crop whereas Taichung Sen-yu 189, 194, 195, and 191 yielded higher in the second crop.

5. Optimum date of planting in the west coast: in the first crop the optimum date of transplanting was from March 10 to 20 using 45 day-old seedling. The transplanting of young seedling too early caused cold wind damage, whereas transplanted too late yielded low. In the second crop, early transplanting crop yielded high. The optimum date of transplanting was prior to July 15. Seedlings transplanted later than the above date showed lower yield due to strong salty wind prevailing in the west coast during the later part of growing season.

6. Effects of wind-break in the west coast: beef-wood (Casuarina equisctifolia F.) was the best wind-break against salty wind in the second crop, followed by Miscanthus grass (Miscanthus japonicas A. Honda) or fenced with straw. Salty wind damage was less significant, as paddy field was farther than 500 meters from the coast. The protected distance of wind-break was about 5 times of the eight of wind

break.

7. Improvement of drainage system: a total of 3300 meters drainage canal was enlarged from 1.5 meter wide to 2.5 meters, and from 1 meter deep to 2 meters. The duration of flooding was then shortened from 3 to 1 day.

8. Drainage demonstration: a total of 10 ha was adopted for the demonstration of timely irrigation and drainage in the second crop. The result showed a 18% increase in grain yield.

29. Methods for Raising Rice Seedling for Power Transplanter

A. Protection against cold temperature and the materials for raising seedling and their effects on the seedling growth:

(1) The temperature of the soil and rice-hull in the woodbox or woodframe increased 2-17°C when covered with PVC-paper in the open field. The differences were great at 2 : 30 p.m. and less at 8 : 30 a.m. Covering 2-layer-PVC-paper gave higher temperature than 1-layer did. The green-manured bed similar to the rice-straw one in increase of temperature, particularly in the afternoon, showed the highest temperature among the all treatments. In the wood box the temperature of rice-hull was higher than that of soil. The woodframe stuffed with soil and bottomed with PVC-paper on soilbed showed less fluctuation in temperature than the woodbox did. Covering PVC-paper prevented cold injury and might be used for replacing the high cost growth chamber with steam-or electric-heater.

(2) The cost of material of woodframe for raising seedling was only one-fourth of the woodbox. Moreover, in field operations and storage, the former was much simpler and easier. As to its effect on seed germination and seedling growth it was the same as woodbox.

(3) The growth rate of seedling in height was significantly correlated at 1% level with soil temperature either in the morning or afternoon. Increasing soil temperature also showed increase in leaf-width and leaf-age. The seedling growth in rice-hull did not show so markedly as in the soil in correlation with temperature. The soil treatment gave better and more uniform growth of seedling than that of rice-hull. Drilled in PVC-groove with soil showed better growth of seedling in early stage but poorer in later stage. Covering 2-layer-PVC-paper gave the best growth in height, leaf-width, and leaf-age followed by 1-layer and no covering was the worst. However, the trend was not identical in number of roots. Top-dressing on rice-hull gave better seedling growth than without top-dressing. The seedling of Taichung (N) 1 showed more vigorous germination and growth than that of Tainan 5.

B. Varietal response to rates of fertilizers for raising seedling:

(1) The same as in the previous experiments, the seed germination rate and seedling growth in the soil were obviously better than in the rice-hull.

(2) The seedling growth increased with the increase of N-P-K fertilizers from 0-0-0 to 12-12-6 gms/box in dealing with Taichung Sen 2 and Tainan 5. However, in Taichung (N) 1 and Taichung 186 the maximum growth peak only went up to 8-8-4 gms/box. As far as the growth appearance was concerned, the proper rate of fertilization for soil for raising healthy seedling was 8-8-4 gms/box. Over the rate tended to have looping, soft, and juicy leaves that was apt to cause leaf blast and bacteria sheath blight. However, in case of rice-hull there was a linear effect of N-P-K fertilization on seedling growth from 0-0-0 to 12-12-6 gms/box.

(3) The indica varieties Taichung (N) 1 and Taichung Sen 2 showed earlier germination and faster growth of seedling in early stage, but surpassed by japonicas Taichung 186 and Tainan 5 under PVC-paper covering. It seemed that the indicas were more thermo-sensitive than the japonicas.

C. Effects of Tachigaren and fertilizers application on seedling growth in rice-hull:

(1) Tachigaren diluted from 1ml to 375ml/box markedly depressed germination, growth rate of rice plants and elongation of radicle, but hastened leaf-age. However, over 20 days after sowing it tended to accelerate the growth of rice plants, activity of secondary roots, root number and dry matter weight in comparison with control. In appearance, the Tachigaren treated seedling in later stage tended to have root systems of white, crooked, coarse, and branched and able to stand against cold weather, drought, and water submerging. There was no symptom of damping-off either in the treatments with or without Tachigaren since the daily air-temperature was higher than 18°C.

(2) The soil mixed with 8-8-4 gms/box of ammonium sulfate, calcium superphosphate, and potassium chloride was the best in seedling growth as compared with either rice-hull mixed with 8-8-4, 12-12-6, and 16-16-8 gms/box of the same fertilizers or dipped in the same rate of fertilizers solution or even as high as 20-20-10 gms/box of fertilizers. The seed germination and seedling growth in rice-hull were extremely uneven and slow especially when the rate of fertilizers was increased and mixed with 500 gms/box dry-soil and rice-hull.

(3) During this experiment the PVC-paper was used for protecting against cold and there was cold spell rather than warm climate. The seedling growth of Taichung (N) 1 was faster than that of Tainan 5.

D. Methods of fertilizer application in rice-hull to seedling growth:

(1) Mixing 8-8-4 gms/box of ammonium sulfate, calcium superphosphate, and potassium chloride fertilizers with soil before sowing gave the best germination and growth of seedling as compared with two times of top-dressing and without fertilization. Top-dressing of P and K fertilizers was harmful to seedling growth.

Treatments differed in height was markedly observed 15 days after sowing and maintained up to 32 days. However, the differences in leaf-width among treatments were only seen at 15 days observation.

(2) The seed germination and seedling growth in early stage was faster in Taichung (N) 1, but exceeded by Tainan 5 in later stage except root number and leaf-width.

E. Rates of soil and seeding and soil-press to seedling growth:

(1) Increasing the amount of soil in the seedling box tended to accelerate the growth rates of height, leaf-width, secondary root length, and root number. The proper amount of semidry soil in the seedling box was about 4.5 kg/box.

(2) Soil without press before sowing showed better germination and growth of seedling in the early stage but no difference in the later stage.

(3) Higher rate of sowing tended to produce slender and thin seedling but more number of roots and less dry-matter weight.

(4) Tainan 5 showed better growth in height, leaf-age, root length, and dry matter weight but narrower leaf and less root number.

F. Rates of seeding to seedling growth in broadcast:

(1) Increasing the rates of seeding tended to depress the increment of dry matter weight but slightly accelerate the growth in height and leaf-age.

(2) Tainan 5 was more sensitive to the density of sowing when the rates were increased from 150 to 300 gms/box.

(3) In order to maintain the proper number of seedlings per hill to be transplanted by machines the proper rate of seeding at 180 gms/box for Yanmar and 220-250 gms/box for Iseki, Michubishi, and Kubota are recommended.

30. Introduction to Field Inspection Methods of Seed Multiplications

The present regulations govern the certification of the following crops: rice, sweetpotato, peanut, soybean, wheat, sorghum, corn, barley, rape, cotton, jute, flax, kenaf and vegetables. All registered crop varieties are subjected to certification for seed multiplication.

The purpose of field inspection is to examine the phenotypic characters of the crop and purity in the field, and to assess and determine the number of weeds, isolations and the disease infection of the seed farm.

Field inspectors will examine the seed plot of all levels. No laboratory seed testing will be made, until the field inspection meets the standards.

Standards for field inspection:

A. Ponlai rice:

(1) General standards:

(a) One variety only shall be grown on one seed plot.

(b) Seed farms shall be established on sites where no rice was planted during the previous two crops, except that the same variety was planted in the previous season.

(c) Isolation between seed farms of different varieties shall not be less than 3 meters.

(d) Contract seed growers shall have, at least, five years' experiences in rice cultivation with good reputation and have a concrete drying ground and proper seed cleaning and storage facilities.

(e) A signboard shall be erected on the farm showing:
(i) crop season, (ii) kind of seed farms, and crop kind, (iii) names of the varieties and the growers.

(2) Specific standards:

Item	Foundation seed farm	Stock seed farm	Extension seed farm
Other varieties (max.)	None	None	None
Barnyard grass (max.)	None	None	10 plants/ha.
Other objectionable seeds	None	None	100 plants/ha.
Seed-borne diseases and diseases affecting seed	None	None	None

B. Hybrid corn:

(1) General standards:

(a) At least 3 field inspections shall be made on all classes of seed farms.

(b) Isolation area for two different classes of seed farms shall not be less than 300 meters.

(2) Specific standards:
  (a) Inbred lines: The percentage of off-type plants shall not exceed 2%.
  (b) Single cross farms:
    (i) The percentage of off-type plants shall not exceed 2%.
    (ii) Detasseling of female plants shall be completed before shedding pollen. Field inspection shall be made twice successively when the female plants have 5% or more receptive silks. The total non-detasseled female plants of the two inspections shall not be more than 2.5%.
  (c) Double cross farms:
    (i) The percentage of off-type plants shall not exceed 0.1%.
    (ii) Detasseling of female plants shall be completed before pollen shedding. Field inspection shall be made twice successively when the female plants have 5% or more receptive silks. The total non-detasseled female plants of the two inspections shall not exceed 2.5%.

31. Effects of PVA and PVC Materials on Raising the Rice Seedling of the First Crop

The temperature under NB50N film covering was 1-5°C higher than under PVC when covered in the night. In the daytime, however, the former was 1-2°C lower than the latter under the cloudy day and 0-3°C higher under the sunny day. The tunnel shaped covering increased 2-5.5°C as compared with the flat covering on the seedling. The highest temperature was seen in the treatment of PVC and NB50N in tunnel showing the extreme of 34.9°C in cloudy day, and 47.5°C in sunny day. The ST3800S, having 45-50% of shading, showed nothing for increasing temperature, but was effective for buffering the rapid changes of temperature. The range and c.v. between treatments increased with the increase of temperature.

Both materials of NB50N and PVC markedly increased temperature and hastened the growth of seedling. However, over-temperature (40°C) seemed to overturn the assimilation-respiration rate from positive to negative, resulted in leaf burn and the decrease of dry matter weight. The temperatures were positively correlated with seedling height and negatively with dry matter weight but had nothing to do with the leaf-age. The highly significant affection of the materials on the dry matter weight of rice seedling indicated that the soil was much better than the seedling plate. The seedling raised by soil was less sensitive to temperature fluctuation than by seedling plate.

The rice seedling in the covering treatments in which the temperatures exceeded 40°C showed the symptoms of leaf burn. The degree of leaf burn was apparently influenced by its extreme temperature; the higher the extreme temperature the more serious the seedling showed the symptoms of leaf burn. TN 67 was more sensitive to extreme temperature and heat injury than TCS 3. Seedling raised by plate was more resistance to high temperature than by soil. It was attributed to the better aeration of plate material and root system. Flatting material on the seedling caused mechanical damage to the leaves during the strong monsoon prevailing in the nursery stage of the first crop of rice. TCS 3, having thinner blades, was easier to be damaged as compared with TN 67. However, no mechanical damage was seen in tunnel coverings.

32. Effects of Covering Materials in Preventing the Heat and Rain Damages to the Seedling for the Second Crop of Rice

The directions of tunnel shaped covering materials, either east-to-west or north-to-south, did not show any difference to heat-stress and rain-erosion. The silver tafbell (ST3800S) in E-W direction, however, was better in ventilation to the north-to-south, thus, showed a little effect in lowering temperature. The PVC film had the virtue in preventing rain-erosion but was apt to raise temperature to cause seedling necrosis.

Since ST3800S has proper ties for shading and reflecting solar radiant for 45-50%, it was able to bring down the temperature for 1.5 to 7.8°C in torrid noon-time, and particularly capable of accelerating seedling growth at initial stage but gradually become obscure in later stage. Flatting nylon net on the nursery did not depress the temperature, but minimized rain-erosion. The transparent natural belltef (NB50N), having the similar virtue in increasing temperature as PVC film, was only effective in serving protection to seedling from rain-erosion. The temperature of the nursery under its covering often reached as high as 60°C to cause serious necrosis of seedling. Therefore, ST3800S as well as PVC films were only suitable to be used in the first crop of rice.

The growth of seedling, age and dry weight in the second crop was highly negatively correlated with the temperature over 40°C. TCS 3 was significantly more tolerant to torrid temperature and better in growth than TN 67.

33. Rice Cultivation in Northern Iran: Effects of Rice Planting Date

The results strongly suggested that the earlier the sowing time, the higher the grain yield. Variety Meher sown on March 25 and transplanted on April 18 was ready for harvest on August 25, and yielded 1.1 t/ha or 20.6% more than that sown one month later. Taichung 65 sown on March 25 and also transplanted on April 18 gave 0.84 t/ha or 12.4% more than that sown one month later. In pilot rice farm, Meher transplanted on June 20 yielded 1.6 t/ha or 37.7% less than that transplanted one month earlier. The pooled analysis of correlation between grain yields from two experiment farms and Pilot Project was highly significant. The negative regression coefficient at 59.4 kg/ha/day in reduction of yield was found in delayed planting. In the extension farm, Meher planted in early-mid May outyielded those planted in early-late June by 1.5 t/ha or 29.1% under the same rate of N-fertilizer.

The early sowing tended to inhibit the plant height but accelerated the increase in tillers, the panicles per unit area, and the number of grains per panicle. In pilot rice farm and extension farms, Meher transplanted in June showed yield reduction mainly due to bad weather at ripening stage. Thus, the unfilled grains increased and the grain weight reduced. The result suggested that rice in this area should be seeded as early as possible under cold protected nursery.

34. Rice Cultivation in Northern Iran: Water management of lowland rice

The purpose of this experiment is to compare the effect of water managements scheme on rice growth, yield and water consumption.

The best treatment was the continuous flooding to heading interposed with 5 days' drainage each at 10 and 25 days after transplanting, and 10 days' drainage each before panicle initiation and heading, and further with weekly irrigation after complete heading. Irrigation with timely drainage during the vegetative stage was much better. The treatment increased 6.1% grains and saved 26% water as compared with continuous flooding, being 565 mm vs 759 mm per crop season. The response of rice growth to various water treatments in Taichung 65 was more sensitive than in Meher. Taichung 65 was more beneficial by irrigation with timely drainage, but more easily injured by drought than Meher. Meher, was a leafy variety of lower yield. It consumed more water per kilogram of grain or 1.09 m^3/kg than Taichung 65, with 0.69 m^3/kg. Irrigation with timely drainage was helpful for soil aeration, thus resulting vigorous rooting activity, tillering ability and grain increase.

35. Rice Research and Prospect of Rice Production in Arid Regions of Saudi Arabia: First trial of double croppings in Gassim

In 1978, the first trial of double crops of rice in Saudi Arabia was made with three long-grain indica varieties. One was local Amberbook and the other two from Taiwan, NTU and Sipi (used in the spring only). These varieties were tested with 4 dates of sowing/transplanting, starting from January 30 to February 26 at 10-day intervals, as the spring crop. And, 5 sowing/transplanting dates, from May 30 to July 30 at 15-day intervals as the summer crop, in a sandy clay soil of Prince Naif's farm in Gassim basin of Saudi Arabia.

From the spring experiment, it was found that rice yield was the highest in February 2 seeding, 5.00 t/ha in Amberbook and 8.43 t/ha in Sipi. The variety NTU gave the highest yield of 10.32 t/ha seeded on February 16, however.

Too early planting plots suffered from serious cold damage in seed-beds and in the early growth stage after transplanting. Late planting reduced tillers and grain yield.

(1) The summer experiment showed that the eariest planting yielded the highest, variety Amberbook was 4.88 t/ha and NTU 7.25 t/ha.

(2) The optimum seeding time was before early June, using 20-day old seedlings.

(3) Late plantings suffered from cold injury after October. Double cropping rice on the same land in Gassim is not practical due to the constraint of weather. Amberbook is suitable for late spring and/or early summer cultivation, while NTU for spring cultivation.

36. Studies on the Yield and Yield Components of Rice under Different Environmental Conditions

I. On the duration of flower-bud formation and young panicle development under different conditions in rice

The process of flower-bud formation and young panicle development of rice was studied under the conditions of different varieties, crop seasons, locations and methods of fertilizer application. Twenty one developmental stages of young rice panicles reported by Matsushima and Manaka were identified and thoroughly described after the detailed microscopic studies.

In the first crop, the panicle differentiation begins 47 days after transplanting in Taipei (45 days in Chiayi) and is completed in 35 days (36 days in Chiayi). In the second crop, the young panicles begin to differentiate 16 days earlier than those of the first crop. Duration of panicle formation in the second crop is 38 days in Taipei (Northern Taiwan), and 33 days in Chiayi (Central Taiwan). It was noticed that the growth period of young panicle differed according to different tillers within a plant.

The high correlation coefficients (r=0.80—0.90) between growing date and

developmental stage of the young panicles indicated that the growth of young panicle is in parallel to the growing days. No marked difference in the mean values of developmental stages of young panicle due to spacings was noticed.

