AVRDC is the international center responsible for vegetable crop research in the humid and subhumid tropics. Established in 1971, its activities include crop improvement, environmental and nutritional studies, germplasm deposition, and training for national program personnel.

AVRDC's research and support staff is made up of some 380 people from a dozen countries. The Center's core budget, which totaled US $4.3 million in 1984, is provided by the governments of the Republic of China, the United States, the Republic of Korea, Japan, the Philippines, Thailand, and the Federal Republic of Germany. Special project funds are provided by a variety of international donors, including the Asian Development Bank, IDRC of Canada and the International Board for Plant Genetic Resources. The Center is governed by an international board representing the various donor countries and experts from collaborating organizations.

about the cover: Detail from mural painting by Cheng Lei Sun.

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AVRDS
Progress Report
Summaries
1984

About this Report

This report provides an overview of AVRDC research in 1984. Readers who would like more detailed information are asked to consult the Center's 1984 Progress Report. The Progress Report, which should be available by the end of 1985, describes in detail all of the research conducted at AVRDC in 1984. Personal copies can be purchased for US $10.00 (see Publications section). Complimentary reprints of up to eight sections of the report can also be requested by sending the attached postcard to AVRDC's Office of Information Services. The reprints are grouped according to crop and discipline and correspond to the summaries found on the following pages.

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Foreword

The following pages will reveal consistent progress by AVRDC staff during 1984. Improved varieties of the five mandate crops performed well in international trials, resulting in 15 new official releases of AVRDC crops in five countries. These include new releases of mungbean in Fiji and the Philippines and Chinese cabbage and tomato in Indonesia.

The year 1984 has been informally designated the "Year of the Sweet Potato" at AVRDC since after years of work the sweet potato improvement program has led to fruition with release of a total of nine cultivars in Bangladesh and French Polynesia.

At this writing improved cultivars from AVRDC have been officially released on almost 100 occasions in 30 countries. AVRDC's improved varieties often become popular with farming communities involved in their trials, before they are formally released by national programs. This is the case in Taiwan with AVRDC's improved soybean cultivar AGS 66. Since official trials began three years ago, the farmers have slowly increased the land under cultivation to about 100 ha.

In areas of research, considerable progress has been made in the understanding of heat tolerance physiology in the tomato. There is improvement in resistance of Chinese cabbage to soft rot and downy mildew through two breeding approachs: the conventional method using resistant accessions, and interspecific hybridization using Hakuran, a Chinese cabbage x common cabbage cross, as one of the parents.

A laboratory method has been developed using water absorbent polyvinyl formate sheets to assess heat tolerance and/or drought resistance in Chinese cabbage and sweet potato. This represents an important step in identifying or developing appropriate cultivars for confirmation of good performance in the field.

The garden program is beginning to have an impact on farmers in Thailand, both as a source of vegetables for home use and as a source of additional income.

The highlight of the year was the External Review which assessed AVRDC programs and performance. The Committee identified AVRDC as a good investment with a high level of output per unit of input. A number of very useful recommendations were made by the Committee which will be adopted by AVRDC programs in due course.

AVRDC has responded very positively to its responsibility for the world's mungbean and the Asia and Pacific sweet potato germplasm collections by constructing a new germplasm resources and storage unit. The facility houses AVRDC's 2,300-sample germplasm collection of five species and has the capacity for additional vegetable species in the future. The unit has short- medium- and long-term storage facilities for seed and laboratories for research and training.

By press time there had been considerable discussion in the international agricultural research community about vegetables. TAC has been considering - for CGIAR deliberation - the elevation of the priority given internationally to vegetables in the next decade with AVRDC to play a leading role. AVRDC stands ready, as the only IARC dedicated solely to the improvement of vegetables, to meet any new challenge for the future.

G. W. Selleck
Director General

Abbreviations and Acronyms

a.i. - active ingredient
ARRT - advanced rust tolerance trial
ASET - AVRDC soybean evaluation trial
AVRDC - Asian Vegetable Research and Development Center
AYT - advanced yield trial
AzMV - adzuki bean mosaic virus
BARI - Bangladesh Agricultural Research Institute
BCMV - bean common mosaic virus
BGMV - bean golden mosaic virus
BICMV - blackeye cowpea mosaic virus
BIMV - blackgram mottle virus
BLS - bacterial leafspot
BV - biological value
BW - bacterial wilt
BYMV - bean yellow mosaic virus
CAMV - cowpea aphid-borne mosaic virus
CAT - combining ability trial
cc - cubic centimeter
CCMV - cowpea chlorotic mottle virus
CFU - colony forming units
CGR - crop growth rate
CLS - Cercospora leaf spot
cm - centimeter
CMV - cucumber mosaic virus
CMV-Y - cucumber mosaic virus-Y
CPATU - Centro de Pesquisa Agropecuaria Tropico Umido
CPA - 4-chlorophenooxyacetic acid
CPMV-S - cowpea mosaic virus S
CPMV-Y - cowpea mosaic virus Y
CV - coefficient of variance
cv - cultivar
CMS - cytoplasmic male sterility
DAE - days after emergence
DAG - days after germination
DAP - days after planting
DAT - days after transplanting
DNP - dinitrophenol
ELISA - enzyme-linked immunosorbent assay
EMBRAPA - Empresa Brasileira de Pesquisa Agropecuaria
EYT - elite yield trial
FAO - UN Food and Agriculture Organization
FE - feeding efficiency
FMV - feathery mottle virus
g - gram
ha - hectare
HGR - height growth rate
HI - harvest index
HR - highly resistant
HS - highly susceptible
IAAS - Institute of Agriculture and Animal Science
IARI - Indian Agriculture Research Institute
IBPGR - International Board for Plant Genetic Resources
ICA - Instituto Colombiano Agropecuario
i.d. - inside diameter
IITA - International Institute of Tropical Agriculture
IMN - International Mungbean Nursery
INRA - Institute national de la recherche agronomique
INTSOY - International Soybean Program
IRAT - Institut de recherches agronomiques tropicales et des cultures vivrieres
IRRI - International Rice Research Institute
IRTT - intermediate rust tolerance trial
ISEM - immunosorbent electron microscopy
IYT - intermediate yield trial
kg - kilogram
LAD - leaf area duration
LAI - leaf area index
LER - leaf area expansion rate
m - meter
min - minute
ml - milliliter
mm - millimeter
MR - moderately resistant
MS - moderately susceptible
NAR - net assimilation rate
NIAS - National Institute of Agricultural Sciences
NIRS - near infrared reflectance spectroscopy
NSC - National Science Council
NSSL - National Seed Storage Laboratory
NT$ - New Taiwan Dollar
NTU - National Taiwan University
OYT - observational yield trial
PER - protein efficiency ratio

PDA - potato dextrose agar
PM - powdery mildew
PMV - peanut mosaic virus
ppm - parts per million
PRTT - preliminary rust tolerance trial
psi - pounds per square inch
PSV - peanut stunt virus
PSV-B - peanut stunt virus B
PvF - polyvinyl formate
PVX - potato virus X
PVY - potato virus Y
PYT - preliminary yield trial
PeMV - pepper mottle virus
R - resistant
RB - reddish-brown
RCB - randomized complete block
RDA - recommended dietary allowance
RDW - root dry weight
RGR - relative growth rate
RH - relative humidity
S - susceptible
SARIF - Sumatra Agricultural Research Institute for Food Crops
SBMV - southern bean mosaic virus
SHAM - hydroxamic acid
SLW - specific leaf weight
SMV - soybean mosaic virus
SPD - split plot design
SPV-A - sweet potato virus A
SPV-N - sweet potato virus N
SSV - soybean stunt virus
t - metric ton
TARI - Taiwan Agricultural Research Institute
TEV - tobacco etch virus
TLCV - tomato leafcurl virus
ToMV - tomato mosaic virus
TOP - Thailand Outreach Program
TSWV - tomato spotted wilt virus
TYDV - tomato yellow dwarf virus
TuMV - turnip mosaic virus
TYLCV - tomato yellow leafcurl virus
USAID - United States Agency for International Development
USDA - United States Department of Agriculture
VAM - vesicular arbuscular mychorrhizae
VISCA - Visayas State College of Agriculture
WAP - weeks after planting
WAT - weeks after transplanting
WP - wettable powder

Horticultural Crops Program

TOMATO

INTERNATIONAL COOPERATION

Seed Distribution

The tomato program distributed 4,729 seed packets to 304 cooperators in 77 countries in 1984.

Crop Release

The Central Research Institute for Horticultural Crops, Bogor, Indonesia officially released AVRDC accession L15 under the name "Berlian" which is highly resistant to bacterial wilt and can be grown in the lowlands.

International Trials

Brazil - EMBRAPA-CPATU found CL 1131-38-4 the best line for the wet, low-light-intensity season of the Amazons.

Indonesia - The ROC Agricultural Technical Mission to Central Java tested 10 lines from the CL 1131 and 5915 series. Four lines stood out in terms of overall productivity and wilt resistance.

Liberia - The Central Agricultural Research Institute, Suakoko tested 10 AVRDC lines and found CL 1131-7-2-0 yielding substantially more than the local check during the hot season.

Malaysia - CL 9-1-3 was considered more acceptable than the local check cultivar in terms of wilt resistance, fruit size, shape, and color. Two AVRDC germplasm carrying Tm1 and Tm2a genes for ToMV resistance are being used in the Universiti Kebangsaan, Malaysia.

Nepal - IAAS, Rampur tested 16 AVRDC lines and assessed the potential of the tropical lines to be very good for production in the plains during the hot season.

Reunion (France) - IRAT screened AVRDC lines for wilt resistance. MST 25-7 showed the least wilt infection and was one of the two highest yielders.

Zimbabwe - The Chidrezi Research Station found that the commercial cultivars performed better than the 16 AVRDC lines tested.