37. Studies on the Yield and Yield Components of Rice under Different Environmental Conditions

II. On the relation among leaf-age index, number of tillers and the stages of young panicle development in rice.

1). Four varieties of rice, Taichung 65, Chianung 242, Taichung (N) 1 and Tsai-yuan-chung were planted at Taipei and Chiayi to study the relations among young panicle length, young panicle developmental stage, leaf-age index and tiller numbers so that to identify the reliable indicators for determining the time of fertilizer application. Three different methods of fertilizer application and three planting densities were used.

2). It was observed that in the first crop at Taipei, leaf-age index at the panicle neck differentiation stage was 77, that of the branch differentiation stage was 78-87, that of the spikelet differentiation stage was 84-91, and that of the end of panicle pregnancy period was 98-100. The leaf-age index was considered to be a good indicator to determine the right time for top dressing of fertilizers.

3) When the young panicles reached branch differentiation stage (IV—VIII), the tillering reached its maximum, and approximately 5-7 days after the maximum tillering stage, the young panicle increased its length to 2–5 mm. This was considered to be a good time for the application of "panicle fertilizer".

4) Correlation coefficient between number of tillers and young panicle length is r=0.837–0.880, that between number of tillers and growing date is r=0.443–0.521. Tiller number can also be served as an indicator to determine the developmental stages of young panicles.

5). The maximum tillering stage was found to correspond to the leaf-age index of 70 in the first crop at Taipei, and 70-80 in the first crop at Chiayi. Correlation coefficient between leaf-age index and tiller number was r=0.98.

6). The distance between the auricles of the flag-leaf and that of the immediate lower leaf was also a good measurement to identify the different developmental stages of meiosis and young panicles, though it may vary according to varieties, planting densities and locations.

7). The effectiveness of the splitted way of fertilization to bring about the high yield of rice was discussed.

38. Study on the Genotype Variation and the Standardization of Embryonic Rice

The purpose of present studies is to set up the standard of embryonic rice and also to screen the suitable varieties for the embryonic rice processing.

The results indicated that tested varieties differed significantly in the percentage of residual embryo of milling rice. Toyonisiki is the best one for embryonic rice processing, Tainung 67 and Taichung 189 followed after it. Indica varieties are reversely. Generally, a variety with more short, wide and thick grain was more suitable for embryonic rice processing. The results suggested that the standard of embryonic rice should have more than eight degrees of milling whiteness than its brown rice and at least 70% of embryo left in the milling rice.

39. Variations in Ratooning Ability of Rice

One hundred and sixty three varieties of rice from different countries were evaluated for varietal difference in ratooning ability. The results indicated that the ratooning ability ranged from 0 to 122.9%, or differed from variety to variety. The indica-type (or Sen-type) varieties showed a higher (29.0%) ratooning ability than that of japonica-type (Ken-type) varieties (19.5%).

Broad sense heritability, estimated from various variety groups, ranged from 11.18% to 60.17% for ratooning rate and from 0 to 81.81% for ratooned tiller number. It is considered from the present study that the ratooning ability is heritable and can be used as one of the selective traits in a breeding program of rice.

40. Improvement of Rice Variety for Resistance to Blast and Bacterial Blight by Crossing Japonica with Indica

In order to improve the pest resistance of japonica rice, a hybridization by crossing japonica (Tainung 67) with indica (IR 4227-18-3-2) was made in the second crop of 1982. Although partial sterility and black husk grains appeared in the F_1 generation, the phenomena reduced following the backcrossing with japonica. From the progenies of the cross, two lines with the characters of high yield, similar rice quality as Tainung 67, but resistance to rice blast and bacterial blight were selected. This suggested that in the first backcrossing, the genes of blast and bacterial blight resistance in the indica had been transferred to japonica. On the other hand, the physico-chemical properties of rice in the selected lines were similar to Tainung 67, but the eating quality was better.

UPLAND CROPS

Sorghum, wheat, barley, triticale, buckwheat, cassava, sweet potato are the main crops under study at this station. Improvement of varieties and cultural methods for these crops are being carried out.

To cope with the governmental policy to turn part of the rice field into upland crop land, efforts are being made to develop new and high yielding hybrid sorghum varieties. As the results, Taichung Nos. 1, 2, 3 and 5 were released successively in recent years. Taichung 5 is now regarded as the most important variety in Taiwan because of its high yield, aphid resistance and good grain quality. It occupies 90% of the sorghum field in Taiwan at the present time. The improvements of male sterile lines and fertility restoration lines are being carried out and the new promising lines are continuously selected.

Wheat is one of the main winter crops in central Taiwan. This station has released several varieties including Taichung Nos. 29, 31 and 33. New wheat varieties Taichung (sel) Nos. 1 and 2 which are characterized by short stature, stiff straw, high fertilizer response and high yield, were released to the farmers in 1982.

Barley breeding is directed to develop varieties of low protein content (below 11%) to suit brewing. As for buckwheat, varietal improvement and experiments related to planting date, harvesting method, as well as utilization are all subjects of study at the present time.

Efforts are also being contributed to job's tear in the field of varietal improvement, mechanized methods of culture and utilization of grains (noodle, powder, tea, bread, etc.). Because of its high economic value and easy-planting nature, the acreage has been increased rapidly in recent years.

A. Grain Sorghum

1. Yield Trial of Grain Sorghum Hybrid

Four new grain sorghum hybrids-Taichung bred 69-22, 69-24, 69-27 and Taichung Yu No. 7 were tested with Taichung No. 5 as the check variety in the spring and fall crops of 1983 at 5 localities.

Results showed that Taichung bred 69-27 and Taichung Yu 7 have many good agronomic characters and high yield as compared to Taichung 5. The yield averaged over five locations were 5,753 kg/ha and 5,597 kg/ha, respectively, for Taichung bred 69-27 and Taichung Yu No. 7, namely, 10.9% and 7.9% higher than the check variety. Due to its high starch content and better germination rate, the hybrid Taichung Yu 7 is qualified to replace Taichung 5 which often germinates poor.

2. Regional Trial of New Hybrid Grain Sorghum

Hybrid sorghum tested under irrigated and non-irrigated plots showed different results. In the irrigated plot, the crop grew extremely well, yield was high and stable, in non-irrigated plot yield was poor.

In irrigated plots, Shiyuechia and Putzu, grain yield was 7–9 tons per hectare, but at Peikang plot, grain yield was affected by rains during maturity. Although, plant height did not differ between irrigated and non-irrigated plots. The grain yield, 1,000-seeds weight, and panicle length were significantly different. Peikang plot had longer growth period than the other.

Among the hybrids tested lines 69-2 and 69-6 had high yield potential, but the plants were too tall respectively 162cm and 178cm. The most promising hybrid in this trial was 69-24, it was dwarf, early maturity, slender stalk, loose panicle, good germination and intermediate resistance to aphids. Hybrid 70-1 has large panicle, dwarf plant, and high yielding potential. They are subjected to further test.

3. Cultural Practice for New Grain Sorghum Varieties

The results showed that new grain sorghum variety Taichung 5 has the best germination and grain yield under the seeding rate of 20 kg/ha and planting depth of 6 cm.

Although row spaces have less influence on agronomic characters but significantly affected the grain yield. Large space between plants obtained higher head weight. However, narrow space got more number of panicles per unit area. The highest grain yield was found in the planting space of 50x10cm.

Sorghum intercropped with bean at Peikang showed that 2-row sorghum with 2-row bean obtained the highest income (102,833 NT$/ha) but at Tacheng, the best was 3-row sorghum with 3-row peanut (106,833 NT$/ha). Either intercropping system gets higher income than the check of single sorghum plot.

4. Yield Trial of Newly Introduced Grain Sorghum

This yield trial was conducted at Chingsui and Tatsun in the spring crop of 1983 for the selection of suitable varieties in Taichung area. The growth period of C-10R was 86 days, R 17 was 98 days, R 49 and Taichung Yu No. 7 were 99 days. However, the rest of the lines were 1-9 days longer than that of the check variety, Taichung Yu No. 7. The new grain sorghum lines have plant height of 72.3 to

111.7 cm which were shorter than that of Taichung Yu 7 (134.1 cm) and Taichung 5 (124.4 cm). None of the newly introduced varieties showed higher yield than the two checks, Taichung Yu 7 and Taichung 5. Most of the newly introduced grain sorghum were short statured, early matured, insect and disease resistant as compared to the check. They were good for making hybrid sorghum.

5. Cause of Low Germinability in Hybrid Sorghum, Taichung No. 5

The germination rate of hybrid sorghum cultivar, Taichung No. 5 is usually low in the seed production in Taiwan. The cause of low germinability were regarded to be related with the anatomy, physiology and pathology of the seeds. However, all efforts failed to improve its germinability to pass germination test. This study, therefore, emphasized on the measures during seed harvesting, seed processing, seed drying, seed storage etc. The results were summarized as follows:

1. The low germinability of Taichung No. 5 was not correlated with its seed vigor, dormancy, post-ripeness and panicle storing heat.

2. The tannic acid content in the grain of Taichung No. 5 increased to 0.275% at middough stage and down to 0.134% at full-ripened stage, while the pathogenic infection rate of seed increased to 39.4% at harvest.

3. Taichung No. 5 can be divided into four groups by its seed size. The largest seed percent was 24.9% in individual panicle. This seeds obtained high tannic acid (0.191%), low pathogenic infection rate (29.8%), and best germinability (86.5%). Unfortunately, this part decreased to 7.9% during seed processing so that the germinability was down to 54.5% in average.

4. The seed breakage including damage of testa, endosperm and embryo changed from 9.4% to 49.0%. This breakage was due to mechanical damage by using tractor and combined harvester during de-seeding process.

5. Contribution percentage computed by path analysis was evaluated for the cause of low germinability in Taichung No. 5. It indicated that seed breakage resulted from mechanical damage was the major factor to cause pathogenic infection to induce the low germinability in Taichung No. 5.

B. Sweet Sorghum

1. Biomass Yield, Juice Quality and Alcohol Production of Sweet Sorghum

Cultivation of energy crops under the normal conditions to produce biomass energy is thought to be one of the important ways to develop substitute energy.

The present experiment was conducted to detect the biomass yielding capacity, juice physicochemical properties and the alcohol productivity of the selected sweet sorghum line AM-4, and to evaluate its possible value as an energy crop.

The results showed that AM-4 had the advantages of high biomass yield (44.4–46.1 t/ha), high brix value (18.2–23.2) and sucrose content (11–12%), short growth period (four months) and wide adaptability. Results from the fermentation test indicated that higher than 9% of alcohol production rate can be obtained through the juice fermentation with either S. cerevisiac or Sf yeast strain at 30°C within two days. The needed temperature can be easily achieved by the use of the abundant solar radiation in Taiwan. Therefore the input cost can be reduced considerably.

2. Studies on the Stalk and Grain of Sweet Sorghum for Alcohol Fermentation and Animal feed

The results showed that the sooner to squeeze the juice from the stalks of sweet sorghum after harvesting, the higher the rate of its sugar content, and the quantities of alcohol production through fermentation.

The residues of the squeezed stalks of sweet sorghum still had 3.62-7.36% crude protein and 1.77-3.01% crude fat contents. Variety Keller, for example, had 7.36% crude protein and 1.83% crude fat in the stalk residues that was still suitable to feed the cattle.

In general, the crude protein content of sweet sorghum grain was as high as 9.88%, and crude fat was above 3.33%, that were also good for animal feed.

The juice of sweet sorghum could be directly used for alcohol fermentation without adding any nutrients by Zymomonas mobilis B-906 and Saccharmyces formosensis.

3. Population Densities in Sweet Sorghum Cultivation

Data collected from two locations indicated that the highest stalk yield 44-46 tons/ha were obtained at the row-plant spaces of 50x10cm.

Wide space tended to have large stalk. However, narrow space gave more number of millable stalk per unit area.

4. Planting Date of Sweet Sorghum

This experiment was conducted to find out the optimum planting date for the spring and fall crops in central Taiwan.

The results showed that for the fall sweet sorghum, the crop should be planted before the late August, to obtain high fresh stalk yield (34,667–57,666 kg/ha), high stalk juice production (14,2000–24,249 kg/ha) and high alcohol production via fermentation. Sweet sorghum was unsuitable to grow in the spring crop season in central Taiwan.

5. Harvest and Squeeze Dates on Sugar Content of Sweet Sorghum

The result suggested that the optimum harvesting dates for sweet sorghum hybrid AM-4 were from milky to maturing stages. Harvested during these stages obtained a maximum brix of 12.3% and 14.7%, respectively. It also showed that the sooner to have the sweet sorghum squeezed, the more juice to be obtained. For example, 3kg of stalk could get 1.09 kg juice if squeezed in one day after harvest. However, it showed 0.48 kg reduction in juice if squeezed 12 days later.

C. Barley

1. District Yield Trial of New Barley Lines

Four barley lines CB-3, CB-10, CB-15 and JB-3 were grown with two check varieties, Chung-hsin No. 1 and 2 in Shiusui, Tacheng, Longching and Taya in Taichung district. In general, Two-rowed barley (JB-3 and Chung-hsin No. 2) showed lower grain yield than the six rowed barley (CB-10, CB-15, and Chung-hsin No. 1). The former barley had less number of grains per spike. Since CB-15 had good agronomic characters with a growth period of 122 days from planting to harvest and 82cm in plant height, its yield (4,302 kg/ha) was the highest among the tested lines.

2. Cultural Methods for New Barley Lines

Two cultural methods combined with three seeding rate were conducted with two fold split plot design. Four new barley lines were planted at Taya, Shiusui and Erhlin. Among them, CB-15 obtained the highest grain yield. However, with 12% of protein content, it was no good for brewing. Broadcasting obtained significantly higher grain yield than the row planting. The grain yield from the plot

seeded at the rate of 90kg/ha was similar to that of 120kg/ha, but the barley from the former plots seemed to have low protein content. Therefore, for brewing purpose it should be broadcasted at the rate of 90kg/ha.

3. Different Genotypes and Cultural Methods on the Grain Yield and Protein Content of Barley

This experiment was designed to study the effect of 4 spring genotypes (six-rowed lines CB-15 and CB-3, two-rowed lines JB-3 and Chung Hsin No. 2), 2 sowing methods (broadcasting and row seeding) and 3 seeding densities (60kg/ha, 90kg/ha and 120kg/ha) on the grain yield and protein content of barley. A two-fold split plot design was used in the three experiment sites at Taya, Shiusui and Erhlin. The results are summarized as follows:

1) The results showed that the line CB-15 had the highest grain yield among the 4 genotypes, especially at Erhlin where grain yield was 4,968 kg/ha. However CB-15 was unsuitable for brewing due to its higher protein content.
2) As to sowing methods, broadcasting obtained significantly higher yield than rowseeding.
3) The grain yield was not significantly different between the two seeding densities of 90kg/ha and 120kg/ha. But broadcasting at the rate of 90kg/ha resulted in low protein content, and was good for brewing beer.

4. Correlation and Path Analysis of Important Characters in Spring Barley

The main purpose of this study was to find out the correlation between yield and yield components of spring barley varieties grown during the winter season in Taichung, Taiwan. These experimental materials included 31 two-rowed barley varieties and 32 six-rowed barley varieties collected from Japan, USA, Mexico and Taiwan. Seeds of barley were sown on November 14, 1979.

The coefficient of variation and simple correlation among agronomic characters of two- and six-rowed spring barley were studied separately. The grain yield and its components of spring barley were also investigated by multiple regression and path analysis.

Results of the studies indicated that the genetic behavior of cultivated barley differs in different spike types (two-row or six-row).

Tests of simple correlations showed significant negative association between heading days and grain yield in two-rowed barley. Highly significant positive

correlations were found between grain yield and fertile spikes, spike weight, number of rachis node per spike, kernels per spike and volumetric weight. Therefore, all of these characters can be used as major characters for selecting high-yielding varieties in two-rowed barley. Similarly, kernels per spike, seed fertility, volumetric weight, fertile spikes, spike weight and number of rachis node per spike were the most effective characters in the selection of high yielding varieties in six-rowed barley.

The results of multiple regression and path analysis indicated that fertile spikes, spike weight and kernels per spike are the three major factors which caused high yield in two-rowed barley, and kernels per spike, fertile spikes and volumetric weight in six-rowed barley. It seems that these characters can be used as a selection criterion in barley breeding programs.

A highly significant negative correlation was also found between grain yield and grain protein content and husk percentage in two- and six-rowed spring barley.

5. Influence of Planting Dates and Planting Methods on the Yield and Quality of Brewing Barley

Two-row barley (Chung-hsing No. 2) and six-row barley (CB-15) were used to study the effects of planting dates (Oct. 25, Nov. 5 and 15) and planting methods (broadcasting, single-row drilling and double-row drilling) on the agronomic, yield and quality characters. Experiments were conducted at Fushing and Taan areas. The results of variance analysis showed that, in general, planting date had more effect on the performances of barley than planting methods. No interaction was found for the two treatments. The yield difference was not significant among the three planting methods tested. However, there was a tendency that broadcasting might increase the grain yield of barley. Planting methods did not affect the quality (e. g., protein content and 1,000-grain weight) of the grain. Neither did broadcasting show any positive effect on quality characters. The influence of planting date on yield and brewing quality varied according to variety and location. Correlations between characters showed that yield and quality of both varieties were markedly influenced by environmental factors. Lodging was suggested as a significant factor in decreasing the brewing quality of barley.

D. Wheat

1. District Yield Trial of New Wheat Lines

Sixteen new wheat lines were evaluated in yield trial conducted at 3 locations,

Taya, Shiusui and Kuoshing in Taichung district. The results showed that grain yield of CI13-224, CI17-006, CI12-037, CI13-279 and CI13-452 were 20-48% higher than that of the check variety (Taichung wheat Sel. No. 1). Among these 16 lines, CI12-038 had outstanding agronomic characters of 82 cm in plant height, 41.3 gm of 1,000-kernel weight and a growth period of 128 days from planting to harvest.

Five wheat lines, CI11-259, CI12-206, CI12-443, VI13-434 and Taichung wheat Sel. No. 1 were selected for advanced district yield trial. CI12-443 has the good characters of 83cm in plant height, 38gm of 1,000-kernel weight, 57 days from planting to heading stage, 127 days from planting to harvest and 4,688 kg/ha of grain yield.

Although CI12-443 was highly resistant to rust and powdery mildew, it was lightly susceptible to BYDV-like disease. Since CI12-443 has good potential, it was registered as Taichung wheat Sel. No. 2 in March, 1983.

2. Yield Trials of Newly Bred Wheat Varieties and Correlation Analysis of Their Agronomic Characters

This experiment showed that varied field managements resulted differently, especially the irrigation after heading. Trial at Tatsun was conducted under early planting and irrigation on time.

The result showed that correlation coefficients between yield and heading days, plant height, fertile spikes and test weight were positive and highly significant.

Trial at Shiusui was conducted under regular planting date and no-irrigation after heading. The result showed that the correlation coefficients between yield and heading days, maturing days and plant height were negative and significant. However, the correlation coefficient between yield and test weight was the same as the trial at Tatsun.

3. Estimates on Heritability of F_2 Progeny and Selection Criterion on Reproductive Characters of Early Generation of Wheat

In order to estimate selection index for breeding, a study on the broad sense heritability of agronomic and yield component characters of 7 F_2 progenies crossed from 7 parents were conducted. This experiment was carried out in Taichung. The results were summarized as follows:

1). The modes of gene action on heading days and plant height appeared in near normal distribution showing polygenic-additive effect. Estimated mean of

heritabilities for both traits were highly significant with a range from 70% to 94%. Moderately high heritability for harvest index was estimated with a range from 57.9% to 64.4%.

2). The experimental results in two crosses of CI11-17xW.T.S. No.1 and CI11-68x W.T. No. 33 showed that the genetic effect were negative with highly significant between heading days and grain yield but positive with highly significant between flag leaf width and grain yield, 1000 kernels weight and grain yield, harvest index and grain yield. Using reproductive characters as dependent variables and other agronomic characters as independent variables, a multivariant analysis was conducted by multiple regression equation. The results indicated that the improvements of selection in kernel numbers per spike, kernel numbers per spikelet and grain yield of these two crosses were on genetic effect in F_2 early generation. But the selection criterion for grain yield improvement on harvest index of these two F_2 crosses, showed highly significant effect. Since high correlation existed between grain yield and harvest index, grain yield may be improved indirectly by improving harvest index.

4. Grain Yield and Quality of Spring Wheat Grown in Different Years

This studies dealt with the grain yield and quality of 100 spring wheats grown over three years (1978-80) in Taichung. The results were summarized as follows:

1. Stepwise multiple regression analysis was made taking grain yield as dependent variable and other agronomic character as independent variables. The results showed that earlier heading date, higher plant height, higher grain fertility, greater kernel weight and volume weight contributed significantly to the grain yield.
2. The high positive correlations between protein and dry gluten contents as well as between dry gluten content and baking volume were observed. The baking volume is mainly determined by glutenin content in flour. Although high protein content can't fully express the high baking quality, it is still a useful selecting index in wheat breeding program.

E. Triticale

1. District Yield Trial of Triticale Lines

A total of 11 triticales lines was involved in this experiment conducted at Taya and Hsinyi. The results were summarized as follows.

1. Taya plot was in paddy field area and Hsinyi plot in upland area. Due to different environmental factors the characters of triticales became very different. The average heading days of triticale in Hsinyi was 20 days longer than that of Taya, and the average yield in Hsinyi (2,138 kg/ha) was 870 kg/ha higher than that of Taya. The results showed that Hsinyi was suitable for triticale.
2. T-11-196 performed the best among the 11 tested lines in both areas. Its grain yield was 2,262 kg/ha, namely 40% outyielded the check variety Taichung Yu 1. The T-11-196 was 133 days from planting to maturity and 106 cm tall. The lines may fit the winter catch crop season.

2. Yield Trials of Newly Bred Triticale Varieties

This experiment showed that all the variances of agronomic characters of the crop were significant. The correlation coefficients between yield and maturing days, plant height and fertile spikes were all highly and positively significant. The average test weight and fertile rate of triticale were still low and resulted in low yield. The maturing dates of triticale were too late to fit it as a winter catch crop. So early maturity, highly fertile rate and high yield were the important characters to be improved in our triticale breeding program.

F. Job's Tears

1. Planting Density on the Growth of Job's Tears

Low planting density in paddy field resulted in increased fertile tillers, spikelet number, grain number and unit grain yield. The plant height and total yield were not proportion to the increase of yield components. From the results of polymonial equation analysis, the optimum plant population was 125,000 plants per hectare in paddy field with respect to the highest grain yield. Under dryland conditions, it was difficult to obtain high yield by high plant density. Higher planting density resulted in poor yield, poor seed fertility and less fertile tillers per plant owing to more competitive effects. The good planting density was 50 x 20 cm or 60 x 15 cm. As far as two cultivated conditions were concerned, the job's tears was more adaptable for high planting density in paddy field than in dryland field.

2. Cultural Method of Job's Tears

Job's tears grew well in paddy field. The proper time for transplanting of

seedling is 25 days after sowing for the first crop and 15 days for the second crop. Direct seeding yielded 2.24-2.87 tons/ha of grain, which was 75-87% less than that of the transplanting. This is because that the germination and seedlings of job's tears are easily damaged by the flooding during seedling stage.

G. Buckwheat

1. Newly Introduced Buckwheat Varieties

Twelve exotic buckwheat varieties were introduced to Taichung DAIS. This observation trial was conducted for the investigation of their agronomic characters and yield potential. The result showed that all exotic varieties were shorter than 72.9 cm and matured 16-31 days earlier than the control, Kao-sha. The grain yields of Shi-nung 1 and Hokaido were 34.8% and 18% higher than the check variety, Kao-sha (2,055kg/ha), respectively, however, others were 15.4% to 59.2% lower than control.

2. Planting Dates and Furrowing Practice in Buckwheat

Experiments were conducted on Oct. 1, 1983 with a sequence of 15-day interval. The result showed that early planting induced higher grain yield for having long vegetative growth; while early flowering resulted in low grain yield when the planting date was later than Nov. 11, 1983. Kao-sha is more suitable for early planting than Feng-ten 1.

Four furrowing methods, namely: normal-tillage (NT), semitillage (ST), non-tillage with rice straw coverage (NTRS), and non-tillage with rice straw ash coverage (NTRA) were designed to identify the best cultural practice in production.

The result showed that owing to have better germination rate and more unit plants, ST practice gave higher grain yield than other practices.

H. Edible Canna

1. Yield Trial of Edible Canna Varieties

Yield trial of two edible canna varieties, green leaf and red leaf were planted in two locations in Taichung area. The result showed that tuber yield seemed significantly affected by soil fertility and soil texture. In general, more canna tubers were produced from fertile soil. It caused early maturing and low tuber production

as it was grown in sandy soil. Red leaf variety produced more tuber with rich starch content as compared to green leaf variety.

Edible canna was significantly influenced by soil texture and organic matter content (OM). In general, edible canna produced 12.09%-50.47% more tuber in sandy loam with higher OM. However, as compared with green canna, red canna possesed higher yield potential under water stress condition. Besides, red canna also produced 2.3%-3.4% more starch than green canna (16.3%-17.8%).

2. Planting and Harvesting Dates on Tuber Yield of Edible Canna

Green and red edible canna cultivars were planted in four growth periods at one-month interval from Dec. 16, 1981. High canna tuber yield was obtained by Dec. 15, 1982. Most canna plants died before Jan. 1, 1983. It can not survive to overwinter. Besides, the new shoots produced as it was harvested on Mar. 15, 1983. The starch content of canna was affected by growth period. Higher starch content was obtained by the shorter growth period and the lowest starch content of canna was obtained on Mar. 15, 1983.

Four planting dates in combination with four harvest dates in a 15-day interval were designed to evaluate the effect of planting and harvesting dates on the tuber production of edible canna. The result showed that early planting (Dec. 16, 1983) did not help tuber yield as compared to the late planting on March 16, 1982. However, late harvest (March 15, 1983) obtained higher yield in tubers but got lower starch content than that of early harvest one. It is suggested that canna is unnecessary to be planted in winter, but harvest before the spring season is necessary.

3. Planting Density on Growth and Tuber Yield of Edible Canna

A yield trial consisting of six individual spaces (30, 40, 50, 60, 75, and 90cm) combined with a row distance of 60 cm was conducted at two locations. Among the six treatments, 60 x 30 resulted in higher plant height and more tillers and higher tuber yield. However, starch content was inversely correlated to tuber yield. Although dense planting treatment (60x30) produced 24.15% more tuber than that of thin planting (60x90), it reduced 2.31% starch as compared with the latter.

Soil fertility influenced the tuber production and starch content of edible canna. In general, more tubers were obtained from fertile soils and the proper planting density for canna is 60x50 or 60x60 cm. Higher planting density often caused 1-2% reduction in canna starch percentage.

4. Tuber Size and Planting Depth on the Growth and Yield of Edible Canna

An experiment consisting of four tuber sizes (200, 100, 50 and 20 gm) combined with three different planting depths (10, 5 and 0 cm) was conducted at 2 locations. The results showed that the larger the tuber was planted, the higher the tuber yield was obtained. Since soil moisture was quite different in the 2 locations, it indicated that deep planting treatment (10cm) induced more tuber to germinate under water stress condition. However, there was no significant difference in starch content among the planting depths.

Big seed-tubers resulted in tall plant and higher tuber yield. Deep planting delayed the emergency of canna bud so as to decrease the tuber yield. However, tuber size and planting depth did not have significant effects on the starch content of edible canna. The better cultural method for edible canna is to select big seed-tuber and shallow planting.

5. Studies on the Agronomical Characteristics of Edible Canna Tuber

Two local edible canna cultivars, i. e. green leaf variety and purple leaf variety were involved in this experiment to evaluate their differences in tuber characteristics. The results showed that purple leaf variety yielded 1205.4 gm/plant of tuber in fresh weight which was 133.0% better than that in green leaf variety. The agronomical characteristics of tuber number, tuber fresh weight, tuber moisture content and crude starch extraction rate found in purple leaf variety were 20.9/plant, 55.6 gm/tuber, 66.4% and 22.9%, respectively and those in green leaf variety were 10.0/plant, 49.9 gm/tuber, 55.7% and 13.5%. However, the better tuber germination rate (61.8%) and seedling growth rate (0.96 cm/day) found in green leaf variety seemed to be the reason why the farmers accepted it as a popular cultivar.

I. Soybean

1. Root Activity and Photosynthetic Rate on Grain Yield of Soybean

We evaluated the relationship among root activity, photosynthetic rate and yield of soybeans. Excluding a-NA oxidizing act., P-32 absorption rate, root respiration rate and succinate dehydrogenase act. were concurrently related with the photosynthetic act. of soybean plants. Moreover, soybean cultivars with high grain yield obtained high shoot growth, while the plants passed the pod-filling stage, the growth of plant height stopped earlier before this stage. In poor yield cultivars, plant

height continuously grew, but the shoot weight stopped growing 5-10 days before pod-filling. This suggested that higher root activity in pod-filling stage of soybean plants could be a sensitive indicator for selecting a high yield variety.

2. Selection Index of Effective Rhizobium Japonicum Nitrogen Metabolism of Denitrifying Rhizobia

TGP-042 is an indigenous effective rhizobia. As compared to ineffective strains, TGP-042 maintained 70% (1.17 umole C_2H_2/plant/hr) of N fixing ability in 50 ppm N soil. Specific activities of nitrate reductase and nitrite reductase in TGP-042 were very active and it produced N_2O or N_2 gas in anaerobic Durham tube. The available N found in the rhizosphere of nodulated soybean was reduced to 10.5-14.7 ppm. The evidence suggested that TGP-042 is a denitrifier and its effectiveness is correlated to its tryptophane/IAA conversion rate in vitro. Hereby, the antagonism between TGP-042 and combined nitrogen is deleted.

3. Alkali Production and Denitrification Properties of Rhizobium Japonicum

Due to crop rotation system, soybean cultivation in Taiwan is always followed by paddy rice. Based on a five-year study, only 32.6% (8.08/24.80) of effective nodules/plant was measured in 616 localities. Since soil was immersed for about 6-7 months before soybean planting, the failed revealed low nodulation and resulted in less rhizobia population by 6,309-63,095/gm soil around the V_3-R_2 developmental stage of soybean rhizosphere. Besides, acidic soil condition (pH5.6) and high residual nitrogen content (44.9ppm) were statistically significant to inhibit the nodulation.

However, a few indigenous isolates kept alkali producing ability in acidic nutrient broth (pH4.0). These rhizobia can produce more crude polysaccharide so as to shorten their lag phase when they were in acidic condition. This was the reason why pH variation in rhizosphere were usually 0.4 unit higher than that of surface soil. Moreover some isolates (30/616) with denitrification ability could still maintain certain N_2 fixing ability (C_2H_2 reduction ability) in 50 ppm NO_3-N soil.

4. Denitrifying Rhizobium Japonicum on Soybean-Maize Cropping System and Soil Fertility

TGP-042 is an indigenous nodule bacteria (Rhizobium japonicum), which was isolated from Kao-Ping area of the southern Taiwan. The objectives of this study is aimed to evaluate the influences of soybean inoculation and ammonia fetilization on soybean-maize cropping system. Results are summarized as follows:

More nitrogenase activity (2.64 umole C_2H_2 , / plant / hr) was detected in Taichung 4 soybean nodules. On the basis of seedling growth and chlorophyll content, the difference was insignificant between nodulation treatment and 20 kg/ha basal N application one. According to the previous report, TGP-042 was a denitrifying bacteria, therefore, it maintained 82.2% of nitrogenase activity when 20 kg/ha basal N was applied.

TGP-042 supplied 13.8 mg per plant of biological fixed nitrogen (BFN). However, this unit plant BFN reduced to 2-2.0 mg in proportion to the increase of 20-60 kg/ha ammonia fertilizer; and 22.3-35.0 mg N per plant due to ammonia fertilization (AF) was also in parallel to the increase of ammonia application rate. This suggested that more AF stayed in shoot to induce higher vegetative growth; otherwise, more BFN in nodulated plant might be translocated to the pods.

Soil factors varied at soybean harvest, i.e. soil pH was 0.45 unit higher, organic matter was 0.52% lower, P_2O_5 was 24.5 kg/ha lower and K_2O was 5.9 kg/ha higher. Soil total nitrogen in nodulated plots significantly increased for 0.02-0.05% which was consistent with 2.03-4.12 ppm of soil available nitrogen increase. The growth effect of residual nitrogen due to previous soybean crop was the same as suppling with 20 kg basal N to 20-day maize seedlings.

Based on the soil available nitrogen variation during soybean-maize cropping system, maize may absorb 13.2—33.4 kg/ha of residual nitrogen. Treatment of inoculation with TGP-042 and 20 kg/ha basal N was rather out-standing which remained 33.4 kg/ha N and yielded 3.23 ton/ha of maize grain.

Hence, the cropping system in central Taiwan may be suggested as rice-soybean-maize. Besides, inoculation with denitrifying effective rhizobia and supplying 20 kg/ha basal N for soybean planting is necessary.

5. Root Activity and Photosynthesis on Grain Yield of Soybeans

This experiment was conducted to evaluate the relationships among root activity, photosynthetic activity and yield of soybeans. Except a-NA oxidizing activity, P-32 absorption rate, root respiration rate and succinate dehydrogenase activity were concurrently related with the photosynthetic activity of soybean plants. Moreover, soybean cultivars with high grain yield gave high shoot-growth while plants were pod-filling and the growth of plant height stopped before this

stage. In the low grain yield cultivars, plant height continuously increased, while shoot weight stopped 5-10 days before pod-filling. It is suggested that the high root activity of soybean in pod-filling could be a reliable index for grain yield selection.

J. Others

1. Labor-saving Cultivation in Sorghum, Soybean and Corn Production

The objectives of this experiment were to find out a good cultivation practice for saving labor in sorghum, soybean and corn.

The results showed that yield and net profit of both sorghum and corn could be increased significantly by means of irrigation and fertilization during growth stages. However, as far as the net profit and labor cost were concerned, the cultural practices including non-tillage, irrigation and fertilization in sorghum; non-tillage, irrigation, fertilization and pest control in corn were the best. The studies on soybean cultivation during summer crop showed that non-tillage with fertilization but without weed and pest control may save the labor cost.

2. Flooding Resistance of Tainung 351 Corn

A new high yield corn variety, Tainung 351 was released recently to provide as a subsitute crop for paddy rice. Evaluation was made to study the flooding resistant ability of this variety. As compared to local varieties, Tainan 5, Tainan 11 and Tainan 16, Tainung 351 germinated well in a wide soil moisture range between 45.2% to 86.2% of maximum holding capacity (MHC) and those local varieties only showed good germination at 72.7% MHC. Taichung 351 also got 45.0% higher germination rate than others after a 2-day flooding treatment. It was found that CaO_2 seed-coating could not improve the low germination caused by flooding.