BREEDING

Breeding Program

Breeding achieved the incorporation of resistance to tomato mosaic virus (ToMV) in nearly 100% of the new tropical lines, continued work for nematode resistance, and started focusing on fruit size and firmness and resistance to bacterial wilt.

A total of 1,142 segregating families were planted for selection, and 1,427 line selections/plants were derived for further tests. The breeding program received 53 new introductions which are undergoing evaluation and proper cataloguing.

Germplasm Evaluation

None of the 82 accessions evaluated against two heat-tolerant lines equaled the fruit-setting ability of these two superior check cultivars. However, three lines T97 (Sri Lanka), L-12 (Panama), and Saladette (USA) were rated medium-to-high set.

Diallel Analysis of Heat-Tolerant Parental Stocks

The seven-parent diallel analysis indicated that the trait (expressed as percentage of fruit set) is conditioned by both additive and non-additive acting genes. Similar results were obtained for antheridial cone splitting, an important component of heat tolerance. This congruence in results is interesting and is partly supported by the highly significant correlation ($r = -0.67$, $df = 26$) between fruit set and antheridial cone splitting tendency in the experiment. The results imply that either conventional or hybrid breeding methods would be effective in improving the trait.

Evaluation of New Tropical Breeding Lines

Four sets of hot-season trials identified new indeterminate tropical lines with better yields than the fresh market cultivars (checks) or with comparable performance to the best heat-tolerant determinate tropical lines. In several cases, fruit size of the new lines were twice that of the check (especially in the determinate group) and had better, if not equal, vigor than the check. The largest fruit size among the indeterminate lines was only comparable to one check cultivar, but it yielded at least seven times more. The main advantage of the tropical indeterminate lines over the check was in the level of heat tolerance.

All new lines tested carried ToMV resistance and represented one of the major improvements over the old tropical ones. Better fruit size was also apparent especially in the newer single seed descent lines.

Yield under Improved Drainage

Bed height (60 cm) did not affect the yield of the tropical lines during the humid summer season. Neither did it significantly influence almost every character measured, except fruit size (which occurred consistently in both determinate and indeterminate lines), BLS infection (determinate), and days to flowering (indeterminate).

Regardless of the bed system, the highest marketable yield was 33 t/ha in the best determinate line and 18 t/ha in the best indeterminate cultivars.

PATHOLOGY

CMV Resistance

Forty-one accessions were screened for resistance to cucumber mosaic virus (CMV). All were susceptible except accession L 5339 which shows promise as a source of resistance to this disease.

Hairy Tomato for CMV

Resistance or even tolerance to CMV is not easily found in tomato or its wild relatives. A study with hairy tomato showed that 30 days after transplanting (end of the growing season), CMV incidence ranged only from 33.8% to 76.3% in these lines but reached 100 in the non-hairy checks.

Screening for Resistance to PVY

A screening method was developed by which symptoms could be expressed more distinctly. Sixty-one randomly chosen accessions comprising mainly wild type tomato lines and 14 reportedly resistant accessions were screened. Among these, only two accessions of L. hirsutum were found with resistance.

Characterization of Four Poty Virus Isolates

Four poty virus isolates (T-697, T-1077, T-1082 and T-704) recovered in previous surveys for tomato viruses, were partially characterized. They reacted identically in transmission, host range, physical properties and serology. Their host range was confined to the Solanaceae but apparently excluded Capsicum sp. They were transmitted by aphids in a non-persistant manner. In ISEM tests they were not trapped by 10 antisera of poty viruses known to infect tomato.

It is assumed that the isolates represent a new virus not described previously. This virus does not appear important in terms of distribution on tomato in Taiwan.

Investigation of a Severe Necrotic Disease

More than 50% of the necrotic plants were found to be infected with PVY. There are reasons to believe that the necrotic disease is caused by a synergistic reaction of PVY with other viruses, notably CMV or ToMV, which were also recovered in these samples. Simultaneous artificial inoculations with PVY and CMV isolates, recovered from necrotic samples, were able to produce severe necrotic symptoms similar to those observed in the field. The possibility of involvement of other viruses, however, cannot be excluded.

Tomato Leaf Mold

Growth of the tomato leaf mold fungus (Cladosporium fulvum) was slow on all artificial media tested. Therefore, another method was used to speed up inoculum production which consists of flooding the Petri dish with a water spore suspension to obtain many colonies seattered over the whole surface of the solid medium.

The fungus isolate used in this study was identified as race 7, according to the original race nomenclature system, or as race 2-3-6 by another system which is gaining wider acceptance.

All AVRDC accessions previously reported resistant to C. fulvum were found susceptible to the isolate used in this study.

Testing for Disease Resistance

All 29 of the AVRDC advanced tomato lines tested were found susceptible to leaf mold (Cladosporium fulvum), early blight (Alternaria solani), and bacterial spot (Xanthomonas vesicatoria). An additional 10 lines from the USA reported to be resistant to bacterial spot were tested and found susceptible, except Hawaii 7998.

Comparative Virulence of *Corynespora cassiicola*

In general, cultivars of C. Cassiicola were most pathogenic on the host (tomato, sweet pepper, soybean, and tobacco) from which they were isolated, indicating a pattern of host specificity. This indicates that care should be

exercised in selecting isolates for resistance screening and in characterizing the nature of host resistance.

Bacterial Wilt

Efforts to find reliable methods of quantifying bacterial wilt resistance continued this year. The linear component of quadratic fit provided a good measure of wilt resistance. Root-dip inoculation was a very harsh treatment and might have accounted for the increased wilt severity in this year's experiment.

Infectivity Titrations

The general method for stem-inoculation infectivity titrations was to grow seedlings, inoculate them with bacteria, and then record the number of wilted plants at several intervals. Infectivity titration provided a satisfactory method of determining relative resistance and susceptibility of tomato to bacterial wilt. Within a given test set, the materials considered resistant based on field tests showed a higher ED 50 than material reported as susceptible. Lines intermediate in their resistance also indicated ED 50 values intermediate between resistant and susceptible.

Interaction Between Root-Knot Nematodes and Bacterial Wilt

Root-knot nematodes exerted little influence on bacterial wilt development when the bacteria were applied to the stem. In root inoculations, however, the presence of nematodes caused the rapid development of wilt. With regard to the final amount of wilt present, there was a difference in response among lines. This suggested that there were more than one type of bacterial wilt resistance and that the presence or absence of nematodes would drastically affect certain types of resistance.

Late Blight

During an artificial late blight (Phytophthora infestans) epidemic, line L 1197 did not develop any disease despite the presence of the inoculated plants and the overhead sprinkler irrigation. Although L 1197 displays excellent resistance under field conditions, screening will have to be continued because the actual reasons for resistance are still unknown.

ENTOMOLOGY

Fruitworm (*Heliothis ormigera*) Resistance

After two years of backcrossing by plant breeders and resistance screening by entomologists, a fruitworm-resistant tomato progeny with bigger fruits than the resistant parents was chosen. However, further backcrossing and selection are

Fruitworm

necessary to improve fruit size which is still smaller than that of conventional cultivars.

Tomato Fruitworm Studies

A technique to mass-rear fruitworm for the production of female sex pheromones to combat this insect was developed as part of a NSC project. The artificial Bio-Serv diet gave better rearing results: minimum abnormalities and mortality, greater pupal weight, and relatively short larval period. This diet is now the standard food source for raising tomato fruitworm. Over 17,000 insect pupae have been supplied to three organizations involved in this NSC-supported project.

Aphid Resistance

A hairy wild tomato (*Lycopersicon hirsutum* subsp. *glabratum*) entry 76W-P113417-A had the lowest number of aphids among the entries. All hairy *L. esculentum* varieties had significantly lower aphids than the standard high-yielding susceptible cultivar, TK-70, which does not have hairy leaves or stems. In general, certain hairy entries of the above two varieties showed moderate levels of resistance to cotton aphids.

PHYSIOLOGY

Effect of Temperature on Flower Membrane Stability

High temperature increased the membrane permeability of both the tomato leaf and floral organs. The pistil and anther

of various varieties demonstrated different responses to temperature. Pistil damage was the highest regardless of development stage and growing temperature. Anthers were particularly sensitive to temperatures between 45° and 50°C at anthesis. The comparative responses of membrane permeability offers one method to study heat stress on the reproductive process and screening for heat tolerance.

Effect of Temperature on Proline Content

Proline concentration in the tomato anther increased with advancing developmental stage, but free proline decreased with increasing temperature. In the leaf tissue, it accumulated as the temperature increased, but its concentration was lower than that in anthers and pistils. The addition of proline to the germination medium made pollen more resistant to high temperature. These results suggest that the high proline concentrations in the anther may confer resistance to the anther at unfavorably high temperatures.

Pollen Respiration

Germinating pollens of two lines exhibited high rates of respiration at 20° and 26°C. Higher temperatures (32° and 38°C) clearly inhibited pollen respiration and germination. In general, CL 5915-153D_4-3-3-0 had lower pollen respiration and germination than L 387; but the addition of proline or betaine to its medium enhanced these processes. These results reinforce earlier assumptions that proline is important to the tomato reproductive processes at high temperature.

Floral Bud Development *In Vitro*

An in vitro study obtained satisfactory results with a modified MS medium for the culture of tomato buds at 6, 4, and 2 days before anthesis. In general, bud opening was at a satisfactory level, browning was not severe and pollen staining was high. Pollen germination, however, was low and was reduced by high temperature. CL 5915 had more germinating pollens, opened buds, and stained pollens, but less browning than L 387. The addition of proline to the medium slightly reduced browning. In vitro floral bud culture may be a good tool for facilitating physiological studies of gametogenesis.

Heat-Tolerant Characters

An inventory of 25 entries previously identified as heat-tolerant and two entries as heat-sensitive was made to identify genetic variation in fruit set and fruit yield, together with their associated morphological characters and physiological processes under hot, wet conditions.