However, CaO_2 coated seeds reduced microorganism infection by 41.3%. While different ages of seedlings were under a 5-day flooding treatment; 10-days-old seedlings were more sensitive to water logging than the others. Flooding treatment caused the wilting of lower leaves and yellowing. In conclusion, Tainung 351 has been proved to be more resistant to water logging and was suitable as a substitute crop in paddy field than local varieties.

3. Cropping Pattern Improvement for Rice Substitution Crops in Paddy Field

In order to find out an optimum rotation system for growing upland crops in paddy field, some experiments were designed to study the efficiency of six substitution crops for the 1st rice crop season and eight crops for the 2nd season on their yield and net profit.

The results indicated that job's tears was the best substitution crop for the 1st crop in paddy field due to its highest net profit, then followed by corn and sorghum. For the 2nd crop, the better substitution crops were soybean, corn and peanut. All of them gave higher net profit than rice. Therefore, in order to achieve the objective of reducing rice production and to obtain high net profit, the suggested crop rotation systems are: rice-soybean-wheat, rice-green manure-corn, rice-peanut-fallowing, and rice-sorghum-wheat.

4. Studies on the Cropping Pattern Changes in Low-Yield Paddy for Dryland Food Crops

To evaluate the possibility for changing the cropping system in lower yield area of rice, experiments were conducted in Tachia and Sensi, during the 1984 crop seasons.

The result showed that sorghum and corn are the ideal crops as a substitute for the first crop of rice in Tachia. The pattern of sorghum-sorghum (ratoon)-corn may be the best cropping system to replace rice production in this area. However, the crops used in this experiment can not replace rice crop in Sensi.

HORTICULTURAL CROPS

Vegetable breeding work on pea, Chinese cabbages, cabbages and other vegetables are emphasized. The pea varieties Taichung 9, Taichung (sel) 1 (for pea use), Canner King, Perfection (for green pea use), Black Eye and Melting Sugar (for sprout use) are now extensively cultured by the farmers. The recently developed pea variety Taichung 11, characterized by its bright green color, sweetness and tender eating quality, is currently the most popular variety in Taiwan.

The muskmelon variety Taichung 1 developed by this station has excellent eating quality and good skin appearance and is suitable for greenhouse culture.

The protected culture methods, including water culture, plastic-tent culture, etc., for various vegetables are now being studied to produce pesticide-free vegetables. It is expected that the protected way of vegetable production will be introduced to the growers in the very near future.

Fruit tree researches are directed to develop the techniques of regulating the flowering time so that the fruit trees can be harvested 2-3 times a year. Practical techniques, such as the application of growth regulator cyanamide and defoliation practices, have been developed on grape vine and three harvests a year is now possible for grape production in Taiwan. Another example is the top-grafting of temperate-zone pear on Hengshan pear to regulate the flowering time of the latter. Pears can also be harvested 2-3 times a year to meet the market demands. Other fruit trees under study with regard to the similar nature are tropical mango, peach, plum and other fruit trees with certain degree of success. Basic physiological studies related to the regulation of harvesting time, such as the status of flower-bud formation and development following plant hormone treatment, are being taken with the help of electron microscopic and biochemical anaylses.

A. Vegetable Crops

1. New Pea Variety-Taichung No. 11

Taichung No. 11 is a new edible podded pea cultivar developed in Taichung District Agricultural Improvement Station by crossing Odome (female parent) to Melting Sugar (male parent). It was named and released in 1980.

The plants are about 160 cm in height, having large leaves with lemon-green color, pinkish-white flower, more vigorous and quite resistant to drought and hot weather as compared with Taichung No. 9. It first sets on the 17th node, about 57 days for first picking under winter catch crop condition, or 10 days earlier than Taichung No. 9. The yield of Taichung No. 11 was 58% higher than Taichung No. 9 in the local yield trials. Edible pods are 8.76 x 1.52 cm., bright green,

straight, thick-walled, blunt ended, borne singly, sweet, tender, excellent in quality, and adapted for fresh market and quick freezing.

2. Pea Breeding

This breeding program was subjected to develop new edible podded pea cultivars with resistance to powdery mildew and to select new cultivars of snap pea.

From the progenies of (Taichung No. 11 x Manoa Sugar) and (Snap Sugar x Knight), 8 podded pea lines and 3 lines of snap pea were selected respectively, and will be used as experimental materials in next crop season.

3. Breeding of Rust-Resistant Kidney Bean Varieties

The purpose of this breeding program is to develop new kidney bean varieties for being resistant to rust by the backcross method.

This breeding program was started in 1978 by using "Black-seeded Creasback" as recurrent parent and "15R-55-BK" as donor parent. After backrossing two or three times, the breeding material is handled by the pedigree method.

According to the result of preliminary test in 1984, 72-7-11 and 72-7-12 were considered as promising lines. They all possessed high degree of resistance to rust and other good characteristics.

4. Variety Trials in Cabbage

Regional tests of thirty-seven cabbage cultivars of domestic and foreign resources were performed. The results showed that Tzao-chiou cabbage, Know-you 691, Know-you 692, Shyr-Jiau 8312 and Shiah-chiou cabbage are early and can be harvested in 55-60 days from transplanting. Occuring incidence of black rot disease was found to be lesser in YR50, Shyr-Jiau 8212, Shyr-Jiau 8213, and YR Jiin-chiou cultivars.

5. Regional Trial of Baby Carrot

The growing period of baby carrot is about 70-80 days. It is suitable as a interrelaying crop between the first and the second crop. Result of spacing trial showed

that the spacing of 10x5 (cm) had the best yield of 3,975 kg/10a.

6. Purification of Chinese Leek

After 2 years observation, 18 promising lines were selected from 300 collected lines of Chinese leek Cv. "Nan-Hua". The average plant height of the 18 lines was 36.4 cm and the number of branches per plant was 4.5.

7. Purification of Water Chestnut

This experiment was conducted to purify and evaluate the 8 collected varieties of water chestnut.

Among the 8 varieties, Homei B had the largest tuber size. The average size was 3.27x2.05 (cm). The next were Thailand and Fuchou varieties.

The average tuber weight of 8 varieties was 11.2g, among them Homei B had the largest tuber weight (13g), the next were Fuchou (12.4g) and Tailand (12.1g).

8. Improvement on the Cultivation Technique of Water Shoot (Zizania latifolia Turcz.)

The wide-narrow row triangular planting increase the plant number about 33.3% per 10 a, but the diameter and weight of water shoot young stem are decreased, so the yield just increased about 15% per 10a only. The cultural method is inconvenient in field management, therefore it is necessary to be improved.

C.C.C. treatment retarded the elongation of leaf sheath. The plant treated with C.C.C. reduced about 11.6% in length as compared with that of non-treated. The difference of tiller number and yield between C.C.C. treatment and control are not significant.

9. Cultural Practice of Honewort

Honewort is a new kind of vegetables in Taiwan, the way of its cooking and taste were similar to celery. The growing period is about 90 days.

The result of fertilizer experiment showed that the rate of N-P_2O_5-K_2O at 225-50-50 kg/ha had higher yield (green plant) of 2,958 kg/10a among the 5 treatments.

Among the 4 treatments of Gibberellin spraying, the concentration of 50ppm had the best effects on stem elongation and yield performance (3,540kg/10a) from the economic viewpoint.

Seed production test showed that the best time for seed harvesting was 90 days after flowering, which had the higher seed yield (148g/10m^2) and the best germination rate (80%) among the 4 treatments.

10. Effect of Herbicides on the Weed and Radish Growth

Seven herbicides, A-820, diphenamide, oxyfluorfen, alachlor, linuron, propazine and pendimethalin were applied in radish field to test the efficiency of controlling annual weeds. The results indicated that radish was seriously injured by linuron and propazine. A-820, diphenamide, pendimethalin caused no crop injury and radish yield was similar or even better than the hand weeding plot. Alachlor at the rate of 1.72kg ai/ha showed slight injury to radish. Oxyfluorfen applied preemergence at 0.24 or 0.35 kg ai/ha were effective against annual weed, but showed 19% and 35% injury rates respectively. Among the seven herbicides, oxyfluorfen, linuron and propazine controlled most annual weeds effectively. The uncontrolled weed growth caused the highest reduction in radish yield (80%). Stomp and A-820 were the most suitable herbicides for the annual weed control in radish field.

11. Growth Characters of Carrot (Daucus carota)

Six characters in three types of carrot varieties are investigated for studying their growth behavior. Results are summarized as follows:

(1) Growth curve of leaf number, leaf length and root length were stable. The leaf weight and root weight were increasing rapidly from the 8th weeks, and the root size was increasing rapidly from the 6th weeks after sowing.

(2) The small type variety of carrot showed high growth efficiency of root at 10th to 12th weeks, and the middle and large type varieties of carrot showed at 12th to 14th weeks after sowing.

12. Genetic Behavior and Breeding of Sweet Pepper

Fifteen characters were investigated to study their genetic behavior in the parents, F_1 and F_2 generation of a diallel cross (not include the reciprocal cross) involving four Capsicum annuum varieties.

Data were used to estimate the phenotypic and genotypic correlations among various characters and path coefficient among the yield and yield components. Results are summarized as follows:

(1) In general, genotypic correlation was found to be higher than phenotypic. Yield was significantly correlated with the number of fruit, fruit width and flesh weight, and was correlated negatively with days to first flower and fruit maturity.

(2) Path analysis showed that yield was mainly depending on the number and weight of the fruits. The fruit number had an appreciable direct and indirect effect on yield and influenced the yield through fruit weight and fruit length.

13. Adaptation and Variety Improvement of Fresh Soybean Production in Taiwan

8 varieties of fresh soybean from AVRDC were taken as materials for this regional test, where the variety Tzuzunoku was the check. The results indicated that high photoperiodism sensitive and medium photoperiodism sensitive varieties were not suitable for the spring crop. The high productivities of autumn crop may be resulted from the high temperature and short day in the autumn that dwarfed the plants and increased the branch numbers. So far as the cultivation and market demand are concerned the variety Tzuzunoku still stands the best.

14. Use of Non-woven Material in Yellow Leek and Cauliflower Production

In this experiment, we evaluated the effects of non-woven material on the quality of yellow leek and cauliflower. The results indicated that covered with native non-woven material could not improve the quality of yellow leek due largely to the high light transparency and water-retaining ability. High rotting percentage (90%) and more greenish of yellow leek were obtained from the plots covered with native non-woven material than that of imported material.

In cauliflower, the color of curds turned slightly yellowish when covered with native non-woven material, and lodgging of plants as well as the rotted curds were found frequently due to the high water-retaining of this material as well as the over-burdening of the plants.

15. Improvement of Common Bean Varieties for Rust Resistance

(I) Development of rust resistant common bean lines

The objective of this study is to develop new rust-resistant bean varieties for stablizing the bean production in Taiwan.

This work was initiated in 1977 to make a screening for the rust-resistant parental lines. Original cross between Black Creashack (recurrent parent) and 15R-55-BK (donor parent) was made in the fall of 1978. After two or three backcrosses, the progenies were subjected to selection and line yield trials. Preliminary result showed that 72-T-11 and 72-T-12 had high level of rust resistance. The former also showed high yield and low first-poded node and the latter gave long pods of good appearance.

16. Improvement of Common Bean Varieties for Rust Resistance

(II) A comparison test for the newly bred rust resistant lines

A comparison test was conducted in two different crop seasons for the newly bred lines of common bean, Taichung 1, 2, 11, 12, and 15 obtained from a back-cross breeding. The check variety was the recurrent parent cv. Black Creasback. The results are summarized as follows:

1. All the tested lines performed the same or better than the check variety in terms of days to first harvest, last harvest, pod shape, and pod color. Line Taichung 11, yielded the highest in both crop seasons, being 26.7% and 32.6% higher than that of the check. Line Taichung 12 yielded slightly higher than its recurrent parent, also with its long, round and straight pods, showing a good marketing potential.
2. All the tested lines had less rust infection than the control variety in both crop seasons. In the spring crop, the infection rate of Taichung 11 and Taichung 12 was 1% that is much lower than the 19.5% of the check. The corresponding values for the fall crop were 10.3%, 5% and 87.8% respectively indicating the good rust resistance of the two lines Taichung 11 and Taichung 12.

17. The Effects of Covering Facilities on the Production of Vegetables

This study was conducted to compare the effects of covering facilities on the production of vegtables. The growth of the edible herbs and radish root was promoted and the yield were increased under covering facilities. But the heading of the head vegetables, such as cabbage and Chinese cabbage; and the flowering of edible flowers, such as broccoli, were delayed, and their yields were also reduced,

whereas the growth of lettuce was not affected.

The covering facilities provided a special effect in eliminating rain injury, but there is no absolute effect on the control of insects and diseases. Disease, such as soft rot, is easily found under facility environment, whereas those easily induced by rainfall were well-controlled. Isolation with nylon net can not prevent the injury of diamond-back moth and turnip flea beetle.

B. Fruit Crops

1. Effect of Calcium Cyanamide and Merit on the Rest Breaking of 'Kyoho' Grapevine

Experiment was carried out by applying a leaching solution of calcium cyanamide or the Merit No. 1 solution on the resting buds in autumn and winter respectively. The effect of the treatment of calcium cyanamide on the rest breaking was unstable. But it increased the percentage of budbreak, promoted more budbreak of basal buds and reduced the tendency of apical dominance considerably, when the resting buds were treated either with the mixed solution of calcium cyanamide and Merit or separately. It is concluded that the mixed solution of 20% calcium cyanamide and 50% Merit was much more effective than the ethylene chlorohydrin.

2. Effect of Cycocel on the Enhancement of Fruit Setting in Grape

The inhibition of the shoot growth before blooming was an effective treatment in enhancing fruit setting, and various concentrations of Cycocel do this well. The higher the concentration of Cycocel was used the more the grape berries were settled, whereas the cost of labor in the berry thinning was increased. Therefore, a higher concentration is not recomended.

3. Application of Alzodef on the Termination of Dormancy in Grapevine Bud

(1) In Vitro Cutting Test

1% Alzodef application was effective and comparable to ethylene chlorohydrin application in inducing budbreak of Kyoho grapevine cuttings. 2.5% Alzodef or DNOC application also induced budbreak to some degree but not as effective.

(II) Field Test

Application of Alzodef was effective and comparable to that of ethylene chlorohydrin in inducing budbreak of field Kyoho and Golden Muscat grapevines. During January 1983, budbreak started 21 days after 2.5% Alzodef spray. The optimum rates of Alzodef applied before and after mid-February were 4% and 2.5%, respectively.

4. Re-utilization of Shoots of Shinseiki Pear Grafted on Hengshan Pear

(I) Topping, bending the shoot and spraying with Alar effectively inhibited the growth of the shoot and induced the development of flower buds of Shinseiki pear that grafted on Hengshan pear.

(II) Smearing with 166666.6ppm ethylene chlorohydrin on the differentiated flower bud, cut surface, scar branch or terminal bud during August to November induced budbreak and fruiting of flower bud.

(III) A fruit thinning method to get better yield and quality is to retain 1-4 fruits per fluorescence and a total of 4 fruits per shoot.

5. Flower Bud Differentiation and Forcing of Budbreak of Pear

Two years of observation of the tissue sections indicated that the flower bud differentiation of Shinseiki pear started from early July and completed in mid-August. As for Hengshan pear, initiation started from early June and completed in August. Many chemicals were applied to induce bud burst of the shoots, the result indicated that calcium cyanamide, cyanamide and thiourea were effective. A more intensive study on the screening of the chemical is still carring on.

6. Non-woven Material Bagging in Top-grafted Pear Production

Three kinds of bag made of non-woven material as well as the paper bag commonly used in pear production were taken as bagging material in this experiment. As the non-woven bags retained water after the rain, worse epidermal color and more rotted fruits were obtained during harvest period than that of paper bags bagging. Higher percentage of physiological spots on Shinseiki pear also occured when non-woven bags were used. For the application of this new material in pear bagging, further study in improving the quality of non-woven material should be taken into consideration.

7. Inhibition of Lateral Buds of Loquat

MH-30 sprayed on the loquat plant effectively inhibited the growth of lateral buds, whereas the practical concentration is to be reconfirmed. MH-30 is a mobile chemical which may cause fruit drop, therefore the spray during blooming and setting should be avoided.

8. Non-woven Material Bagging in Loquat Production

In this experiment, we compared the effects of non-woven material bagging and paper bag bagging in loquat production. The result showed that two kinds of paper bags used were better than the non-woven material in the improvement of fruit skin color and the increasing of sugar content. There was no difference in number of fruit and single fruit weight between bagging materials.

9. Forcing Culture of Mango

This study was to find a method to promote flower initiation and bud burst of mango. The results indicated that ethrel can effectively inhibit the new shoot growth, therefore enhanced the flower initiation. Subsequent application of either calcium cyanamide or acetylene water could promoted the bud burst. But it still remains a problem to be dissolved, i.e., a parthenocarpy or abnormal small fruit always gained due to the low temperature in the winter.

10. Forcing Culture of Peach and Plum

In Taiwan, peach and plum are usually harvested from April to May yearly. This study was dealing with a forcing culture method to advance the harvest for 3 to 4 months earlier than the usual. In August, defoliation with C.C.C. or B-9 inhibited shoot growth and promoted flower bud initiation. Then, sprayed with cyanamide or ethrel to induce bud burst and blooming. The fruits were then harvested in February or March.

11. Cultivation of Strawberry

(1) A variety 'Harunoka' was selected for cultivation in Taiwan. It has a low chilling requirement, big fruit size, high sugar content, and desirable taste, with a yield of 20,000 to 28,000 kg per 10 a.

(2) A plastic film with outside silver white and inner black color was used as covering material. It increased the light intensity by reflecting the sunlight, kept the earth temperature, inhibited the growth of weeds, decreased diseases, and protected the fruits from rotting.

(3) In the herbicide screening, Lasso, Enide, and Dual were selected.

PLANT PROTECTION

Both basic and applied research on the epidemiology of insects and diseases are studied. Life cycles of various insects such as rice brown planthopper, vegetable cutworms, insects of grapevine, etc. are extensively studied. The controlling measures by the application of insecticides and sex pheromones are also the major subjects of concern. In order to enforce an effective insect and disease control, a system for "forecasting insect and disease epidemics" is adopted and is operated based on the field observation and the analysis of meteorological data.

To ensure the safety of vegetables on the market, the vegetables are randomly sampled and analyzed for the amount of insecticide residues by both chemical and biological assays.

Insect Pest and Their Control

A. Rice Insects

a. Brown Planthopper (Nilaparvata lugens)

1. Life History of Brown Planthopper

This insect has 10 generations annually and lived over-winter as egg, nymph and adult but the population density of the insects in overwinter is very low.

It completed a generation about 21-58 days. Egg, and nymph stages lasted 6 to 11, and 15 to 36 days respectively. The egg mass was laid into the leaf sheath and was arranged into one straight row. The number of eggs contained in an egg-mass is about 8.8 in average, but may deposite as many as 30-176 eggs.

There were two types of brown planthopper; the short winged occurred during the plenty of normal diets and was unsuitable for flying, but their capacity of oviposition was larger than the long winged. The optimum temperature for the development of the insect was 25-28^{o}C; temperature below 8^{o}C or above 35^{o}C was unsuitable for the development of the insects.

Depending on the variation of accumulative average temperature in over winter one can forecast the prevailing of the brown planthoppers. If the accumulative average temperature of over-winter is higher than 2100^{o}C and then the outbreak of these insect pests may be forecasted in the next year.

2. Economic Methods for Brown Planthopper Control

Different pesticidal formulations and application methods were tested in the

field to select the most effective and economical control measure for the control of the brown planthopper on rice. Results showed that two applications of insecticidal dust, one at midbooting and the other at the uniform heading stage, gave the most profitable result. The application of a granule at mid-booting and a dust at the uniform heading stage also showed a high profit. Carbofuran G 3% when used under shallow water condition, gave a better result in terms of its efficacy and profit. However, application of granule before transplanting of rice seedlings would do nothing to either pest population or rice yield. And spraying usually gave lower profit.

3. Tank-Mixed Insecticides for Brown Planthopper Control

For the brown planthopper control on rice, preliminary results showed the formula consisting of MIPC at 1/3 recommended rate + ethyl parathion at 1/3 recommended rate + kerosene was more effective than that of MIPC at 1/2 recommended rate + ethyl parathion at 1/2 recommended rate. The former formula was similarly or more effective than each respective insecticide alone at conventional recommended rate. In the 1979 experiment, MIPC at recommended rate + kerosene was found to be the most economic and effective mixture, while MIPC at 1/2 recommended rate + Furadan at 1/2 recommended rate was as effective as Furadan alone at full recommended rate. Both of these mixtures, therefore, can be recommended to the farmers. In addition, MIPC at 1/2 recommended rate + carbaryl at recommended rate and MIPC at recommended rate + sun spray 7E oil were also satisfactory, and provided alternative formulae for tank-mixing when necessary.

4. Different Application Method for Brown Planthopper Control

Among the insecticides tested, dust formulated insecticides had fast knockdown effects than the liquid ones and caused higher mortality of the brown planthopper (BPH) as well. No distinct differences were observed between the effect of dust on BPH control by using hand-operated blower duster and powered duster. On the other hand, among liquid sprays, insecticide sprayed on the stems either by using hand-operated knapsack sprayer or mobile-type high-pressure mistsprayer with multiple-hand nozzles had 6.8 to 40% more effect for BPH control than those sprayed on leafcanopy. Differences in contact insecticides generally were greater than those systemic ones. Conventional application with a motorized mist blower machine generally had poor effect on BPH control. However, 10 to 32% more

effect than foliar sprays on the canopy was obtained when the machine was equiped with a curve blow-tube and fanshaped cover or with duck-mouthshaped cover in the tip of blow-tube to spray on the stems of rice. In term of work efficiency, powered-duster and mobile-type high pressure mistsprayer needed least application time to cover the crop and followed by motorized mist blower machine and hand-operated blower duster and hand-operated-knapsack sprayer.

5. Lower Dosage for Brown Planthopper and Green Rice Leafhopper Control

The field tests were conducted during 1977 and 1978. Comparisons were made for each chemical between efficacy of presently recommended dosage (PRD), 1/3 of PRD and 1/2 of PRD. Tainan 5 rice variety was used in all tests. The plot was $40m^2$ in size and was arranged in randomized complete block design with 4 replication. Chemicals were applied by a knap-sack sprayer at 1200 l/ha.

The dosage currently recommended for the brown planthopper (BPH) control is 0.6 kg ai/ha for 40% Hokbal E. C., 50% Unden W. P., 40.64% Furadan F. and 75% Orthene sp. and 0.3 kg ai/ha for 20% MIPC E. C. Among the comparisons made, only 40% Hokbal E. C. and 40.64% Furadan F. showed non-significant difference when both were used at 0.6 and 0.4kg ai/ha. Hence, we recommended that the dosage of these two chemicals can be reduced from presently recommended dosage to 0.4 kg ai/ha for the BPH control.

In case of the rice green leafhopper control, the dosage currently recommended is 0.6 kg ai/ha for 40% kilval S., 75% Orthene S. P. and 50% Tamaron L. C., and 0.33 kg ai/ha for Azodrin S. Results showed that the dosage of Azodrin and Tamaron can be reduced to 0.25 and 0.4 kg ai/ha, respectively, for the green rice leafhopper control while its population is low.

6. Control Timing of Planthopper and Leafhopper

The optimal frequency and best timing for chemical control of planthoppers and leafhoppers (mainly Laodelphax striatellus, Sogatella furcifera and Nephotettix cincticeps) were studied in the first rice crop of 1978 to 1980. Single application each at the initial booting, heading and doughy grain stage as well as 2 and 3 applications at 2 or 3 stages were compared in terms of the net profit gained. The control at the heading was more critical than either at the initial booting or the doughy grain stage. However, the highest net profit was gained when 3 applications were made at 3 consecutive stages. When 2 applications were planned, both at the

heading and the doughy grain stage would give better result. We would like to recommend that in the first cropping season when the hopper number reached 5 per net sweep at the initial heading (ca. 55-60 days after transplanting) a chemical application should be initiated. Another application during late booting to heading stage was indispensable. Whenever the hopper number reached 10-20 per net sweep at the milking to doughy grain stage one more spray was recommended.

7. Technique and Effectiveness of Ultra-low-volume Application

Viscosities of eight ULV grade pesticides, i. e., 95%Sumithion, 96% Malathion, 95% Ambithion, 93% Elsan, 60% Azodrin, 50% Hinosan, 60% Lebaycid and 3% Kasumin, were examined. Preparations containing more than 90% active ingredient in a liquid form were found four times more viscous than those containing 50-60% active ingredient. The viscosity of a chemical was inversely related to temperature. The flow-rate of a liquid preparation, emitting from a motorized mistblower with an orifice restrictor installed in between the nozzle and spray-gun, was also inversely related to its viscosity. By the ULV ground spray application method described, an effective range of 7-8 meters and a droplet spectrum of 40-90 microns were achieved when the spray gun was held horizontally or pointed upward at 10 degrees. If an operator carrying a mistblower advances at a pace of 36-50 meters per minute during spraying, tests showed that he would be able to cover one hectare in about 25-35 minutes.

8. Resistance of Brown Planthopper to Commonly Used Insectides

Among the nine areas surveyed, brown planthoppers of Huatang strain was found resistant to MIPC, MTMC, Hokbal and Azodrin. Puyen, Taichung and Tachia strains were resistant to MTMC. The brown planthoppers of Puyen and Taichung strains were shown to be highly tolerant to MIPC and Azodrin, respectively. There is a conspicuous correlation among the resistance levels of these commonly used insecticides occurred in the field populations of brown planthoppers in central Taiwan, they may have the multiresistance to these insecticides.

Vertical polyacrylamide slab gel electrophoresis was used in the study of the esterases activity of the strains collected from various locations. There was positive correlation between the esterases activity and the resistance level of brown planthoppers to these insecticides. The esterases activity is considered to be an important factor in the appearance of the resistances.

9. Current Status of Brown Planthopper (Nilaparvata lugens Stal) Resistance to Four Commonly Used Insecticides in Central Taiwan

Intensive application of insecticides has produced instances of brown planthopper resistance to these four insecticides. As large quantity and wide kinds of insecticides were used for rice insect pest control, results obtained so far indicated that relatively even population of brown planthopper has developed resistance to a great variety of chemicals. By using the dosage-mortality line or some portion of it such as LD_{50}, LD_{90} and the slope etc., we had been able to establish a quantitative measure by which a change in susceptibility to the test chemicals were determined. The brown planthopper were collected from rice paddies in central Taiwan. Higher LD_{50} value for each strain than those susceptible data in 1981 was shown. A year later as the results obtained in 1982, however, a general trend of higher resistant level than those data reported in 1981 was found, indicating that brown planthopper can survive well under heavy selection pressure of insecticides. The occurrence of resistance in rice brown planthopper population as collected in 1982 were found in substantial increase in comparison with data obtained in 1981, especially Huatan, Puyen, Hsensi and Chutang strain to Isoprocarb, Tali and Chutang to MTMC, Tungshih and Tali to Hokbal, Tungshih and Hsensi to Monocrotophos. According to resistance factor, Tachia to Isoprocarb and Hokbal has the trend of reduction, Huatan to MTMC, Tachia, Puyen, Chutang, and Yuchu to Monocrotophos have the same phenomenon and the other strains have the trend of increase.

b. Green Rice Leafhopper (Nephotettix cincticeps)

1. Life History of Green Rice Leafhopper

The average life cycle of this insect is usually completed in about 70 to 80 days in summer months and about 120 to 130 days in winter months. In general, the preoviposition period averaged 6 to 7 days in summer months, 10 to 12 days in the fall and an average of 16 to 18 days in winter months. Eggs were laid as a mass under the inside cortex of the rice leaf sheath, but in less frequent cases, females deposited the egg masses half exposured outside the leaf sheath. Usually a insect deposites as many as 22-314 eggs. Egg, nymph and adult stages lasted 5 to 15, 14 to 32, and 27 to 30 days respectively.

2. Resistance of Green Rice Leafhopper to Commonly Used Insecticides

Among the areas surveyed, green rice leafhopper of PY strain was found resistant to monocrotophos, TC strain was also resistant to malathion, while strain Hs was highly tolerant to monocrotophos.

The green rice leafhopper strains from PY was found to be highly tolerant to vamidothion and carbaryl. The small correlation among the resistance levels of these commonly used insecticides in the field populations of green rice leafhopper in central Taiwan implies that they may have multiresistance to these insecticides.

Vertical polyacrylamide slab gel electrophoresis was used in the study of the esterase activity of the strains collected from various locations. There was positive correlation between the esterase activity and the resistance level of green rice leafhopper to these insecticides. The esterase activity is considered to be an important factor in the appearance of resistance.

c. Rice Stem Borer (Chilo suppresalis)

1. Life History of Rice Stem Borer

The rice stem borers multiply 5 generations annually. The length of each generation was influenced by the variation of the climatic conditions.

The first crop damaged by the insects was more severe than the second one.

The rice stem borers overwintered in the larvae stage in rice residues. The overwintering larvae survived until the spring of the next year, and then transformed into pupae, and moth. Longevity of adult estimated around 2 to 7 days. And deposited as many as 80 to 143 eggs. Egg, larval, pupal stages lasted 4 to 15, 42 to 118, and 3 to 16 days respectively.

d. Rice Leaf Folder (Chaphalocrocis medinalis)

1. Life History of Rice Leaf Folder and Varietal Resistance of Rice Plants to the Insect

Rice leaf folder completed 8 generations at Taichung area. It took about 96 days and 30 days to complete one generation in the winter and summer seasons, respectively. The larva molted 4 times and the developmental durations of the 1st and the 5th stages were usually longer than other stages. The number of eggs laid varied from generation to generation. One single female moth could produce 19-70 eggs in average under screenhouse conditions, while more eggs could be produced by

the moth collected from the field. It appeared to have 8 peaks of moths annually. The first major peak (the third generation) appeared in June and the second major peak (the sixth generation) appeared in November. The larvae of these two generations were, mainly responsible for the damages done on the 1st and 2nd crops of the rice plants, respectively. At the end of second crop, the larvae or moths of 7th generation migrated to the adjointing rice fields and continued to multiply for one more generation on the weeds or regrowing ratoon rice during the winter season. Some moths of the 7th generation which developed with a slower pace could appear during January to February.

Forty-two entries including most of the commercial rice varieties were tested for their resistance to rice leaf folders in the fields. No resistant variety was found throughout the trial and there seemed to have no difference in resistance between the indica and the japonica types of rice plants.

e. Others

1. The Assessment of Rice Yield Loss due to the Damage of Pomacea lineata

The rice plants are most susceptible to the damage of Pomacea lineata at young seedling stage right after transplanting. The damage level depended on the size and number of snails. The highest damage percentage was observed at the 14th and 24th days after transplanting for the 2nd crop, 1985 and the 1st crop, 1986, respectively. The yield losses were 71.2, 47.4 and 22.3% when 50 large snails or the same number of middle snails or small snails were released, respectively, in the 2nd crop, 1985; while the corresponding percentages were 19.9, 2.8 and 1.8% in the 1st crop, 1986.

The yield reduction resulted from the damage of P. lineata were 50.4, and 26.4% by 50 large snails and 20 large snails, respectively; while the yield loss of other treatments have no significant difference in the 2nd crop, 1985. In the 1st crop, 1986, the yield reduction were 14.7, 8.2 and 6.7% by 50 large snails, 20 large snail and 50 middle snails, respectively. In general, the yield reduction and damage level are found more serious in the 2nd crop than in the 1st crop.

According to the cost/benefit analysis, when one large snail or 2 middle snails or 5 small snails are found in one square meter paddy field, respectively, some control measures are considered necessary.

B. Upland Crop Insects

1. Life History of Sorghum Aphid and Varietal Resistance of Grain Sorghum to the Insect

The sorghum aphid, Melanaphis sacchari (Zehntner), is one of the major pests of grain sorghum in the central Taiwan.

High population of the aphid ubiquitously occurs in the booting and the heading stages of the host plant. It reduces the quality and yield of the grain sorghum severely. Both temperature and rainfall are the influential factors on the prevailing of the aphid, especially the effect of the latter factor is remarkable. This aphid develops 51 to 61 generations annually. The longevity of adult estimated around 14-37 days. It deposites as many as 45-89 nymphs. Nymphal stage lasts 4.3 to 12.4 days.

The resistance of sorghum to aphid was estimated for 95 varieties of the sorghum. The results revealed that 5 different groups existed in the tested 53 varieties. They consisted of 3 resistant, 10 moderately resistant, 21 moderately susceptible, 17 susceptible and 2 highly susceptible varieties in R-line.

C. Orchard Insects

1. Morphology and Life History of Red Coffee Stem-borer

Red coffee stem-borer (Zeuzera coffeae Nietner) is one of the most important pests of grape-vine in Taiwan. A newly hatched lava at first penetrates into young twig of grape. Later, it removes to larger limb or trunk with its larval development. The infested twig is characterized with the symptom of excreta of larva from a penetrated hole. A damaged twig becomes fragile and easy to be broken off from just beneath a hole. Furthermore, sudden leaf withering on twig ubiquitously occur. In the case of seriously damaged plant, the grape-vine entirely killed. A mature larva pupates in the larval burrow. Before emergence of adult, a pupa escapes to the outside of a burrow, and splits down pupal skin to backward. It has 2 generations annually. Periods of adults emergence fall on during April to June and August to October. Longevity of adult estimated around 2-6 days. And deposites as many as 190-1134 eggs. Egg, larva, pupal stages lasted 9 to 30, 73 to 205 and 19 to 36 days respectively.

D. Vegetable Insects

1. Injury and Seasonal Occurrence of Melon Fly

Cue-lure + DDVP (20:1), methyl eugenol (poisoned) and Cue-lure + methyl eugenol (1:1, poisoned) were used for monitoring the population density of melon fly, Dacus cucurbitae Coq. The results showed that the population density in bitter

gourd field was the highest; the pear field in Puli was the least one; the population density was the highest on November in 1982 at different crop. Temperature and rainfall may regulate the population of the melon fly. The efficacy of Cue-lure + methyl eugenol was the best based on its attraction. Sponge gourd damaged in Nan-tou was the severest, averaging 39.4% while bottle gourd damaged in Hsihu was the lightest, averaging 5.2%.

2. Chemical Control of Diamond Back Moth

Among the three different concentration of chemicals at 0.1, 0.05 and 0.025%, the best mortality was shown by 24% Phosdrin E. C. but this kind of insecticide is more toxic to human being than others and can not be used in two weeks before the harvesting of vegetables. The chemicals DDT and Phosdrin ranked second and 25% Nerion E. C., the third. So far the results of 50% DDVP E. C. and 25% DDT E. C. were more effective at high concentration than at low one. The parathion and metasstox which were highly toxic to human being were less effective in the control of diamond back moth than malathion which had low toxicity. So the resistance of diamond-back moth to insecticides differed with compositions of insecticides.