CL 5915-153D_4-3-3 was found the most tolerant entry having high fruit set with the least stigma exsertion, antheral cone splitting, and anther heat injury at 50°C. L 3958 (Saladette) had comparable fruit yield but lower fruit set percentage and fruit number. However, it had large fruits and a high SLW which may facilitate high dry matter accumulation in the fruit.

Tomato fruit set through *in vitro* pollination

Endogenous Plant Hormones in Tomato Fruit-Setting

Results supported the assumption that temperature plays an important role in controlling the levels of endogenous plant hormones in tomato. Furthermore, it showed an obvious relationship between fruit set or early ovary growth and the changes in hormone levels in the ovary under favorable and unfavorable environments.

High levels of extractable IAA and GA_3 and low levels of extractable ABA in pistils were associated with plants having favorable growth conditions; and vice versa with plants having unfavorable growth environments. For parthenocarpic fruits, it was suggested that a threshold concentration of endogenous IAA was necessary for fruit development. The level of GA_3 may hold the key to controlling fruit set at high temperature.

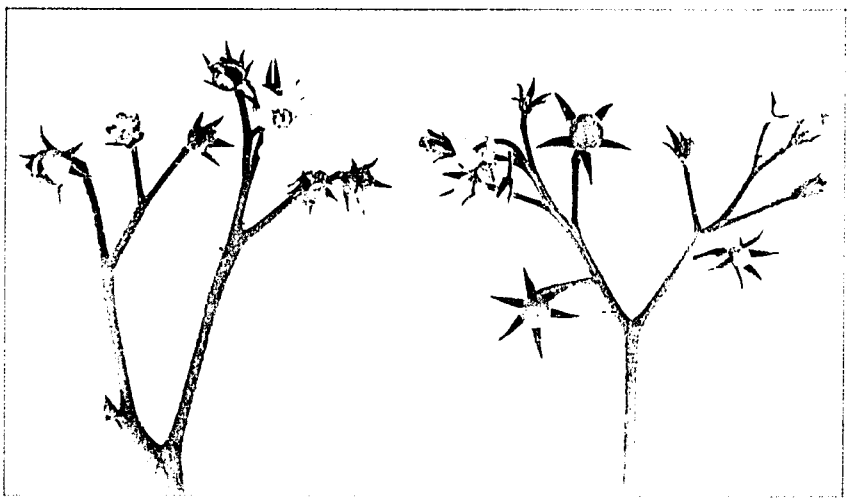
Pollination

CL 1131-0-0-43 and BL 6807 were able to produce viable pollen under high temperature conditions, and to pollinate and set fruits by themslves. Emasculation with artificial pollination substantially improved fruit set of these lines but not of Severianin.

The results suggest that either ovules/pistils of Severianin may be damaged by high temperature, or that the spontaneous fruit set ability under high temperature may be so overriding that pollination with viable pollen is not effective.

Heat Tolerance

Fruit set and fruit yield were lower in parthenocarpic tomato than in the seeded, heat-tolerant tomato. However, parthenocarpic PT 1461 was comparable to seeded, intermediate, heat-tolerant tomatoes on these characters, suggesting that it possesses heat tolerance to some extent.



Fruit set: Parthenocarpic (left); Normal (right)

Fruit sizes of parthenocarpic PT 1441, PT 1461, and Severianin were generally larger than those of the other entries, which compensated for their low fruit set. This study confirms the finding that the AVRDC improved seeded, heat-tolerant tomatoes have higher yields and better fruit set than parthenocarpic tomatoes at high temperatures.

Parthenocarpy Inheritance

Plants with fruits containing mature or immature seeds performed much better in terms of fruit yield under high temperature. Although there was some level of heat-tolerance in fruit setting of parthenocarpic tomatoes, their yield did not match that of seeded plants. Seeded plants with mature or immature seeds had larger fruits than seedless ones.

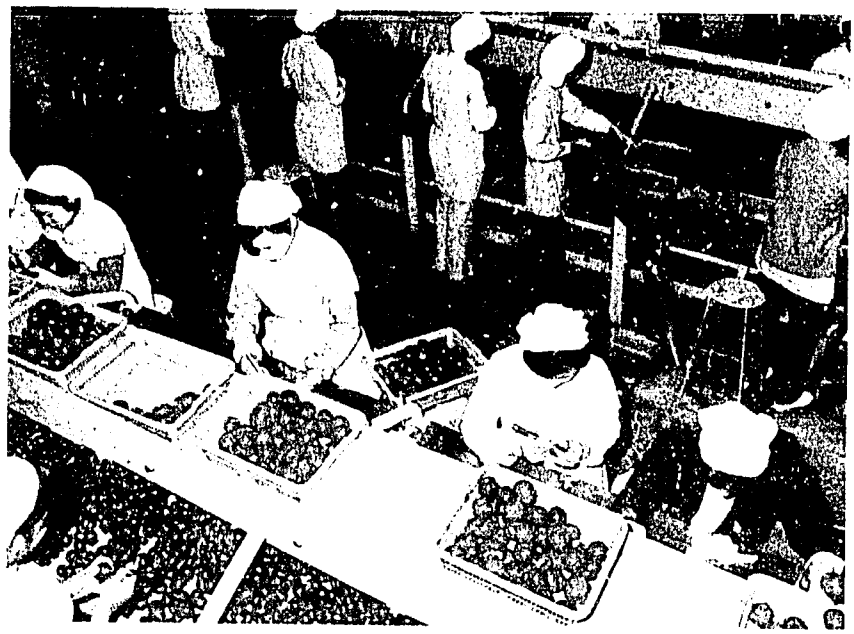
PROCESSING TOMATO

Heat-Tolerance and Disease-Resistance

Some F_1 selections (PT 3023, PT 3025, PT 3026, PT 3027, TM 103, PT 858) produced two to three times more fruits than the superior control cultivars. Most of the entries showed a good level of resistance to high temperature but had relatively small fruits. PT 3025, PT 3027, and PT 600 had the best overall rating in terms of fruit setting under high temperature, size, firmness, and color of fruits.

Verifying Disease Resistance

A series of seedling inoculation tests showed that most of the 24 cultivars tested were resistant to root-knot nematode and all but one were resistant to fusarium wilt and TMV (strain 1).



Canning processing tomatoes

Regional Yield Trials

The hybrid selection TM 103 produced up to 78 t/ha of marketable fruits - 74% higher than that of the most commonly used local cultivar or 48% higher than that of the newly released processing tomato cultivar, Tainan Selection No. 2. The overall mean yield in nine trials was 77 to 84 t/ha in comparison with 62 to 63 t/ha of the control cultivars.

Heat Tolerance of Parthenocarpic Tomato

Although parthenocarpy in tomato is controlled by a single recessive gene, there are differences in the expression of seedlessness in different families, and the intermediate type (partial seedlessness) seemed to have the best ability to set fruit in high temperature. In the completely parthenocarpic lines, there were also differences in the ability to set fruit under high temperature.

CHINESE CABBAGE

INTERNATIONAL COOPERATION

Seed Distribution

The Chinese cabbage program distributed 1,525 seed packets to 174 cooperators in 68 countries.

Crop Release

The Central Research Institute for Horticultural Crops, Bogor, Indonesia officially released AVRDC-bred 77M (3)-26 and 77M (3)-40 as "Sanguihe" and "Talaud", respectively.

International Trials

Australia - In the semi-arid subtropical areas in the north, AVRDC ASVEG 1 performed well in a trial conducted by the Department of Primary Production, Darwin.

Brunei - The Sinaut Agricultural Research and Training Center reported two AVRDC entries with commercial potential for the dry and wet seasons: 77M (3)-35 and 77M (2/3)-41. Both were most tolerant to soft rot.

Indonesia - A number of AVRDC hybrids and open-pollinated cultivars showed excellent performance in a preliminary trial at the Australian Livestock Development Project at Kupang. The best entries yielded 36 to 38 t/ha in 61 to 65 days, averaged more than 1 kg/head, showed nearly 100% heading harvest rates and had no soft rot infection.

The ROC Agricultural Technical Mission in Central Java tested Hybrid 58 and ASVEG 1 against two commercial hybrids. ASVEG 1 outyielded the check cultivar at higher elevation.

Philippines - The Director of the Institute of Small Farms and Industries of the Ateneo de Davao University recommended Hybrid 58 and B 189 for use in the area. These entries did not suffer any soft rot damage, averaged 1.5 kg head weight and obtained nearly 100% heading.

USA - Reports from cooperators in temperate regions indicated a surprisingly acceptable preformance of the AVRDC cultivars bred especially for the tropics. Heading ability, however, depended on planting season.

At Michigan State University, East Lansing, ASVEG 1 performed well and was highly preferred over other Asian cultivars because of the prevailing market demand for 2- to 3-lb heads.

BREEDING

Germplasm Evaluation

Of the 15 newly acquired accessions tested, three (B 808, B 812, Summer Sun) were found heat tolerant. Summer Sun yielded well and had 100% heading and harvest rates. These accessions had heading rates comparable to ASVEG 1, but were late maturing and more prone to soft rot attack.

Combining Ability Trials

A total of 165 new combinations were tested against the standard check, ASVEG 1, in five different sets of combining ability trials. None of the new hybrids in the first set was clearly superior to ASVEG 1. However, some were selected for further tests based on their overall appearance. A number of superior hybrid combinations derived from the TuMV backcross program and crossed with the older tropical inbreds proved markedly better than ASVEG 1 in a series of related tests. The best new combinations will be retested in 1985.

Stability in Yield Performance

A series of advanced yield tests identified two new hybrids (82-156 and 82-157) as having a relatively more stable performance over a wide range of environments than the others. ASVEG 1, the standard check, was also fairly stable. The main advantage of the two hybrids over ASVEG 1 was in overall appearance: smoother leaf texture, hairlessness, and a more erect growth habit. They were also more turgid in severe summer heat and moisture stress than the others, including ASVEG 1.

Improving ASVEG 1

Further intercrosses of sibs within ASVEG 1 did not alter the general morphology of the hybrid. Slight changes among them did not warrant replacing ASVEG 1. Although the present form has the disadvantage of puckered leaves, the possibility of economically producing its seeds and the stability of its performance throughout the summer more than make up for this limitation.

Seed Blending of ASVEG 1

Seed blending is a real possibility for ASVEG 1. The blended seeds did not differ from either the direct and reciprocal cross in all traits measured. Seed blending makes seed production more economical and easier.

Hakuran, a synthetic form of *Brassica napus*

Disease Resistance Breeding: Hakuran Backcross

Backcrossing, testing, and selecting derivations from the Hakuran backcross family were continued to improve the resistance of tropical Chinese cabbage to downy mildew and soft rot. Preliminary evidence indicated that more advanced generations tended to have lower levels of resistance to downy mildew.

Heat Tolerance of Tropical Inbreds × Hakuran Backcross Derivatives

A number of combinations between lines derived from Hakuran backcrosses and tropical inbreds performed comparably to ASVEG 1 and were superior to the recurrent stock B 129 in almost every trait measured, except head solidity and level of natural soft rot infection. This indicated that there was an adequate heat tolerance for these combinations. Selection for lines showing good disease resistance and better horticultural attributes should improve the usability of these combinations.

Cytosterility Backcrosses

The program to transfer cytoplasmic sterility to tropical Chinese cabbage is progressing. Cytosterile backcross derivatives with mustard and radish as sources of the sterility-inducing cytoplasm showed improved leaf color, flower size, functional nectary and seed/pod fertility. Continued progress can be expected through repeated backcrossing in the future.

PATHOLOGY

Downy Mildew

Resistance to downy mildew in Chinese cabbage is expressed in the seedling stage. In vitro studies with artificially inoculated, detached cotyledons of 77M(3)-27, 77M(3)-35, and Hybrids 62, 58, and 59 showed lower rates of spore production when compared with the susceptible check, Pinluh. The inbred lines used as parents for the hybrids were also tested in this manner, and the regression line of each of the F_1 hybrids was the average of its parents, suggesting that downy mildew resistance is an additive trait, and that the resistance of a hybrid may be estimated from the relative performance of its parents.

Soft Rot

Experiments with soft rot caused by Erwinia carotovora continue to examine different methods of inoculation and environmental factors leading to disease increase.

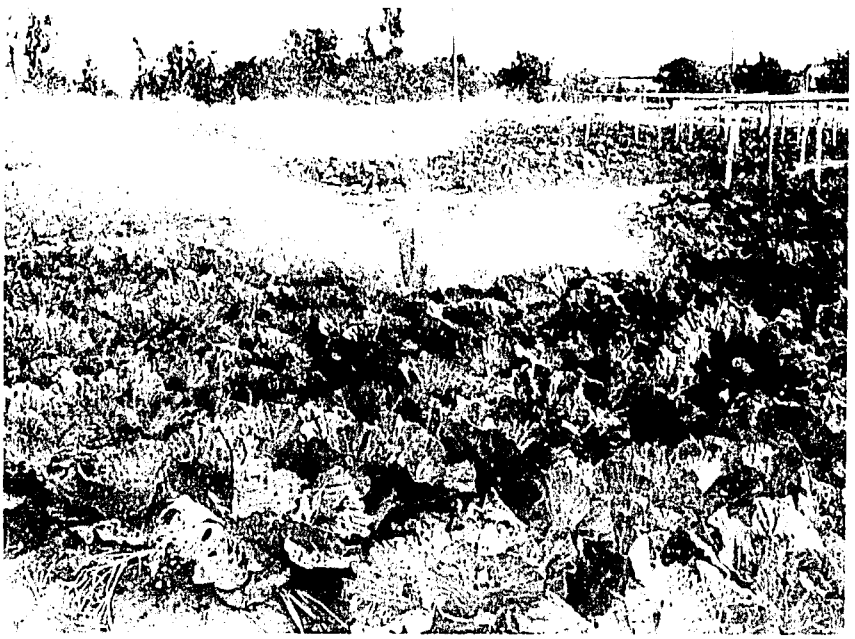
In a 2 by 4 factorial experiment, the effect of breaking leaves was greatest in the spray-inoculated plots. Leaf breaking had a minimal effect in the injection-inoculated and non-inoculated treatments. Overhead spray inoculation produced high levels of soft rot when combined with leaf-breaking by the stems.

In a plant density experiment with three different intra-row spacings, and 1, 2 or 3 rows per bed, no effect of plant density on the incidence of soft rot was observed.

Screening for Resistance to TuMV

Fifty-eight accessions were screened for resistance to strains C4 and C5. Accessions B 819 and B 820 were found resistant to C4. None of the accessions were resistant to C5.

Soft rot



Sprinkler irrigation for diamondback moth control

ENTOMOLOGY

Sprinkler Irrigation for Diamondback Moth Control

Nine years of diamondback moth monitoring has demonstrated its prevalence during the dry season. In 1983 it was found that sprinkler irrigation significantly reduced diamondback moth infestation.

In order to reduce variable factors, the control common cabbage in this year's experiment was given the same amount of water through drip irrigation as plots irrigated by sprinkler. Overhead sprinkler irrigation significantly reduced diamondback moth (and somewhat reduced aphid) infestation, increased marketable heads, head weight and yield of common cabbage.

Cabbage Webworm Resistance

Young larvae of cabbage webworm (Hellula undalis) feed on the growing point of Chinese cabbage seedlings. This provokes either the plant's death or failure to form a head. Seedlings of 133 accessions were transplanted in the field and exposed to the ambient level of insect population, and the number of insect-damaged and healthy plants were recorded. Although all accessions were damaged by cabbage webworm larvae, nineteen accessions were relatively less damaged. They will be rescreened in 1985 to select consistently least damaged entries for possible use in the resistance breeding program.

Chemical Control of Cabbage Webworm, Aphids and Diamondback Moth

Three insecticide screenings, each involving nine insecticides and one untreated check, were conducted during 1984 to investigate the effectiveness of various conventional, as well as new chemicals in controlling insect pests of Chinese cabbage.

In the first trial, profenofos, EPN, and triazophos sprayed at weekly intervals gave equal or better control of cabbage webworm than did the standard chemical, parathion. These insecticides also gave superior yields than control plots which received no insecticide.

In the second trial aimed mainly at controlling aphids, pirimicarb and profenofos sprayed at weekly intervals gave superior control and doubled the yield compared to control plots which received no insecticide spray.

Aphid infestation of Chinese cabbage during seed production

In the third trial, aimed primarily at diamondback moth control, MK936 (18 g AI/ha), bendiocarb, and profenofos sprayed at weekly intervals gave excellent control of diamondback moth and significantly increased cabbage yields.

Tomato Leaf Extract Deters Diamondback Moth Oviposition

As a consequence of the intercropping experiment, the effect of tomato leaf extract on the oviposition of diamondback moth on common and Chinese cabbage was studied. The seedlings sprayed with tomato (wild or cultivated) leaf extract had significantly reduced numbers of eggs compared to seedlings sprayed with water only. Apparently, the tomato leaf extract deters the diamondback moth from laying eggs on treated leaf surfaces.

Intercropping for Diamondback Moth Control

As a result of the larvae of diamondback moth (*Plutella xylostella*) feeding on foliage, the yield and quality of the produce is reduced. To assess the possibility of controlling

infestation through intercropping instead of insecticides, common cabbage was grown together with 99 different crops from India, Taiwan, Thailand and the USA. Although barley, oat and safflower hinder access of common cabbage to insect infestation, they also drastically reduce cabbage yields because they completely cover the cabbage. Since dill, garlic and tomato reduce insect infestation without covering the cabbage plant, they will be further investigated during 1985.

Oviposition Behavior in Daimondback Moth

Since diamondback moth larvae do not migrate but instead feed and pupate on the host plant on which the female lays eggs, host plant selection by the adult female is crucial. The diamondback moth laid significantly greater numbers of eggs on two Chinese cabbage cultivars than on common cabbage. A future study will examine the relationship between this insect's oviposition and the trichome density on the Chinese cabbage leaf surface (common cabbage is essentially glabrous).

PHYSIOLOGY

Water Usage Studies

A method of measuring water consumption daily by use of PvF strips was devised to study water use efficiency. Heat-tolerant Hybrid 62 utilized water more efficiently under high temperature conditions during the growth period and produced more heads and dry weight than heat-sensitive B-33. The results support the finding that heat tolerance depends not only on a plentiful supply of water, but more importantly, on the plant's ability to uptake water and preserve it.

SWEET POTATO

INTERNATIONAL COOPERATION

Distribution

A total of 110 sets of sweet potato breeding lines and accessions was sent to 99 cooperators in 44 countries. A safer, reliable, and more efficient distribution system using small virus-free storage roots was developed to replace the tissue culture method in which survival rate is low.

Crop Releases

Bangladesh - After extensive trials three AVRDC cultivars, BNAS-white, AIS 0122 and Tinirining, were recommended for release by BARI because of their high yield, shape and size of roots, chemical composition, keeping quality and weevil resistence.

Tahiti (French Polynesia) - Five AVRDC selections were released - CN 942-47, CN 1038-16, CN 1038-15, CI 590-33 and CI 591-14 - which were especially recommended for their superior yield, early maturity, and better eating quality.

IRAT scientists have successfully used AVRDC germplasm as parental stocks to improve local cultivars; seven breeding lines were being selected for release.

International Trials

Indonesia - Four AVRDC selections significantly outyielded the local check and were used for regional trials by SARIF, Padang.