3. Economic and Safe Application of Insecticides for the Control of Diamond Back Moth, Plutella xylostella L.

This experiment was carried out in the vegetable field of central Taiwan to compare the economic and safe application of insecticides and control costs for diamond back moth, Plutella xylostella L.

Results showed that the dosage of economic and safe application in the common field with the same control efficacy was 441 gm to 1588 gm per 0.1 ha, and the control cost was NT$ 396 to 1588 per 0.1 ha, respectively.

This suggested that the farmers tended to use the mixtures of pesticides at the concentrations higher than the recommended rate and disregard the necessity of economic and safe application of insecticides, therefore, some education must be strengthened.

E. Flower Insects

1. Insect Pests of Chrysanthemum and Their Control

The surveys in several years indicated that among the more than 10 different insect pests on chrysanthemum, aphids, thrips and mites occurred most frequently. Lepidopterous insect pests, though occurring only sporadically, brought much trouble. Higher populations of sucking-type insect pests were mainly found in dry seasons due to the inhibitory action of continuous rain on population density. This suppressive action was less apparent to the chewing-type insects pests. The uniformity of culturing period of chrysanthemum made the effort of timing of control difficult, which generally must vary with planting time. In general, 1 to 2 sprays are necessary during early stage of the plant. According to need, 1 to 2 sprays at an interval of 7 to 10 days can be made before blooming. The most critical stage for exporting chrysanthemum is between budding and time of cutting. In this stage 3 to 5 sprays at an interval of 3–5 days was absolutely necessary. Screened from more than 20 insecticides are 6 insecticides including 25.3% EC mevinphos for aphids, 2 for thrips, and 5 including 50%WP Plictran for mites. Significant reduction of efficacy of some insecticides had been noticed in the field and this may indicate the development of resistance of insects due to continuous application of insecticides for many years.

F. Safety Use of Chemicals

1. The Residue of Dursban in Five Vegetables and Corn Plants

Dursban is one of the currently used effective insecticide for the control of insects in vegetables and corn borer. This experiment adopted both biological test and chemical analysis methods to study the residue of Dursban in the corn leaves. The results showed that the changing tendency of the Dursban residue obtained from both methods were similar. However chemical analysis method is more sensitive. It detected 0.17 ppm of Dursban residue in the corn leaves 14 days after the spray. Biological test showed that the flies were killed up to the 8th day after the spray, and it was estimated to have 0.51 ppm residue according to the conversion factor.

It seemed that the biological method had the advantages of simple and practicality. Further tests with the biological method found that the Dursban residue in the five vegetables, Pak-choi, Chinese kale, field mustard, water convolvulus, and Paitsai on the 6th day after spray were 0.51 ppm, meeting the less than 0.5 ppm permissible residue requirement. Therefore, it is safe to the human body if the application of Dursban is stopped 6 days before the harvesting of the above five vegetables for the market.

Plant Pathology

A. Rice Diseases

a. Rice Blast

1. Epidemiology of Rice Blast

Rice blast usually started 33-36 days after transplanting of japonica varieties in first crop of rice. The maximum percent of infection was usually noted about 57 days after transplanting. The occurrence of blast on indica varieties was usually a little late and the percent of infection was lower. The percent of infection of leaf blast was higher in 1979 than in 1980 based on tested varieties. It was possible that average temperatures during disease initiation were lower in 1979 than in 1980. On the contrary the average relative humidity during disease initiation were higher in 1980 than in 1979. It seems that disease initiation was mainly controlled by temperature rather than relative humidity. Dew period may affect the percent of infection, especially during disease severe stage.

The percent of panicle blast was the highest on Tainan 5 and Taichung Sen 3 was the lowest. The percent of panicle blast was higher in 1979 than in 1980. It was possibly due to the fact that the raining days were longer during heading stage, and the average temperature was lower in 1979. The occurrence of panicle blast was somewhat correlated with ligule blast.

Conidia are always collected from air before lesions are observed. However the number of conidia collected was very low, only 10 conidia were collected every 5 days.

b. Rice Virus

1. Comparative Transmission of Rice Yellow Dwarf

The yellow dwarf of rice was transmitted experimentally by Nephotettix impicticeps Ishihara, besides there are the two known vectors N. cincticeps and N. apicalis. In comparative experiments, N. cincticeps and N. impicticeps were equally efficient in transmitting the disease with a transmission rate of 70.7% for N. cincticeps and 77.4% for N. impicticeps following an acquisition period of 24 hours. These rates were considerably higher than that obtained with N. apicalis which was 51.9%.

There were no differences in the length of incubation period of the yellow dwarf agent in three Nephotettix species. In N. cincticeps, it was from 24 to 34 days, and mostly 26 to 28 days; in N. apicalis, from 24 to 38 days, and mostly 28 to 30 days; and in N. impicticeps, from 24 to 38 days, and mostly 26 to 30 days. Apparently, the leafhoppers retained the infectivity until their death.

2. Effect of Yellow Dwarf Disease on Agronomic Characters of Rice Plant

Two commercial rice varieties, Tainan 5 and Taichung 186 were inoculated with yellow dwarf disease by viruliferous leafhoppers, Nephotettix cincticeps Uhler at different plant ages.

In the field, rice plants of Tainan 5 inoculated at 10, 20, 30, and 50 days after sowing had a longer incubation period, more tillers and panicles, heavier thousand grain weight and less yield losses than those inoculated at greenhouse. The plants in greenhouse inoculated at 10, 20, 30, and 50 days after sowing, the yield reduction was 100, 98, 96, and 27 percent, respectively, while in the field, for the comparable ages, it was 93, 81, 54, and 4 percent, respectively.

Rice plants of Tainan 5 inoculated at the stages of seedling, tillering, panicle initiation and heading showed the yield reduction of 55, 22, 9, and 4 percent in the first crop, and 93, 54, 4 and 1 percent in the second crop, respectively.

3. Varietal Resistance of Rice Plant to Yellow Dwarf

Seedling screening test indicated that optimal temperature for inoculation was 20 to 30°C, in which 40 to 51% of the inoculated seedlings developed symptoms. At 15°C, only 22% of the tested seedlings were infected. The seedling test also indicated that illumination during inoculation feeding has no significant effect on the transmission ability of the insect vector.

All test varieties of japonica type were found susceptible to yellow dwarf. Of 1858 indica varieties, 52 displayed an infection level below 10 percent and 72 varieties between 10.1 to 20 percent. The most resistant variety of this group, Firooz-1 which was introduced from Iran was found completely free from infection in 23 separate seedling tests conducted in different seasons and in 3 separate field tests in different years. Other varieties including Kabara (Sierra Leone), C4-63A (Thailand), Blue-bell (Malawi), Faya (Malawi), IR1487-194-5-3-2 (Philippines), 4bs-6-1 (Iran), B581A6-545 (Philippines), 153IR-22 (SI) (Sierra Leone), MTU 1 (India), IR Early 773 (Philippines), IR994-102-2-3-2 (Philippines) and the wild rice O. nivara (IRRI collection no. 101512 and 101524) were also highly resistant to yellow dwarf.

When tested in the greenhouse on 15 yellow dwarf-resistant and 5 vector resistant rice varieties, Nephotettix cincticeps Uhler, vector of rice yellow dwarf (RYD), showed non-preference toward the highly yellow dwarf-resistant varieties of Firooz-1, Kabara and C4-63A. However, there was preference toward some of the disease resistant varieties such as Ilan-chu-tsu A and Dee-chueh-chu-tsu. The vector-

resistant varieties reacted either as susceptible to yellow dwarf, as in the case of Tetep and Koasenyu 12, or as moderately suceptible, as in the case of H 105 and MTU 1. Under the field conditions, all these varieties were resistant to the disease. Therefore, there appeared a lack of correlation between resistance to RYD and to its vector.

By artificial inoculation at the seedling stage, the 15 RYD-resistant varieties produced yellow dwarf infection in 0-12% of tested plants, as judged by symptoms observable before ratooning and 0-15% on ratooning. The comparative figures for the 5 RYD-susceptible varieties are 32-62% and 33.3-63.3%, respectively. In the field tests conducted during the second crop of 1975, yellow dwarf symptoms appeared at the booting stage, with an incubation period of 83 days or longer on those resistant varieties. Most of the infected plants showed symptoms only on ratooning and their yield seemed to be very little affected. Of the susceptible variety group, TN 1, Tainan 5 and IR 26 had an incubation period of about 50 days.

Firooz-1 is a rice variety which has been shown to produce no visible symptoms with yellow dwarf. However, from inoculated plants, yellow dwarf could be recovered in a low percentage of the test insects which had fed on the upper leaves of the test plants previously receiving yellow dwarf inoculation.

4. Yellow Dwarf Determined by Time of Symptom Appearance

The yield losses due to rice yellow dwarf were significantly influenced by the time of symptom appearance. In Tainan 5 grown as single plant per hill, yield reduction was 80, 46, 30 and 14% in the first crop when symptoms began to appear at booting, heading, dough ripening and maturing stages, respiectively. In the second crop, yield reduction was 99, 89, 53, 39, 24, 19 and 8%, when symptoms first appeared at tillering, booting, heading, full heading, dough ripening, yellow maturing, and maturing stages. In general, yield loss was reduced when symptoms appeared after full heading stage. The percentage of yield reduction could be estimated by the following equations: $Y=777.0593-12.2015X+0.04855X^2$ for the first crop and $Y=37.26395+4.96484X-0.11142X^2+0.00058X^3$, for the second crop, while X represents the plant age at symptom appearance (days after transplanting), Y represents percent yield reduction.

5. Age Distribution of Green Rice Leafhoppers and Remaining RYD-Diseased Plants During Overwintering Period

A survey of age distribution of rice green leafhoppers Nephotettix spp. was made

from September, 1975 to February, 1976 at 47 locations in Taichung area. While surveying on the remaining of RYD-diseased ratoon stubble rice plants, samples were taken at four locations where yellow dwarf incidences have usually been high.

In September, 1976, and January and February, 1977, the overwintering population of rice green leafhoppers was 64.51, 67.49 and 84.35 percent adults; 18.75, 12.38 and 8.31 percent of 1-3 instar nymph; and 16.74, 20.23 and 7.34 percent of 4-5 instar nymph respectively. However, in the cooler month, the rate of propagation tended to be lower than the warm period. There were 3.7-6.7 and 0.8-13.3 percent of the surveyed ratoon stubble infected by RYD-disease in December and January during the year of 1975-1976. Apparently, the diseased ratoon stubble was reduced during the cooler month.

The preceding results indicated that the insect vector not only multiplied in the winter season but also acquired the diseased agent from the RYD-diseased ratoon stubble and then transmited the disease of the following year.

6. Epidemiology of Rice Yellow Dwarf

Active individuals of the rice green leafhoppers, Nephotettix spp. that carry rice yellow dwarf (RYD) was found all year round in the field collections. Two peaks are observed each year. The first one was in February-March with 26-29% being active transmitters. They became the main source of inoculum for the first rice crop. The second peak appeared in July-August with 10-36% as active transmitters which transmitted the disease to the second rice crop.

The green leafhoppers that survived in the winter season and carrying the causal agent (an MLO) played a very important role in the spread of RYD. The surviving nymphs of the 7th generation which acquired MLO from the diseased plants in November became the primary source of inoculum in next January and February. On the other hand, the offspring of some adults of the 7th generation may also acquire MLO from diseased ratoons and then transmit it in March and April. However, due to a low population of RYD-diseased ratoons in the cool season, the latter might not constitute an important way of spreading the disease.

Seven species of Gramineous weeds may act as hosts of RYD by artificial inoculation under greenhouse conditions. They are Leptochloq chinensis, Imperata cylindrica, Leexsia hexandra, Alopecurus aequalis, Digitaria setigera, Paspalum conjugatum and D. Fauriei. However, the symptoms on these weeds were rarely seen in the field and they might not act as important hosts of MLO in the disease spread.

Infection with RYD mainly occurred in the seedling stage or shortly after transplanting either in the 1st or 2nd crop. Because of low vector population and low

temperature in the early part of the first crop, the disease incidence was usually low and the symptoms appeared only after June, thus the disease exerted little effect on the yield of the first rice crop.

7. Rice Transitory Yellowing Virus and Insect Vector

Rice transitory yellowing virus (RTYV) had an apparent harmful effect on its leafhopper vector, Nephotettix cincticeps (Uhler). The average nymphal period of the leafhoppers was 23 days and 21 days for the transmitters and the non-transmitters, respectively, and there were more nymphs of transmitters causing premature death. The average life span of the males and the females that transmitted virus was 18 and 20.8 days, whereas the males and females of non-transmitters lived 21.9 and 26.7 days, respectively. The evidence for the difference in longevity is significant statistically. The deposited egg number of the insects of virus transmitters reduced 35-38% as compared to non-transmitters. However, there was no evidence exhibiting any difference of the hatching percentage of the eggs deposited by transmitters and non-transmitters.

The progeny (F1) of viruliferous insects was more active to acquire the RTYV (55-58%) than the virus-free insects (21-28%). This suggested that the transmission ability was genetically controlled.

8. Factors Affecting Transmission of Rice Transitory Yellowing Virus

Both Nephotettix cincticeps and N. nigropictus were able to acquire rice transitory yellowing virus at the temperature range of 10-35 ^{o}C. Efficiency of virus acquisition increased with the increase in temperature, though at 35^{o}C the mortality of the tested insects was high. On daily transfers of viruliferous N. cincticeps to healthy plants, a higher transmission rate was obtained at 25 and 30^{o}C, at which there were more skippings in virus transmission. Keeping the test insects at same temperature throughout the virus acquisition, incubation and inoculation processes, transmission was obtained at 17^{o}C with an incubation period of 48-66 days, but no transmission at 15 and 16^{o}C. There was a marked effect of virus source plants on RTYV transmission. More insects became viruliferous after they had fed on the leaves with severe symptoms (28.4%) or on the diseased plants of susceptible varieties (20.1-34.6%) than those fed on the leaves in rice plants recovered from symptoms (3.3%) or on resistant varieties (9.0-13.3%). Green rice leafhoppers showed a negative preference to RTYV diseased plants on which 7% of the tested insects

landed as compared to 18% landing on healthy plants and 75% of plants infected with yellow dwarf nymphs of N. cincticeps were more efficient in transmitting RTYV than adults. Males of this insect were slightly more efficient than females as virus vector, but there was no such efficiency difference in N. nigropictus.

The Nephotettix leafhoppers collected from 16 locations on the island of Taiwan were all capable to act as RTYV transmission, regardless of whether the disease incidence has been recorded for the locations, or not.

9. Effects of Rice Transitory Yellowing Virus on Yield and Yield Components

In the field conditions, infection with RTYV rarely caused the death of rice plants. However, there was a positive relationship between the degree of yield reduction and the length of heading delay. For both cultivars inoculation at 40 to 60 DAS caused the longest heading delay in the 1st crop, but in the 2nd crop this occurred at 5-35 DAS for TN 5 and at 5-25 DAS for TCS 3.

In a field test with the number of inoculated plants varying from 0, 1, 3 and 5 plants per hill for 5-plant hills, the yield losses increased with the increase in number of plants that were inoculated with RTYV before transplanting.

Under field conditions, the number of plants infected naturally with RTYV was increased as the planting density increased. The percentages of infected hills were 1.5, 2.8 and 3.0% for hills of 1,4 and 7 plants, respectively, in the 1st crop of 1977; while the corresponding percentages were 40.1, 61.3 and 73% in the 2nd crop. The yield loss was reduced in the 1st crop as the planting density per hill was increased, but no such difference was observed in the 2nd crop.

10. Factors Affecting Transmission of Rice Wilted Stunt

The threshold temperature for the brown planthopper (BHP), Nilaparvata lugens to complete the incubation period of rice wilted stunt virus (RWSV) was about 12^{o}C, at which an incubation period of 37.1 days in average was observed. On hourly transfers of viruliferous insects to healthy plants, none of the 15 tested viruliferous insects transmitted the virus at 8^{o}C. Fasting before acquisition feeding significantly increased the transmission ability of the insect. The nymphs were found more efficient to transmit RWSV and had a shorter incubation period than adults. More insects became viruliferous when they fed on leaves (23%) than on stem (16%) or root (14%) of the same diseased plant. There were 4, 27, 24, and 15 percent of the insects became viruliferous when they were allowed to feed on

diseased plants at 10, 30, 60 and 120 days, respectively, after symptom appearance. In comparing two different methods of virus acquisition, no significant difference of the tested insects became transmitter following a natural acquisition feeding on diseased plants and by insect injection with the crude sap of the plants. However, a longer incubation period and a higher mortality of the insects were observed with the injection method.

11. Rice Ragged Stunt and Wilted Stunt Disease and Growth of Rice Plant

Rice ragged stunt (RRS) was first found in the paddy field of Chiayi in 1978. It caused stunting of plants with leaves slightly darker in color than normal and brittle in feeling; the leaves became twisted and ragged. A few veinswellings were found on the lower surface of leaf blades and outer surface of leaf sheaths. Nodal branches were produced on old plants on which the panicles, if any, had mostly unfilled grains. The latent period for symptoms was 8-10 days in summer but extended to more than one month in winter. The brown planthopper, Nilaparvata lugens Stal, transmitted the virus with an average latent period of 9.6 days (5-14 days). About 22% (15.2–30.4) of the vector insects were active transmitters. Both male and female were capable of transmitting the virus. The minimal acquisition feeding period was 2 hr, whereas that for inoculation was 1 hr. Efficiency of virus acquisition increased with an increased temperature.

Other six rice insects in Homoptera failed to transmit RRSV. Neither was transmission obtained by soil, seeds or mechanical means.