Philippines - Three AVRDC cultivars outyielded the best check line. CN 1232-9 is suitable for human consumption because of its taste and appearance, and for feed without cooking because of better starch digestibility.

Thailand - In trials conducted by TOP, Kamphaeng Saen, AVRDC selection CN 1028-5 significantly outyielded local cultivars; however, it was reported as being unacceptably soggy.

BREEDING

Germplasm Evaluation

In 1984, eight sweet potato cultivars and 4,050 true seeds were introduced from Indonesia, the Philippines, Taiwan, Thailand and the USA. The AVRDC sweet potato collection now totals 1,208 accessions.

Of the 396 accessions evaluated, 21 cultivars showed considerable dry-matter content (35 to 42.7%), 22 had superior dry matter yield potential, 28 cultivars displayed high protein content (9.1 to 13%), and 17 indicated substantial total biological yield (vine plus root). These materials will be further evaluated in 1985.

Hybridization

A total of 94,717 sweet potato seeds were collected during the 1983-84 cool season. Three types of hybridization were conducted: hand crosses, open-pair pollination and polycrosses. Hybridization concentrated on raising dry-matter yield for feed/industrial uses and on improving eating quality and flavor for human consumption.

Seedling Screening

Of the 68,170 seeds sown, 6,557 seedlings were selected based on the qualitative characteristics of the plants, e.g. flesh and skin colors, appearance and shape of storage roots, and plant types, and the results of the rapid determination method for dry matter and protein. Except for a few non-flowering cultivars, sufficient hybrid seeds were successfully produced through controlled crosses, open-pair crosses and polycrosses. Application of multiple selection criteria at various stages of breeding resulted in substantial narrowing down of total population size. Considerable improvement in percentage of dry matter and dry matter yield was observed over previous trials.

Yield Trials

Preliminary and advanced yield trials were conducted in the favorable (cool-dry) and unfavorable (hot-wet) seasons - initially AVRDC and later in multi-locational trials in Taiwan - before shipment to international cooperators for trials.

Clones selected this year were less promising than in the previous year. It appeared that the population is approaching a yield plateau of 20-30 t/ha in the unfavorable and 30-40 t/ha in the favorable seasons. Selection CN 1309-18 was the only cultivar which yielded significantly higher than the control.

Yield Stability Trials

Multilocational trials were conducted during the dry and wet seasons under nine different environments to better

Harvesting sweet potato trials

understand the nature of yield stability. Of the 15 AVRDC advanced cultivars, selections CN 1028-15, CN 1108-13, CN 1232-9 and CN 941-32 were identified as superior cultivars for yield stability, with an average marketable yield of 24 t/ha. The performance of high-yielding cultivars, however, was less stable than that of low-yielding ones.

Hot-Wet Season Yield Trials

In order to reduce the over-production of rice during the wet-hot season, a project was begun with PDAF and TARI to identify superior sweet potato cultivars for this unfavorable season. In hot-wet season trials, selection CN 1108-13, CN 1232-9 and CN 942-47 were found superior to the control cultivar TN 64 and exhibited a similar level of adaptability to the other control cultivar TN 66. The first two superior cultivars and TN 66 showed relative stable yields under both wet-hot and cool-dry seasons.

Selection for Animal Feed and Industrial Uses

This project aims at developing tropical cultivars with superior dry matter and starch yields, and better feeding efficiency for animals and for industrial uses. Two cultivars, CN 1232-9 and CN 1219-1, were identified as having excellent adaptability and starch yield under wet-hot environments. (See Chemistry under NEM for results of the feeding efficiency tests.)

PATHOLOGY

Distribution of SPV-A and SPV-N

These two viruses were found to be very unevenly distributed within mature sweet potato plants. Neither SPV-A nor SPV-N were detected in all leaves with symptoms and both viruses were also found to be present in symptomless leaves. No spatial pattern was recognized for the presence of the two viruses in the leaves. They were, however, detected with more consistency in the proximal stem and branch sections than in the distal sections.

Virus Indexing of Meristem-Derived Plantlets

A high percentage of SPV-N (11.8%) was detected by ELISA in meristem-derived plantlets. SPV-A was found in only 3.8% of the plantlets. To assure absence of virus, it is recommended that vines or tubers be subjected to heat treatment prior to meristem excision and that all the leaves of the meristem plantlets instead of only one or two, as in past practice, be virus-tested. Additional testing of mature meristem-derived plants by grafting to susceptible indicator plants should also be done to assure absence of viruses.

ENTOMOLOGY

Weevil Resistance

In order to control sweet potato weevil (Cylas formicarius F.) cheaply and effectively, weevil resistance screening has been conducted at AVRDC since 1975. In 1984 screening tests, the number of weevil varied from 0 to 87.6 insects/kg roots and damaged roots 0 to 33.6%. The low damage rates, however, may not be due to genetic resistance; they could be due to environmental factors since wide variation was observed among replicates. A reliable source of resistance has yet to be identified.

Sweet potato weevil

Vineborer Resistance Screening

Thirty-seven less damaged accessions from the 1983 testing were screened for the third time at Pe .ghu Island for resistance to sweet potato vineborer (Omphisa anastomasalis). Accessions 1582, 1656, 1708, 1780, 1789 and standard resistant 192 were free of vineborer damage. These accessions' resistance mechanism will be characterized before utilization in the breeding program.

PHYSIOLOGY

Small Virus-Free Roots for International Germplasm Exchange

Because of its susceptibility to extreme temperature, rough handling and lack of facilities/personnel, germplasm exchange in test tubes has a low viability record in surviving international transfer.

An alternative method of producing storage roots from leaf-cuttings of virus-free plantlets obtained through meristem-tip culture was examined. These plantlets were transplanted under insect-free conditions in a sterilized soil medium. The expanded leaves derived from the mature plants were then cut at the base of the petiole and were planted in a new sterilized soil medium where they develop storage roots. The expanded leaf was then subjected to virus indexing by ELISA.

Four to five virus-free plantlets per month can be grown from the in vitro single-node cuttings used to obtain the mature plants. The plants, in turn, produce an average of 15 leaves per month, and of these, approximately 50% produce small storage roots. An average of 22 virus-free roots were produced by each plant in six months.

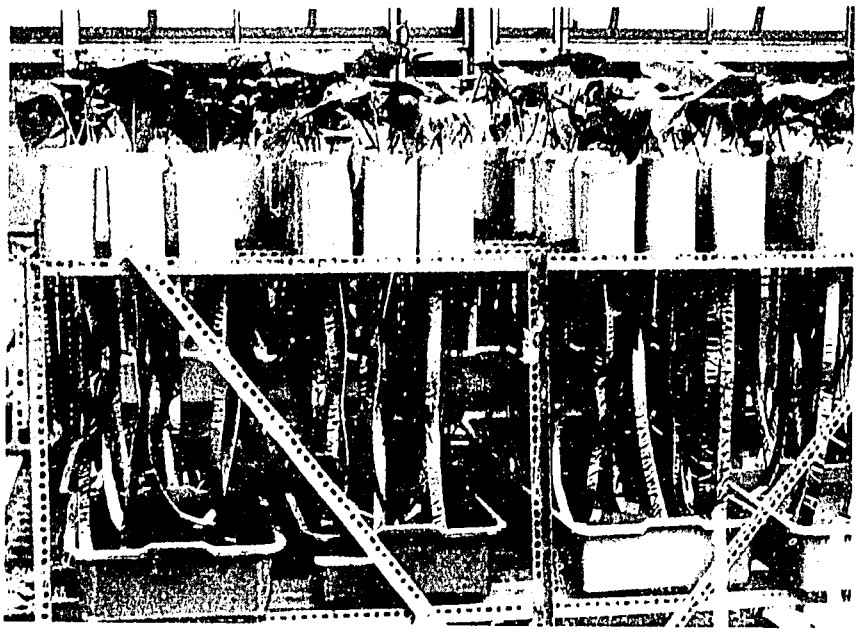
This method represents a better means of obtaining virus-free sweet potato germplasm; storage roots are easier to ship, handle and store than plantlets in test tubes.

Factors Inhibiting Storage Root Formation

Petiole length and leaf age were examined to determine influence on the ability of storage-root formation from leaf cuttings. Newly expanded leaves had better chances of survival, thereby increasing the chance of storage-root formation, but petiole length did not significantly affect storage-root formation, although leaf cuttings with short petiole lengths did form more storage roots.

Leaf-cuttings Response to Drought

Polyvinyl formate (PvF) strips were used as water carriers to maintain soil-water status in screening for drought tolerance. Using three accessions and seven breeding lines, the fourth, fifth and sixth leaves from the vine tip were cut at the petiole base and planted in sand and soil mixture with



PvF strips used in drought stress screening

controlled water by PvF sheets to create four levels of drought stress. AVRDC's high yielding line, CN 1028-15, was consistently the highest storage root yielder under the four levels of drought stress in both tests. The leaf-cutting technique could be an easier method for screening drought tolerance in sweet potato. Although the PvF strip technique needs further improvement, it is potentially useful for drought-stress studies and screening.

Legume Crops Program

29

MUNGBEAN

INTERNATIONAL COOPERATION

Distribution

A total of 108 seed packets was distributed to 90 cooperators in 29 countries: 824 breeding lines and 1,507 accessions.

Crop Releases

Australia - The newly released cultivar "King", which has an AVRDC accession as a parent, has been extended to nearly 7,000 ha in the Northern Territories, Central and SE Queensland.

Fiji - Mungbean breeding lines VC 1007-14-1-5B and VC 1160-1-1-2B have been released as Station 25 and Station 27. Seeds have been distributed to the farmers.

Philippines - AVRDC breeding line VC 1163-2-3-4-2B was released as BPI-MG 1 by the Philippines Outreach Program. It is recommended for dry (1.1 t/ha) and wet (1.4 t/ha) seasons.

International Trials

Fiji - Trials indicated that VC 1560 D appeared promising.

Indonesia - Newly released "Manyar", AVRDC selection VC 1089 A continues to be the highest yielder.

Israel - Preliminary reports indicated that VC 1973 A was promising with high yield potential.

Nepal - In tests by the Agriculture Section of the Tinau Watershed Project, Lalpati, VC 1647 B yielded 0.9 t/ha compared to 0.7 t/ha for the check.

Pakistan - AVRDC accession V 4800 (cv. Type 1 from India) was rated to have better level of mungbean yellow mosaic virus resistance.

Swaziland - VC 2768 A yielded of 3.5 t/ha in trials from the 11th International Mungbean Nursery (IMN).

BREEDING

Germplasm Evaluation

One hundred and forty-three new mungbean accessions were added to AVRDC's collection, bringing the total to 5,263. In addition 144 accessions of other related Vigna sp. were also collected from Pakistan and Laos.

In preliminary evaluation, Pakistan entries 40528 and 40549 had 1000-seed weights of 58 and 61 g, respectively. Entry 40576 had the lowest CLS and PM rating. The screening of AVRDC germplasm in Pakistan identified several accessions with multiple disease resistance useful for their breeding program. An exchange of germplasm between Pakistan and AVRDC is mutually beneficial.

Hybridization

The majority of the 227 crosses made were to combine high yield, resistance to diseases and insects, photoperiod insensitivity and incorporate synchronous maturity. All crosses will be evaluated in 1985.

Yield Trials

In 1984 preliminary yield trials, breeding line VC 3689-1-1-B-1 had negligible CLS symptoms in July planting. Entries VC 3743-2B-1-1-B and VC 3738-2B-2-1-B gave more than 3 t/ha in February planting and had moderate to high levels of resistance to CLS and PM.

In intermediate yield trials, eight entries yielded from 3 to 3.3 t/ha while the check cultivar, V 3476, gave 2.6 t/ha. In advanced yield trials, VC 3117-7-2B-2-B produced 2.9 and 1.9 t/ha in the February and July plantings.

In elite yield trials and IMN trials the outstanding entries were VC 2768 A, VC 2764 A and VC 2768 B. The average yield of February and July plantings was around 2 t/ha.

New selections with a yield potential up to 3 t/ha combining different levels of disease resistance, varying seed sizes and different seed coat lustre have been identified.

Disease Resistance

Three hundred and six breeding lines were evaluated for disease resistance across three seasons under natural disease epidemic. Six breeding lines were highly resistant to both CLS and PM; among them four gave more than 2 t/ha yields in March planting. Three breeding lines which appeared superior to VC 1560 D are: VC 3528-2B-3-B-2, VC 2719-B-18-B-3-B, and VC 3748-3-B-1-2-B.

Performance Under Minimum Management

Optimum and minimum management input elite yield trials reported in 1983 were repeated in 1984. The mean yield

under minimum input was 1.0 t/ha compared to 1.5 t/ha for optimum input. Results in 1984 confirm the 1983 findings that selections with an average yield of 1 t/ha or more under minimum input are available at AVRDC. For example, VC 2771 A yielded 1.3 t/ha while VC 2754 A, VC 3061 A and VC 3031 A each yielded 1.2 t/ha under minimum input. Such cultivars may be valuable considering that mungbean is usually grown with minimum input.

Photoperiodic Response

The yield trial entries are routinely evaluated in order that promising lines with photoperiod insensitivity can be selected.

In 1984, 229 breeding lines were evaluated under both natural and artificially-extended 16 hour photoperiods. Among them 46% were insensitive to photoperiod (sensitivity score 0-4). Five of the photoperiod insensitive lines had an average yield potential of more than 2 t/ha (March and July plantings combined) and combined moderate to high levels of resistance to either CLS, PM or both.

PATHOLOGY

Virus Resistance Screening

Ten accessions representing most of the parents of the elite breeding lines and nine accessions reportedly resistant to the mungbean strain of bean common mosaic virus (M-BCMV) were screened for resistance to the unknown virus isolates M2, M4 and M25. Twenty-two elite breeding lines were screened for resistance to M25 and CMV. All of the 19 accessions tested were susceptible to the three unknown virus isolates. Seven of the 22 elite breeding lines were immune to CMV and two were immune to M25. No line showed resistance to both CMV and M25.

Characterization of Three Poty Virus Isolates

For the characterization of virus isolates M2, M4 and M25, which were obtained in earlier virus surveys, additional hosts were tested. The host range appeared to be restricted to leguminous crops; besides mungbean the isolates also infected French bean, Azuki bean and cowpea. In host range and serological reactions, these isolates closely resembled the unknown soybean virus isolates, even though they were not able to infect soybean. The unknown soybean virus isolates, on the other hand, did not infect mungbean which may reflect host specialization of these two groups of isolates.

Powdery Mildew Resistance

Results of screening seedlings for resistance to mungbean powdery mildew (*Erysiphe polygoni*) in the greenhouse through artificial inoculation were similar to those of previous field screenings.

Powdery mildew

Longevity tests of powdery mildew spores in cold storage showed that storage for several months did not adversely affect longevity and infectivity of the spores. In periods of interrupted screening, spores can thus be stored and used whenever needed to start new infections.

ENTOMOLOGY

Beanfly Resistance Screening

Eight new accessions that proved to be moderately resistant to beanflies (Ophiomyia phaseoli, O. centrosematis, and Melanagromyza sojae) in a second screening in Indonesia were screened with resistant checks for the third time at AVRDC. Three accessions, V 1160, V 5784 and V 5973 showed comparable resistance as our moderately resistant entry V 4281. These three accessions represent additional sources of resistance to beanflies.

Screening for Beanfly Resistance in Segregating Populations

Since beanfly infestation rarely kills susceptible mungbean plants and the insect feeding is concealed within the stems, it is difficult to select segregating materials carrying beanfly resistance and high yield. The populations are bulked until F_6 and selections are then made at this stage for high yield. The F_7 plants thus selected are individually bulked and their harvest is divided in two equal lots: one lot is planted in the field and screened for beanfly resistance and the second lot is saved in storage. Seeds of those entries that showed high levels of resistance to beanflies are

then multiplied and sent to cooperators for screening in various parts of the world.

Using this method in 1984 one F_6 population was screened and several F_7 high yield entries were selected which will be tested for final beanfly resistance in 1985. Three other populations were bulked and advanced through two generations. One of these populations will be selected for high yield in 1985.

Beanfly Resistance Mechanism Study

In 1980 three mungbean accessions were found with moderate levels of resistance to beanflies and since then the most resistant accession, V 4281, has been used in the breeding program. In 1984 the mechanism of beanfly resistance of three accessions was studied. Since unifoliate leaf stage is the most vulnerable for beanfly damage, unifoliate leaves were investigated for possible antibiosis. Larvae of two polyphagous insects, Porthesia taiwana and Heliothis armigera, were reared on the unifoliate leaves of three resistant and two susceptible accessions. At intervals insect mortality and the percent larvae becoming pupae at pupation were recorded. The insects fed on unifoliate leaves of the resistant entries suffered significantly greater mortality and reduced, practically zero, pupation compared to those fed on unifoliate leaves of susceptible entries. This finding indicates that there are certain principles in unifoliate leaves of resistant accessions which are antibiotic to beanflies.

Screening for Bruchid Resistance in Interspecific Cross Segregating Materials

In 1979-80 two blackgram accessions were found to be moderately resistant to bruchid (Callosobruchus chinensis). During 1981-82 the technique for making crosses was perfected, leading to their successful crossing with several advanced breeding lines of mungbean. The resultant F_2s and backcross progeny totalling 113 lines (105 interspecific hybrids and eight parents) were screened for resistance to C. chinensis in 1984. Forty entries (20 free of insects and 20 with some undamaged seeds) showing some degree of bruchid resistance will be backcrossed to advanced mungbean lines to obtain bruchid resistance.

SOYBEAN

INTERNATIONAL COOPERATION

Seed Distribution

The soybean program distributed 5,892 seed packets to 121 cooperators in 39 countries: 58 Asian soybean evaluation trials (ASET), 796 breeding lines, 914 accessions and 28 others.

Unofficial Crop Releases

St. Lucia - PLENTY in the West Indies identified AGS 8 as promising and is extending it to farmers.

Taiwan - After three years of testing by the Tainan District Agricultural Improvement Station, the local farmers had slowly increased AVRDC cultivar AGS 66 under cultivation to about 100 ha.

Thailand - A narrow leaflet AVRDC selection, 16-4, gained popularity in the Sukothai and Chiang Mai area. Since its leaves resemble the leaves of Kang Kong, Thai farmers named it "Pakboon" soybean (Pakboon is Kang Kong in Thai).

International Trials

ASET - In AVRDC Soybean Evaluation Trials, AGS 129, a narrow leaflet selection, performed well across a number of countries. It is resistant to bacterial pustule, moderately tolerant to soybean rust, resistant to downy mildew, immune to soybean mosaic virus and black eye cowpea mosaic virus.

Colombia - A number of AVRDC soybeans were selected as high yielding and multiple disease resistant by ICA, Palmira. AGS 79 produced 3.8 t/ha in 90 days.

Indonesia - A mutant of G 2120 gave 2.6 t/ha in 99 days while the local check gave 1.6 t/ha in 98 days.

Philippines - AVRDC soybeans were screened at IRRI by an IITA scientist for drought resistance. AGS 155, 163 and 170 appear to be drought tolerant with 1.2 t/ha without irrigation.

Saudi Arabia - In trials by the ROC Agricultural Technical Mission for photoperiod insensitive selections, AVRDC cultivars AGS 29, AGS 129, AGS 130 and AGS 66 matured on average 20 days quicker than control check Davis.