Rice wilted stunt (RWS) has a significant influence on rice yield reduction. The major yield components such as panicle number, length of panicle, percent of filled grains and weight of one thousand grains of the diseased plant had decreased in proportion to the increase of the age of the rice plant from the time of infection. During the field trials made in the second crop season, infection with RWS resulted in 94, 78, 58 and 39% yield reduction for Tainan 5 when inoculated at 30, 40, 50 and 60 days after germination. Infection with RWS resulted in 96, 59 and 42% yield loss for Taichung Sen 3 when inoculated at 30, 40 and 50 days after germination. With these varieties, there was no yield at all when inoculation were made before 30 days after germination. At the time of transplanting, 1 and 3 plants per hill (planted 5 plants) were inoculated. This caused about 22 to 52% yield reduction.

12. Three Symptomatologic Types of Rice Virus Diseases Related to Grassy Stunt

Three rice diseases with virus like symptoms were collected from central Taiwan. The diseases were designated as wilted stunt, grassy stunt B, and grassy stunt Y. Their causal agents were all transmitted by the rice brown planthopper Nilaparvata lugens in a persistent manner, with incubation periods in the vector ranging from 3 to 23 days. Symptomatologically, wilted stunt was distinct in that it caused extreme plant stunting and was often lethal to rice plants, especially in the winter months. Both grassy stunt B and grassy stunt Y also caused stunting, but they were not lethal to the tested plants. All three disease types stimulated tillering in some rice cultivars in summer; only grassy stunt B had this effect in winter. On the basis of vector-relationships and enhancement of host tillering, these three diseases were tentatively identified as virus diseases related to rice grassy stunt.

13. Cell Inclusions Associated with Wilted Stunt Disease

In rice tissues from plants affected with a new, Nilaparvata lugens-vectored disease, known as wilted stunt, a particular type of inclusions was found in the nucleus and cytoplasm of both phloem and mesophyll cells. This appeared to be the first record of such inclusion type relative to a viral disease in rice.

14. Control of Rice Virus Diseases by Granular Chemicals in Seedling Boxes

Three chemicals, viz., 4% Padan G., 3% Furadan G. and 5% Disyston G. were tested to prevent the incidence of the rice virus diseases.

The low incidence of the rice transitory yellowing and the wilted stunt was found in our tested field; Nevertheless, after the treatment of Padan G. at 50 g/box, and 3% Furadan G. at 100 g/box or 125 g/box, the infection rates of the transitory yellowing resulting from these applications were four times as low as that of control, that is, 0.44%, 0.55%, and 0.47%, respectively, while those of the wilted stunt were 0.28%, 0.56% and 0.51%, respectively.

The incidence of the rice yellow dwarf which is caused by MLOs and transmitted by the rice green leafhopper was extremely high in this experiment. The infection rates were 12.33%, 11.47%, and 10.00% by the same dosages as indicated above. These rates were only 3 times less than that of control (33.73%).

The results indicated that application of granular chemicals in seedling boxes before transplanting was not only economical and safe, but also may reduce the infection rate of rice virus diseases transmitted by insect vectors, and therefore increases the rice yield.

B. Upland Crop Diseases

1. Resistance of Wheat and Triticale to Rust and Powdery Mildew

Studies on the resistance of 542 varieties of wheat and triticale to rust and powdery mildew were carried out in the field. On the basis of eight reaction types to rust, the number of wheat varieties as classified into immune, hypersensitive, highly resistant, resistant, moderately resistant, moderately susceptible, susceptible, and highly susceptible were 375, 17, 34, 14, 13, 4, 8 and 17, whereas of the triticale were 15, 4, 1, 1, 11, 14, 11 and 3, respectively.

Based on five reaction types to powdery mildew, the number of wheat varieties as classified into immune, highly resistant, moderately resistant, moderately susceptible, and highly susceptible, were 124, 239, 108, 10 and 1, respectively. All of the tricicale lines/varieties were immune to powdery mildew.

C. Orchard Diseases

1. Chemical Control of Loquat Pink Disease

Forty-three fungicides were incorporated in PDA plates for testing the growth of Corticium salmonicolor, the causal agent of loquat pink disease. Eight kinds of fungicides named Rovral M 50% WP 750X, Benlate 50% WP 3000X, Topsin-M 70% WP 1000X, Mertect 40% EC 500X, Delan C 56% WP 500X, Cuprosan 311 super D 72.5% WP 500X, Bavistin 50% WP 1500X and Benlate-C 60% WP 500X, were found to inhibit fungal mycelial growth and were released to control loquat pink disease in the field. Investigation on spore density of Corticum salmonicolor in Tungshih and Hsinsheh by spore trap showed that spore density increased from middle February so that it was suggested to start fungicidal spray on February or March for controlling loquat pink disease. Fungicide treatments in the field showed that Rovral M 50% WP 750X and Cuprosan 311 super D 72.5% WP 500X, were the two best fungicides for controlling loquat pink disease.

D. Vegetable Diseases

1. Bitter Gourd Wilt Physiological, Thermal Death Range of Pathogen

Fusarium oxysporum f. sp. momordicae was the causal organism of bitter gourd wilt. This pathogen grew best on PDA under 24^{o}C, water potential from -1 to -10 bars, arabinose and galactose as the best carbon source, glycine and glutamic acid as suitable nitrogen source.

Temperatures in 35-60°C for different time periods were lethal to F. oxysporum f. sp. momordicae. At 45° and 50°C, the exposure time for a LD_{50} were 100 and 40 minutes respectively. Propagules density of fungi was greatly reduced in field soils solarized for the necessary time period. The exposure time and temperatures necessary to kill this fungi were useful for evaluating the progress of soil solarization under field conditions.

E. Sugarcane Diseases

1. Mild Mosaic and Severe Mosaic of Edible Sugarance

This field experiment was conducted at Puli to compare the influence of mild mosaic and severe mosaic of edible sugaranes, collected from 4 Hsiens of Nantou, Yunlin, Chiayi and Tainan on the stalk growth and sucrose content.

The result showed no significant difference between the two types of mosaic regarding the mean length and circle length of sixth internode, the mean total length of fifth, sixth and seventh internodes and the mean weight of ten stalks. However, there was difference among locations.

The mean content of sucrose showed that there was significant difference at 1% level between two types of mosaic or among locations.

2. Control of Edible Sugarcane Mosaic Virus

The hot-water treatments showed that edible sugarcane mosaic virus was not inactivated by 7-min. treatments at daily intervals at temperatures of 55, 56, 57 and 57°C, respectively, or 55, 57, 57 and 57°C, respectively, or 50, 52, 54, and 56°C, respectively for four days. Neither did by 10-min. treatments at daily intervals at temperature of 54°C for four days, nor by 10.5-min. treatments at temperatures of 55°C and 56°C for two days.

However, the mosaic virus-free edible sugarcane seedling was obtained by apical meristem culture in which an excised apical dome (1-2mm) was cultured on modified Murashige and Skoog medium supplemented with active carobon (300mg/l).

SOILS & FERTILIZERS

Soil samples are regularly collected and analyzed for their contents of both major and minor elements. The results, together with the recommendation of fertilizer application,are transferred to the farmers immediately.

Diagnosis of nutrient deficiency by leaf analysis is also conducted. Studies on the physico-chemical properties of poor soils and low-yielding lands are made frequently. The measures to upgrade the productivity for these soils are proposed and notified to the respective farmers. The efficient methods of fertilizer application such as deep placing, splitted top dressing and the combined application of chemical fertilizer with green manure, are also recommended to maintain the soil fertility. Studies on soil pollution due to the polluted irrigation water have become an important task of this station. A test to determine the degree of resistance of crops(wheat, rice, vegetables, etc.)to air pollutants has also been conducted.

A. Soil and Fertilizer Experiments

1. Utilization of Azolla as N-source for rice

The relative growth rates of Azolla decreased in the following sequence: A. pinnata, A. caroliniana, A. filiculoides, A. mexicana. It also showed that 40 ton/ha of fresh Azolla incorporation had the same effect as 80 kg/ha and 65 kg/ha chemical fertilizer application for rice grown in sandstone & shale and slate alluvial soils, respectively. However, the highest yield cannot be obtained by Azolla incorporation alone. Azolla monoculture in combination with N-chemical fertilizer application may be the most practical method to save chemical fertilizer without affecting rice yield.

2. Improving the Efficiency of Nitrogen Fertilizer in Flooded Rice Soil

The surface broadcasting of nitrogen fertilizer caused much losses and thus had higher requirement for nitrogen fertilizer to achieve the same yield level as the mudball or tissue paper treatment. The efficiency of nitrogen fertilizer (urea) was significantly increased by wrapping the fertilizer in mudball or tissue paper and then applying to the reduced layer of the soil between two hills of rice plants. The grain yields of the treatments accepted 60% of standard rate of nitrogen fertilizer in mudball or tissue paper were as high as those of the treatments accepted 100% of standard rate of nitrogen fertilizer broadcasted in 4 splits. It is also necessary to develop some labor-saving methods to make the mudball method more practical.

3. Fertilization of Hill-Side Paddy

Experiments were carried out at 3 hill-side paddies with strongly acidic shallow soil. Results showed the application of 3 ton/ha slag increased rice grain yield by 4.2 - 2.5% in the 1st and 2nd crop respectively. Optimum nitrogen fertilizer for the 1st and 2nd crop of rice were 80 - 105 and 70-90 kg/ha, of N. The recommended N-fertilizer application method was basal 25%, 1st top dressing 20%, 2nd top-dressing 30% and 3rd top-dressing 25% (at panicle-initation stage).

4. Nitrogen Fertilizer and Delaying Harvest on the Recovery Rate of Ratoon Rice

This experiment showed that among the 3 (N,P,K) elements, N was the only one effective in promoting the growth of ratoon tiller. Applying 25% of additional N fertilizer at yellow maturing stage helped Tainung No. 67, a japonica rice, induce ratoon tiller at the normal harvesting stage. It also showed that applying 50% of additional nitrogen fertilizer for the ratoon rice helped the ratoon rice to get similar or even higher grain yield than that of conventional first crop of rice.

5. Fertilizer Experiment for Badila Cane (Saccharum officinarum L.)

Field experiments were carried out at Puli during 1979-1981. It was found that the application of 30 ton/ha of compost significantly increased stem yield from 13.5-15.1%. Compost also induced better plant height, stem diameter, internode length and number. The proper fertilization for Badila cane might be recommended as 30 ton/ha compost, 750kg/ha N, 54 kg/ha P_2O_5 and 250-500 kg/ha K_2O.

6. Effects of Rice Hull, Lime and Nitrogen Fertilizer on the Silica Content and Growth of Rice in Strongly Acid Sandshale Alluvial Soil

The results showed that low water soluble silica and exchangeable bases were the two main factors that limited the normal growth and caused the lodge and blast in rice plants at high level of nitrogen fertilizer in this strongly acid sand-shale alluvial soil. Liming helped reduce the blast and promote the continuous growth of rice plants at high nitrogen level. Soil treatment with rice hull and limestone significantly increased the silica contents in rice plant, resistance to neck blast and lodge, and panicle number. However, for obtaining the best grown rice plants to perform the highest grain yield in this stronly acid sand-shale alluvial soil, it is not only necessary to apply lime and rice hull to raise silica and basic ions in the soil, but also necessary to provide enough nitrogen fertilizer for the requirement of the good performance of rice plants.

7. Fertilizer Experiment for Job's Tears (Coix lacryma–jobi L.)

Job's tears was tested in the spring and fall crops, 1983 with ten treatments of N. P. K. -fertilizers (N=60, 100, 140, 180 kg/ha, P_2O_5 = 0, 45, 90 kg/ha, K_2O = 0, 45, 90, 135 kg/ha). The best fertilizer combination for commercial production was found to be 180, 90, 135 kg/ha in the spring crop and 100-140, 90, 135 kg/ha of N, P_2O_5, K_2O, in the fall crop respectively. It was found that potassium played an important role on the grain yield of Job's tears.

8. Effect of N. P. K. -Fertilizers on the Yield of Buckwheat (Fagopyrum esculentum Moench.)

Buckwheat is grown for human consumption as a kind of health-care after properly processed. The fertilizer experiment were conducted at Erhlin and Chutang townships during the winter cropping season from 1981-1983. The results showed that the optimum rates of N, P_2O_5, and K_2O for grain yield of buckwheat were 60, 18, 30 kg/ha.

9. Fertilizer Experiment for Tuber and Starch Production of Edible Canna

Edible canna has been cultivated in Nantou County as a kind of starch crops which has high yield of tuber and excellent quality of starch after processing. Field experiments were conducted in Chungliao during 1982-1983. Nine treatments of N. P. K. -fertilizers (N: 0, 40, 80, 130, 160 kg/ha, P_2O_5: 0, 36, 54, 72 kg/ha, K_2O : 0, 120, 180, 240 kg/ha) were adopted, and the fresh tuber yield and starch content as well as the fertilizer responses were studied. The optimum rates of N, P_2O_5 and K_2O for the starch production were 120-160, 36-54 and 180-240 kg/ha, respectively.

10. Accumulative and Residual Effect of Slag on Rice

During 1977-1982, continuous experiments were carried out at Houli and Puli where the soils are strongly acid and low in available silica. The results indicated that the initial application of slag helped increase the grain yield by 3.3 - 6.6% in the 1st crop. The effect of slag application in the 1st crop was greater than in the 2nd crop. Continuous application got better effects on yield increasing up to 18%. The slag raised soil pH and increased the soil available silica, exchangeable Ca, and Mg.

11. Constructing Corrugated Drainage Pipe Lines in Poorly Drained Soils

Field experiment indicated that the poor growth of rice plants in poorly drained paddy soil was mainly caused by the excessive sulfur and iron in the soil, and the tiny brown spots on the old leaves of rice plants was the symptoms of iron toxicity which was also the possible factor to induce the deficiencies of K and Cu in rice plants.

Burying 4" of corrugated drainage pipe at the depth of 60cm from soil surface was very effective for removing off the excessive water, iron, sulfur and thus reduced the Fe content and increased the K and Cu contents in the rice plant for the normal growth of rice plants.

12. Poorly Drained Acid Sulfate Soils in the Coast of Central Taiwan

This survey was conducted to study the characters and distribution of acid sulfate soils. It was found that acid sulfate soils were widely distributed in the coastal township, Ta-an, in the west coast of Taiwan. The total acreage was estimated above 500 ha. Lots of them were poorly drained all around the year, and became a special kind of abnormally low-yielding problem soils.

The results of chemical analysis for the air-dried soils showed that the pH of many soils sharply declined from 6.7–7.5 to 2.7–6.6, the EC abruptly rised from 1.0 - 2.7 mmhos/cm to 1.3 - 15.7 mmhos/cm, and the soluble ions including SO_4, Fe, Mn and Al, etc., had become toxic to the crops upon air-drying. Applying limestone (quick lime) at the rate of 4 ton/ha will be enough for raising the soil pH to a favorable value for the growth of crops. Rice yields were often doubled or tripled after the establishment of drainage system.

13. Adjusting the Transplanting Time of Rice Plants for Preventing Brickfactory Gaseous Injury

The injury of brickfactory waste gases on rice plants in Huatan area mainly occurred in the early stage of growth in the 1st crop and in the late stage of growth in the 2nd crop.

In order to maintain two crops of rice at a considerable high grain yield with minimum injury by waste gases, it was recommended to transplant indica varieties of rice after mid-March in the 1st crop, and before mid-July in the 2nd crop. The 1st crop should be transplanted at the rate of 12 plants per hill, and 2nd crop at the rate of 6 plants per hill will be enough.

14. Response of Rice to P. K. Fertilization in Soil Fertility Classification.

Field experiments were conducted in 7 different types of soils with different limiting factors and P. K. levels in Changhua County to study the requirements of rice for P. K. fertilizers for the maximum economic returns in relation to the soil fertility classification.

Acid soils with low levels of P. K. and coarse subsoil required higher rates of P. K. fertilizers (80, 60 kg/ha for the 1st crop; 60, 80 kg/ha for the 2nd crop, respectively).Good responses of grain yield to additional applications of P. K. fertilizers were also obtained in poorly drained soils. Regardless of the levels of P. K. in soil, it is more economical to apply only moderate amounts of P. K. fertilizers for the soils of other fertility class in which the optimum rates of P. K. fertilizers at 40, and 30 kg/ha for the 1st crop; and 30, and 40 kg/ha for the 2nd crop were recommended.

15. Effects of Different Application Methods and Rates of Nitrogen Fertilizer on Grain Quality and Flour Characteristics of Spring Wheat (Triticum aestivum L.,)

Two spring wheat varieties Taichung 31 and Taichung S-2 were treated with three nitrogen rates (85, 125, 165 kg/ha) and two application methods (A_1 : basal and one sidedressing, A_2: basal and two sidedressings) in winter season, 1984 for studying their effects in grain quality and flour characteristics.

Both two varieties showed a similar response of decreasing in the yield rates of flour when N-fertilizer was increased, but increased in the protein contents of flour. So far as the effects of two nitrogen applications on flour were concerned, the yield rates and yields of flour with A_2 application method were higher than that with A_1 application method.

The series of farinograph curves and quality data indicated that the higher the N-fertilizer applied, the weaker the flour of Taichung 31 became. On the contrary, the flour of Taichung S-2 was slightly stronger with the increasing of N-fertilizer. It was also found that both two varieties got a similar response in the strength of

flour from the two nitrogen application methods, i. e., A_2 method got a stronger flour than A_1 method. The physical dough characteristics of Taichung 31 was more markedly influenced by the nitrogen application method.