BREEDING

Germplasm Evaluation

Through the assistance of USDA and the IBPGR, 1,807 new accessions were added to bring the total collection to 12,330. Useful mutants and new entries from Vietnam and Laos are considered especially valuable additions.

With IBPGR assistance 2,648 non-USDA accessions were characterized using IBPGR descriptors. Among them 26 had characteristics required for vegetable soybeans: large seed size, gray pubescence, large pods and more two-seeded pods.

Hybridization

Thirty-three promising breeding lines were crossed with 30 new accessions to combine multiple disease and insect resistance with high yield. A total of 184 crosses was made to develop improved vegetable and grain soybeans.

Yield Trials

In preliminary (PYT) and intermediate yield trials (IYT) conducted using a split plot design to detect yield differences between treatments with and without fungicide and their interaction, only genotypic differences proved significant. The results suggested that more frequent fungicide treatment is required to contain the disease in order to detect tolerance to soybean rust.

In the February planting, ten breeding lines in PYT yielded 4 t/ha or more with GC 60002-2-10-8 giving 4.6 t/ha in 110 days and the check cultivar Shih Shih 3.0 t/ha in 107 days. In IYT four entries produced more than 3 t/ha in February planting.

Several entries, from both PYT AND IYT, gave more than 3 t/ha yield in about 80 days and many have resistance to bacterial pustule.

Advanced Yield Trials (AYT)

Eight entries (AGS 239, 243, 245, 248, 253, 261, 270 and 272) significantly outyielded the check cultivar in February planting with about 3 t/ha yield. In July planting AGS 283, 288 and 290 were higher yielding (2.4 to 2.7 t/ha) than the check (2.2 t/ha). Several high-yielding resistant lines have been selected for the next ASET trial. Although preliminary results indicate a good correlation between yields in no-tillage and tillage treatments, additional testing in 1985 is necessary to confirm results.

Vegetable Soybean

PYT was conducted with 56 accessions. Four cultivars (G 4035, G 2246, G 10139 and G 6852) outyielded the check G 9053 for pod weight t/ha. G 4035 gave a whole plant yield of 31.3 t/ha compared to 22.2 t/ha for check G 9053. Six new accessions were selected for AYT and possible inclusion in the new ASET trial.

Photoperiod Insensitivity

Yield potential of 101 photoperiod insensitive accessions were evaluated in the hot-wet and cool-dry seasons. The mean days to maturity were 81 days in the hot-wet and 98 in the cool-dry season. Results indicate that either the temperature or photoperiod x temperature appear to influence the days to maturity of photoperiod-insensitive entries in different seasons. G 386 was the highest yielder in the cool-dry planting with 3.9 t/ha in 106 days compared to AGS 129's 3.6 t/ha in 111 days. G 782 and G 180 appear to be high yielding with early maturity.

Mutation Breeding

The selected lines from the AGS 2 mutant were entered in IYT. The mean yields of mutant lines were 2.8 ±0.26 and 2.4 ±0.16 t/ha in February and July plantings and did not differ significantly from the AGS 2 check. However, mutants matured 18 to 24 days earlier than the parent. Late maturing genotypes yielded well ($r = 0.814^{**}$), and as the seed size decreased yield increased ($r = 0.78^{**}$). Thirteen mutants were selected for inclusion in advanced yield trials in 1985.

Rust Resistance

In spite of severe rust infection, several mutant lines from AGS 2 had very high yield (up to 2.8 t/ha), and the yield reduction relative to fungicide sprayed plots and unsprayed plots was minimum. These entries will be reevaluated in 1985.

Continuous Cropping

A three-season experiment was initiated in 1982 and continued in 1983 and 1984 to determine the effects of continuous cropping. For the seventh, eighth and ninth consecutive seasons soybean crops were harvested from the same piece of land in 1984. A total of 6.6 t/ha yield was obtained over three seasons in about 290 days for both AGS 129 and AGS 154. The slightly lower yield in 1984 was attributed to a significantly higher rainfall in 1984 (971 mm) compared to 1983 (814 mm).

Shade Tolerance

Six AGS entries were evaluated with and without shading. The netting for shading reduced the light intensity by 52 to 53%. The difference between genotypes for shade tolerance was significant. Shading reduced yield from 31 to 60% in the February planting and 24 to 51% in the July planting. AGS 129 and AGS 80 appear to be shade- tolerant in both seasons. Since results obtained in 1984 conflicted with those obtained in 1983, further verification is necessary in 1985.

Sole Cropping vs Intercropping

Fourteen AGS entries were further evaluated under both sole cropping and intercropping. In intercropping one row of soybean was alternated with one row of corn. AGS 89, AGS 34, AGS 67 and AGS 158 gave the highest yield of about 1 t/ha under intercropping in February planting. AGS 67, AGS 89, AGS 91, AGS 93 and AGS 94 gave 2.2 to 2.4 t/ha in July planting under intercropping. Results indicate that genotypes with high yield potential under intercropping for specific seasons can be selected.

Management Input Response

Eleven AGS entries and Shih-shih were evaluated in a minimum and maximum management input trial at Phitsanuloke and Nakon Sawan, Thailand. At Phitsanuloke the yield gap between maximum and minimum input was 14% while in Nakon Sawan there was practically no difference between the two treatments. Based on experiments at AVRDC and in Thailand, it may be concluded that the yield gap between maximum input and minimum input vary with location.

PATHOLOGY

Advanced Rust Tolerance Trials

Three advanced trials with seven to eight advanced lines each were conducted, one each at AVRDC, Hualien District Agricultural Improvement Station (ROC), and Chiang Mai Field Crops Research Station (Thailand). Three checks were used: AGS 129, high yielding with low rust tolerance; G 38

Soybean rust

(Shih-shih), moderate yielding with moderate tolerance; and AGS 181 (SRE-Z-11A), moderate yielding with high tolerance. A local check cultivar was included at Hualien and Chiang Mai.

At AVRDC five of the seven tested lines possess tolerance levels similar to AGS 181. They were significantly higher yielding than AGS 181 in both the fungicide and non-fungicide protected treatments.

Five of the eight lines tested at Hualien yielded equal to or higher than the highest yielding check cultivar in both fungicide and non-fungicide treatments. Yield losses of these five lines were less than G 38 and in two lines losses were similar to AGS 181.

The yield of one of the six lines tested in Thailand during both the fungicide and non-fungicide treatments was similar to the highest check in each of these treatments.

At all three locations, the yields of GC 60082-8-14-6-7-68 were similar to or significantly higher than AGS 181 in both the fungicide and non-fungicide treatments. Also the yield losses were similar to or less than AGS 181 at all locations. At two locations, this line was one of the highest yielding cultivars in both treatments.

Intermediate Rust Tolerance Trials

Three trials were conducted, altogether testing 107 lines. The lines were compared with five check cultivars representing the range from high yield with low rust tolerance (AGS 129 and KS 8) to moderate yield with high rust tolerance (AGS 181).

Fourteen lines showed higher levels of tolerance and significantly higher yields in the non-fungicide treatment than the highly tolerant check (AGS 181). Without fungicide protection, these lines outyielded AGS 129 and KS 8, the high yielding checks, by 33-67%. Their yields with fungicide protection were similar to or higher than AGS 181.

Six lines have fungicide-protected yields that are similar to the high yielding checks (AGS 129 and KS 8). They outyielded the checks in the non-fungicide protected treatment by 23-32%.

Biocontrol of Soybean Rust

Previous greenhouse and laboratory studies identified two fungi, Gliomastix sp. and Trichothecium, as potential biological control agents for Phakopsora pachyrhizi. These studies showed that both fungi reduced the reproductive capacity of the rust fungus, thereby theoretically resulting in reductions in the rust severity and yield loss during rust epidemics.

This study evaluated the effectiveness of these two biocontrol organisms for reducing the rate of rust development in the field. The failure of these organisms to cause a reduction in the rate of rust development appear to be the rapid rate of rust development and high inoculum pressure during this experiment. Although these fungi can shorten the reproductive duration of a rust lesion by 60-80%, the rust lesion is active for approximately two weeks after initial infection by the biocontrol agents. Consequently, these biological agents were not effective where conditions permit rapid rust development with completion of the epidemic in 3-4 weeks or in locations with a high inoculum pressure.

Fungicide Spray Schedules and Yield Loss

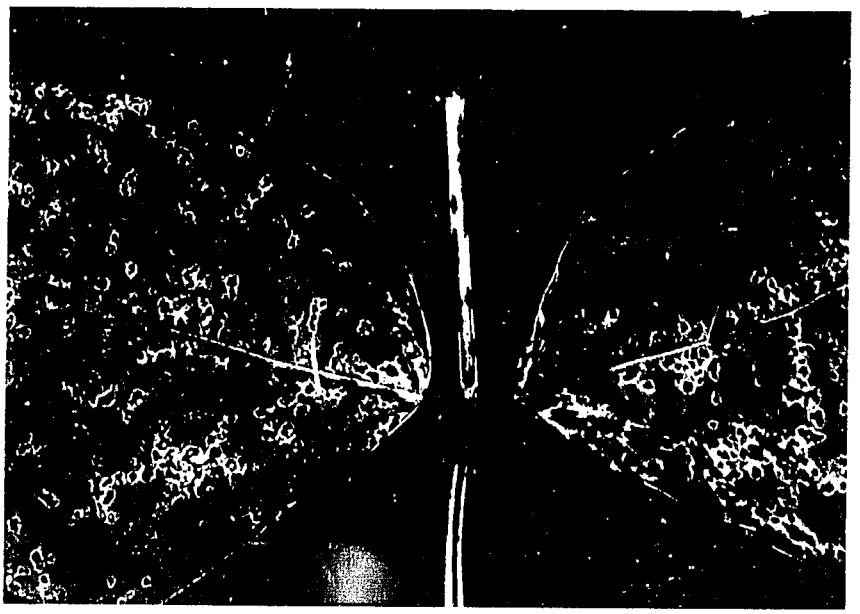
While fungicide protection is still necessary to prevent yield loss from rust, the incorporation of increasing levels of tolerance into soybean cultivars should reduce the frequency of fungicide application.