16. Responses of Corn to Different Kinds and Rates of Fertilizers

Field experiments were conducted at Erhlin (Changhua Hsien) and Waipu (Taichung Hsien) in the fall crop season, 1984 to study the effects of fertilizers N, P, K, and Mg on the growth and yield as well as on the nutrient uptake of corn cv. Tainung No. 351. The results were summarized as follows:

A significant reduction in grain yield was found in the treatments of low rates of nitrogen, phosphorus and potassium. The effect of magnesium fertilizer on grain yield was not significant due to adequate magnesium content in the soil. The optimum rates of N, P_2O_5, and K_2O for corn in paddy field were 150-200, 90, 50-100 kg/ha, respectively.

Highly significantly positive correlation between grain yield and P content in the plant at the age of 5 weeks and K content in the ear-leaf at silking stage were observed. These results indicated that P uptake by corn during the early growth stage and K concentration in the leaves at silking stage played an important role on the grain production.

Generally, the grain yield increased with the increase of N concentration in the whole plant or leaf, i. e., nitrogen content in the ear-leaf at silking stage was closely related to grain yield.

17. Effects of Different Application Methods and Rates of Nitrogen on the Milling Quality and Flour Characteristics of Spring Wheat (Triticum aestivum L.)

Two spring wheat varieties, Taichung 31 and Taichung S-2, were treated with three nitrogen rates (85, 125, 165 kg/ha) and two application methods (A_1: basal and one side-dressing, A_2: basal and two side-dressing) in winter season, 1984 for studying their effects on milling quality and flour characteristics.

For both varieties, yield rate of flour decreased while protein content increased as the amount of N-fertilizer applied was increased. A_2 application method also gave a higher yield rate and absolute yield of flour than A_1 method.

The series of farinograph curves and quality data indicated that the higher the N-fertilizer applied, the weaker the flour on Taichung 31 became. On the contrary, the flour of Taichung S-2 was slightly stronger with the increasing of N-fertilizer. It was also found that both varieties had a similar response in the strength of flour from the two nitrogen application methods, i. e., A_2 method produced a stronger flour than A_1 method. The physical dough characteristics of Taichung 31 was more markedly influenced by the nitrogen application method.

18. Studies on the Cultivation of Corn in Paddy Field
III. Responses of corn to different kinds and rates of fertilizers

Field experiments were conducted at Erhlin (Changhua Hsien) and Waipu (Taichung Hsien) in the fall crop season, 1984 to study the effects of fertilizers N, P, K and Mg on the growth and yield as well as on the nutrient uptake of corn cv. Tainung No. 351. The results were summarized as follows:

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Generally, the grain yield increased with the increase of N concentration in plant or leaf; i. e., nitrogen content in the ear-leaf at silking stage was closely associated with grain yield.

19. Introduction of Soil or Treatment of Rice Hull for the Restoration of the Productivity of the Copper Contaminated Soil

This experiment was carried out in a paddy field in central Taiwan where the soil was rendered unproductive due to the contamination by copper in the waste water from the brass spare parts manufacturing factory. The results are summarized as follows:

1. Excessively higher concentration of copper in the soils mainly retarded the growth of rice roots, and hence affected the nutrient uptake and the normal growth of the whole rice plants. In the extreme cases, the rice roots were completly inhibited in growth and thickened with branched root tip.

2. Soil treatment of sulfuric acid at the rate of 1000 l/ha was ineffective for leaching out the excessive copper in the soils, however, rice hull at the rate of 20 tons/ha significanthy retarded the uptake of copper by the rice plants, and the rice plants were able to grow normally under the higher concentration of copper in the soils.

3. The rice plants looked growing almost normal in the 5 and 10 cm top layers and completely normal in the 15 cm top layer of the normal soils introduced to the copper contaminated paddy field, however, the growth and yield components of rice plants among the three different depths of soil introduction were not significantly different.

4. The pollutant, copper, was mainly concentrated in the rice roots, and the copper content in the rice grain was not increased, therefore, the rice grain from the copper contaminated plots was still suitable for human consumption.

20. Restoration of the Productivity of Paddy Field Contaminated by the Acid Waste-Water from the Wire Smelter

The experiment plot is located at a lower place with about 30 m distance from a wire smelter. The acid wastewater from the factory seeped through the soils to the plot to cause the serious wilting of rice plants, and the plot was unable to grow any more crops again without thorough land reclamation. The results of the anaylses for the samples of wastewater, contaminated soils, and wilting plants suggested that the abnormal growth and wilting of rice plants in the plot was mainly caused by the abrupt decrease in pH, the abnormally high salinity and the toxicities of iron and hydrogen sulphide in the soils that rendered an inhibiting and harmful effects on the roots.

Broadcasting calcium carbonate at the rate of 5 tons per hectare, and constructing 4" corrugated drainage pipelines in accordance with the 0.5% decreasing slope, 50 cm depth, and 15m interval, significantly raised the soil pH, and reduced the soil salinity, extractable iron and sulfur to the levels that were suitable for the normal growth of rice plants.

21. Experiments of Fertilization on Edible Canna (Canna edulis Ker.)

Two varieties of edible canna were tested in the field with nine treatments of N, P, K, fertilizers (N: 0, 40, 80, 120, 160 kg/ha, P_2O_5 : 0, 36, 54, 72 kg/ha, and K_2O: 0, 120, 180, 240 kg/ha) at Jiji in Nantou Prefecture during 1982-1984.

Nitrogen had the largest effect on the yield of edible canna and then, K and P, respectively.

The application of nitrogen at the rate of 120 kg/ha and phosphorus at the rate of 54 kg/ha raised the yield of fresh tubers and starch and gave better net benefit. It was also found that the increased amount of potassium fertilizer had positive effect on the production of edible canna. The results indicated that the best fertilizer combination for commercial production of edible canna was 120-160: 36-54: 180-240 kg/ha of N: P_2O_5: K_2O.

B. Diagnosis of Soil and Plant Nutrition and Fertilizer Recommendation

1. Soil Test

Soil samples from paddy field, upland field, vegetable garden and fruit tree orchard are collected and analyzed for their physico-chemical properties. The results together with the recommendation of proper fertilizer management were made known to the farmers concerned immediately.

2. Plant Analysis

Diagnosis of nutrient deficiency by leaf analysis, especially for fruit tree is also conducted. The nutrient contents varied with the kinds as well as the growth stage of crops. The results were sent to the farmers as a reference for the application of fertilizers and soil amendments. About 3000 soil and plant samples were analyzed each year in this laboratory.

3. Extension of Fertilization Management on Rice

In order to teach farmer the correct use of fertilizers for rice, 32 places of field demonstration were established at the main area of rice cultivation. Results showed that the currently recommended method of fertilization according to varieties, soils, climatic conditions and plant performances for adjustment of fertilizer was feasible for rice cultivation. The paddy rice grain yield in the demonstration plots from 32 places averaged 7161 kg/ha and the rates of N, P_2O_5, K_2O, were 127, 55, 57 hg/ha respectively. While yield in the check plot was 6601 kg/ha and the rates of fertilizers were 161, 56, 86 kg/ha. It was obviously that the recommended method increased fertilizer efficiencies, and grain yield. Most farmers didn't apply fertilizer at land

preparation and panicle initation stage were the main reasons why they applied a lot of fertilizers and couldn't get better yields in the paddy. Soil texture, and soil reaction are the two main factors affected both grain yield and rates of fertilizers, especially nitrogen fertilizer.

AGRICULTURAL MACHINERY

In order to meet the necessity of rapid mechanization of farm land, this station is actively engaged in the improvement of farm machinery and farm tools. In the past, researches had been directed to develop various rice seeding machines, harvesting machines and insecticide application tools. As the results, the following machines have been developed: rice seeder (for the use of transplanting machine), rice direct seeder, rice-husk charcoal producer, machines for integrated operation of rice nursery plate, fertilizer deep applicater (mounted to rice transplanter), mini-corn harvester, solar energy drying machine, etc. More efforts are presently laid on the development of seed huller for buckwheat and job's tears which are becoming more important in the upland field nowadays.

1. Machine for Making Rice Husk Charcoal

A prototype machine equipped with a feeder and a ventilator may process even wet rice husk into charcoal to reduce many unnecessary procedures in operation.

The heat content of rice husk charcoal bars is similar to that of wood-chips charcoal. However, this machine still has some problems, especially in the screw conveyer. It is necessary to continue some studies to find out suitable materials for making an endurable screw conveyer.

2. Combine Machine and Reaper

a. Combine machine:
   During the havesting, most of paddy field are muddy and the rice was wet. Using combine machine, it can save a lot of time to dry. This combine machine also can select rice.

b. Reaper:
   Easy to use and saves a lot of time.
   In this district, the famers are lack of labor, and the wages are increasing every year. Besides, it is hard to find labor to work.

3. Improvement and Demonstration of Rice Straw Cutter and Spreader Attached on Tractor

The rice straw cutter and spreader are attacked on a tractor for cutting the straw into smaller pieces for being easier to turn down into the soils by the tractor.

The straw cutter cuts the straw by intermittent contact of a rotary knife and knife fitter. For dry straw, more than 73.6% of straw can be cut into less than 30 cm length and for fresh straw, it may reach to 82.64%. After the cutting, the straw are short enough for being easily mixed into the soil to improve the soil fertility. However, further improvement is necessary, since some of the straw twisted on the rotary shaft interrupting the smooth operation of the machine.

4. Development of a Seeder for Raising Seedling for Rice Transplanter

It is known that rice yield may be increased about 10% by using rice transplanter when compared with the conventional hand transplanting. However, the bottle-neck for the popular adoption of the machine by the farmers is that it requires a lot of seedling-boxes for raising seedlings and rather high facility investment. In order to minimize the cost instead of using seedling-boxes method, a woodframe-method was developed by Taichung DAIS for raising seedlings.

The investment for the latter method has been cut down to only NT 360,000 for each 100 ha of paddy field. According to the preliminary tests, the adoption of the woodframe-method can reduce the cost for raising seedling to NT 7 per box. In this study, a hand operated seeder was developed for sowing the pregerminated seeds within the woodframe.

It showed that 140 frames can be sown with the seeder which is about 50 times faster than that by hand sowing method. The seeder also can be used for covering seed with dried soil.

5. Attachment of Fertilizer Deep-Layer Applicator to Rice Transplanter

Deep placement of fertilizer is one of the effective ways of fertilization methods. It is not only helpful to save nitrogen fertilizer, but also increase the yield of rice. A fertilizer deep applicator was attached to a two-row rice transplanter for being able to transplant rice seedling and deep-placing the fertilizer simultaneously.

Attachment of fertilizer deep applicator to a two-row rice transplanter is simple and effective for the deep placement of fertilizers.

Rice transhplanting and deep placement of fertilizer may be performed simultaneously either in heavy soil or light soil. Fertilizer deep-placing saved 16.8-18.3% of nitrogen fertilizer, and increased the rice yield for 1.6-11%.

6. Use of Farm Machines for Improving Poorly Drained Paddy Fields

Three different treatments, namely, deep plowing with sub-soiler drawn by a farm tractor, deep plowing by placing rice husk in the subsoils, and placing drainage tubes underground were used to test their effects in improving the drainage conditions of the poorly drained paddy soils. The results showed that subsoiling was only slightly effective, but placing rice hull in the subsoil and constructing drainage pipe lines were rather effective for removing off the excessive water in the poorly drained soils. The yield increased from the three treatments were 6.5, 18.9, and 25.2% respectively.

7. Studies on the Improvement of Adlay's Huller

This experiment is focused on decreasing the milling breakage rate of adlay grain by using a conventional rice-huller.

Most of adlay grain was broken under the roller type rice-huller. It was found that rubber roller hardness, clearance and slippage between twin rollers were the three major factors correlated to the kernel breakage. More than 80% of hulling rate was obtaind by using the roller type rice-huller, under 95° hardness, 40% slippage, 50% of grain width clearance and 80% breakage rate.

From the experimental result, softer rubber rollers decreased adlay breakage rate. Under conditions of 13% grain moisture content, 75° hardness, 35% slippage, 40-45% of grain width clearance and twice dehulling process, 80% of hulling rate and 10% of kernel rate were obtained.

AGRICULTURAL ECONOMICS

With the rapid changes of agricultural structure the need to study the economics of different farming systems becomes very urgent in Taiwan. Surveys and experiments on the rotational systems have been made to meet this end. The total input in terms of costs of labor, fertilizers, insecticides, farm machinery, etc. and total output are calculated. The data collected are analyzed statistically to compare the benefit of self-operated farms to that of jointly-operated integrated farms. A survey on the economy of farm operation of low yielding paddy field has been completed. Attention is now focused on the production costs of grape in central Taiwan.

1. Investigation on Regional Special Crops or Special Cropping Systems

According to the difference in natural conditions, some special crops or special cropping systems are developed in individual regions. This report is based on the analyses of their economy and potential for development in order to adjust regional farmland utilization and increase farm income. The areas of investigation included Yungching, Erhlin, Fangyuan, Tacheng and Shenkang in Changhua Hsien. The method used was benefit-cost analysis and data were collected by surveying the actual operation of the farmers.

The results are summarized as follows:

1) In Erhlin, for job's tears in the 2nd cropping season, since it was the first time for cropping, lack of experience in cultivation and the poor management caused a fall in production. The profit from it was not comparable to that from its competitive crop (the 2nd rice).
2) The cropping of the 2nd onions or garlic bulbs in Shenkang, of Golden Muscat (grape) in Erhlin and of rice-water melon-peanut in Tacheng were more profitable than the cropping of competitive crop (the 2nd rice) or cropping system of rice-rice.
3) In Fangyuan, the cropping of Liuchengs (sweet orange) was more profitable than that of its competitive crops (asparagus or rice).
4) In Yungching, the benefit per hetare for multiple crops of vegetables was high, however, the input was also costly. Therefore, this system had better be used for the small farm with available lablor force.
5) In Erhlin, buckwheat is cultivated in the winter. Due to its short growth period and low input, the net benefit-cost ratio was 0.61. If the house labor was not included in the cost, this ratio increased up to 1.38. Therefore, it is clear that buckwheat is worthy of developing in Erlin.

2. Efficiency of Farm-land Utilization in Taichung Coastal Area

This study was conducted in 1980 to 1982 in the coastal area of Taichung and Changhua. The purpose of this study was to find out efficient land utilization models and better crop patterns. Both farmer visiting and experimental plots were employed to compare the different locations and natual conditions. It was find out that there was no significant difference on rice yield at different locations in the 1st rice crop season. However, the yield difference in the 2nd rice crop was significant. The more the yield decreased the closer the land neared the sea. Considered about the crop pattern, it was also find out that the better crop pattern for Tacheng, Taan, Fangyuan and Lukang was 2nd watermelon (or autumn peanut)-vegetables (sweet corn)-1st rice, vegetables-vegetables-1st rice, spring peanut (or spring soybean)-vegetables-1st rice, and cauliflower-cauliflower-1st rice, respectively.

AGRICULTURAL EXTENSION EDUCATION

Agricultural extension services are usually operated in three ways. Firstly, the farmers are organized into different working groups according to crops and cultural patterns that the farmers adopt. Secondly, training courses for extension agents from the farmers associations are planned and carried out to introduce new cultural techniques and varieties developed by this station and other research organizations. Thirdly, agricultural news and technological know-how are transferred to the farmers through the mass communication media such as TV, radios, newspapers and magazines. Recently, emphasis has been put on the training of "real farmers" or "core farmers" under the project of "Establishment of 80,000 Core-farmers in Taiwan".

Six extension professors from National Chung-Hsing University have been assigned as part-time research follows of this station. They work very closely with the extension specialists of this station to solve problems on technical, economical as well as marketing subjects. This type of work provides very effective ways or transfering new knowledge to farmers and exploring difficult problems encountered by the farmers which will be solved by the follow-up investigations.

In addition to providing training courses to the farmers, the training center of this station also offers courses on some special subjects for the specialists of the private companies and trainees from foreign countries.

HOME ECONOMICS EDUCATION and EXTENSION

To enforce the governmental policy of upgrading the living standard in rural area, training courses such as home management, nutrition, cookery practices, bread and cookie making, dress making, flower arrangement, child care, etc. are held regularly for rural housewives.

Regular visits by the home economists to the farmers are aimed to help improve the living environments both inside and outside the farmer's houses. This kind of operation, under the project of "I love my village", has raised the living standard of the farmers in recent years.

1. Studies on the Breakfast Eating Habit and Nutrient Intakes in the Farm in Central Taiwan

A study of breakfast eating habit and nutrient intakes in the farm in central Taiwan was conducted in 1982. Based on the registers of farmer associations, 800 household in central Taiwan were selected by stratified random sampling. Data were collected and analyzed by X^2 independence test, correlation analysis and class interval analysis. The results were summarized as follows:

1. Breakfast was thought to be the most important among the three meals. However, the eating amount in breakfast was the least of them.
2. The average calorie intake from breakfast was 501.3kcal/person which provided 23.3% of the daily essential calorie intake suggested by the government. Moreover, 65% of household favored rice for breakfast and it provided 470.5 kcal which only occupied 21.7% of daily essential calorie intake suggested by the government. This suggested that some education should be conducted for the farmers to improve the quality and amount of breakfast.
3. It was found that 39.6% of household made their own breakfast, 65% of them had rice as breakfast, 95.5% of them had breakfast at home, and 80% of them had breakfast everyday.
4. According to the basal data of the subject, people who usually learn home economics and dietary nutrient from the workshop of farmer association can understand the importance of breakfast. It is, therefore, an intensive course worth continuing.