Two cultivars, AGS 181 (high tolerance to rust) and Shih-shih (moderate tolerance), received fungicide (Dithane M-45) protection starting from the 3rd, 5th, 7th and 9th weeks after planting. Soybeans protected by the spray schedule initiated at the 5th week after planting had the highest yield. Although in this treatment Shih-shih outyielded AGS 181 by 252 kg/ha, AGS 181 out-yielded Shih-shih by 248 kg/ha when the protective sprays were initiated two weeks later. For each two weeks delay in the initiation of the spray schedule after the 5th week, AGS 181 lost an estimated 299 kg/ha while Shih-shih lost an estimated 485 kg/ha. The yield of the more tolerant cultivar was less affected by the different spray schedules. Therefore, the timing of the first protective spray on more tolerant cultivars is less critical than for the less tolerant cultivars. The higher the level of tolerance to rust in a cultivar, the greater is the farmer's flexibility in fungicide application.

Bacterial Pustule Resistance Screening

This trial screened and evaluated 125 AGS lines and germplasm accessions previously reported as having resistance to bacterial pustule, as well as all AGS lines from 181 to 290 which had not previously been evaluated for resistance.

Eighteen of the 63 accessions were rated as highly resistant (disease severity distinctly less than for the cultivar



Bacterial pustule

CNS used in North American breeding to confer near immunity to pustule). Thirteen of the AGS lines previously reported as resistant were rated as highly resistant. These lines resulted from two crosses and contained a common parent, SRF 400. Although not yet tested, SRF 400 appears to be a source of bacterial pustule resistance.

Seed Weight, Seed-borne Diseases and Germination

The failure to produce soybean seeds with high germinability during the rainy season has been one of the factors limiting soybean production in S.E. Asia. Two factors known to be associated with germinability and storability of soybean seeds are seed size and presence of seed-borne pathogens. This investigation was conducted to evaluate the variation in and interrelationship of 100-seed weight, frequency of diseased seed and germination among 178 AGS lines harvested during the rainy season.

Among the lines tested the frequency of visually assessed disease-free seed ranged from 19-98 , the germination ranged from 5-81 , and the 100-seed weight from 5.8-27.4 g. The correlation between 100-seed weight and percent germination was highly significant (r -0.5628) as was the correlation between percent disease-free seed and percent germination (r 0.5328). However, these correlations only account for 32 and 28 of the variation. The correlation between 100-seed weight and percent disease-free seed was significant (r -0.1905), however this correlation only accounts for 4 of the variation observed. The low correlation between 100-seed weight and percent disease-free seed indicates that selection of cultivars with higher levels of resistance to seed-borne diseases would improve germinability of the seed of these cultivars regardless of seed size.

Benomyl Spray Schedules and Seed Quality

The use of benomyl as a pre-harvest fungicide spray has been frequently reported as a means of reducing the presence of seed-borne pathogens in the harvested seed and therefore improve seed quality. In this study benomyl spray schedules were evaluated in two seasons, spring and summer. In the spring soybeans were planted in the dry and harvested in the rainy season and vice versa in the summer planting. The benomyl spray schedules were started at the R1, R3 and R5 growth stages. Once the spray schedule was initiated, the fungicide was applied at two-week intervals.

In both seasons, the fungicide sprays increased the yield, days to maturity, 100-seed weight, percent disease-free seed and seed germination. However, all of these parameters were lower in the spring season. Even the most frequently sprayed treatment (initiated at R1) was poorer than the non-fungicide sprayed treatment in the summer planting. Seed quality was improved both by growing the soybeans in the better season and by treating the plants with benomyl.

Seed Treatment and Germination

Frequently in the tropics only fungal-infected, poor quality seed is available for planting. Proper fungicide seed treatment should improve the germination potential of these seeds. In this experiment three cultivars received six fungicide seed treatments and were then planted in three different environments; greenhouse (24-35°C), growth room (16-20°C), and outdoors (23-33°C) during the summer rainy season. Three fungicide treatments, Arasan, Captan and PCNP+Captan, were most effective as seed treatments under all three environmental conditions.

Infection of Rice Seedlings by VAM Fungi

Infection of rice seedlings by VAM fungi benefical to soybean prior to transplanting could be a feasible method for altering the field population of VAM fungi to benefit the subsequent soybean crops. This study determined the infectivity of soybean-compatible VAM fungi on rice, determined the effect of phosphate on infectivity, and evaluated the inoculation technique that allows greatest infectivity.

Only Glomus mosseae was mycorrhizal on rice seedlings as evidenced by the presence of internal hyphae and arbuscula. Percent root infection by VAM fungi increased with increasing levels of phosphate fertilization. The inoculation method had little effect on the infection percent.

Characterization of Three Poty Virus Isolates

In previous surveys, three poty virus isolates were recovered which were not identified. In ELISA they reacted positively with BCMV, AzMV and BICMV antisera. Further tests were conducted in 1984 with additional hosts commonly used for identification of BCMV and BICMV.

Based on the results of the host range and serological tests it is assumed that the unknown soybean virus isolates

are neither SMV or BCMV. Host range and serological tests strongly indicate that they are closely related to AzMV and BICMV.

Screening for Resistance to Unidentified Virus

Because of the wide host range and the seed-transmitted nature of this virus, it is considered a potentially serious pathogen whose resistance merits inclusion in AVRDC's improvement program. Initially 52 AGS lines were screened for resistance to the three unidentified virus isolates. Twelve lines were found with resistance to the three isolates. Interestingly, all but one of these lines were also resistant to SMV-1. Line AGS 218, however, was found to be susceptible to SMV-1.

Survey for SMV and the Unknown Isolate

To further isolate additional strains of SMV and to determine the importance of the unknown virus, 458 samples showing typical virus symptoms were collected from all soybean-growing areas of Taiwan. Twenty-seven samples were found to be infected with SMV, 14 contained the unknown virus and four were doubly infected with both. The results of the 1983 and 1984 surveys indicate that the unknown virus occurs in all major soybean-growing areas and occurs almost as frequently as SMV.

SMV Strain Detection

An attempt was made to strain-type SMV isolates recovered from previous surveys by Cho and Goodman's classification scheme. Three isolates were preliminarily identified as SMV G-1, G-5 and G-4.

ENTOMOLOGY

Beanfly (*Ophiomyia phaseoli*) Resistance Screening

Three hundred and eight accessions of the initial 1,000 screened, were evaluated for beanfly (Ophiomyia phaseoli) resistance in Indonesia. Plant mortality ranged from 7.7 to 100% with a mean of 69%. Twelve accessions with mortality between 7.7 and 31% were selected for further evaluation in 1985 to confirm the resistance.

Beanfly (*Melanagromyza sojae*) Resistance Screening

A total of 344 newly received accessions was screened for resistance to a beanfly species, Melanagromyza sojae, at AVRDC. All accessions were damaged by the beanfly. The number of larvae and pupae varied from 0 to 26/10 plants and damaged plants from 20 to 100%. Twelve accessions, all belonging to various wild soybean species, were the least damaged. The level of resistance of these accessions is

comparable or lower than four wild soybean (Glycine soja) accessions that were found to be resistant to M. sojae.

In yet another test 13 soybean accessions which were least damaged by O. phaseoli in early 1983 in Indonesia were screened for M. sojae resistance at AVRDC. All 13 accessions, belonging to wild soybean species G. javanica or G. soja, had the lowest number of M. sojae larvae and pupae, 0 to 2.3/20 plant; and plant damage, 21 to 86%, compared to 42.7 larvae + pupae/20 plants and 100% plant damage in susceptible G. max check.

Because of the close link between small stem diameter of wild soybean and M. sojae resistance, research emphasis has been shifted to developing vigorous growing cultivars in which, despite beanfly infestation, grain yield loss is minimal.

Photoperiod Effect on Beanfly Infestation and Yield Loss

Although beanflies infest the crop throughout the year, only their infestation in autumn results in significant yield loss. In a study to understand this phenomenon, soybean was grown in the autumn season under natural and extended photoperiod of 13.5 hours (by installing lights), and were exposed to beanfly infestation under untreated and insecticide (omethoate) treated regimes.

There was no significant difference in the number of plants damaged under either photoperiods, and insecticide treatment reduced fly infestation under both photoperiods. However, the leaf area, dry matter accumulation and yield was reduced significantly by beanfly infestation under the natural photoperiod, whereas these parameter were unaffected by beanfly infestation under extended photoperiod. The plants under extended photoperiod matured late and this seemed to have compensated for the beanfly damage to the plants. This implies that relatively late maturing cultivars could be tolerant to beanfly damage.

Scarabid beetle damage

Defoliators Resistance Mechanism

Three soybean accessions, PI 171451, PI 227687 and PI 229358 demonstrated resistance to Spodoptera exiqua, Porthesia taiwana and Anomala cupripes at AVRDC and have been reported to be resistant to various defoliator insects elsewhere. In 1984 the mechanism of resistance of these accessions to P. taiwana and A. cupripes was investigated. The larvae of P. taiwana and adults of A. cupripes were fed on the foliage of the three resistant and one susceptible (cv. TK5) accessions and insect development and longevity were recorded, as well as the amount of leaf consumption. It was found that these accessions, in particular PI 171451, had strong antibiosis to P. taiwana. Most larvae failed to pupate and died in last instar prior to pupation. A. cupripes adults consumed significantly less foliage of PI 229358 and survived for only 9.4 days as against 37 days on TK5 foliage. Higher temperature increased the antibiosis effect.

Scarabid Beetle Antibiosis

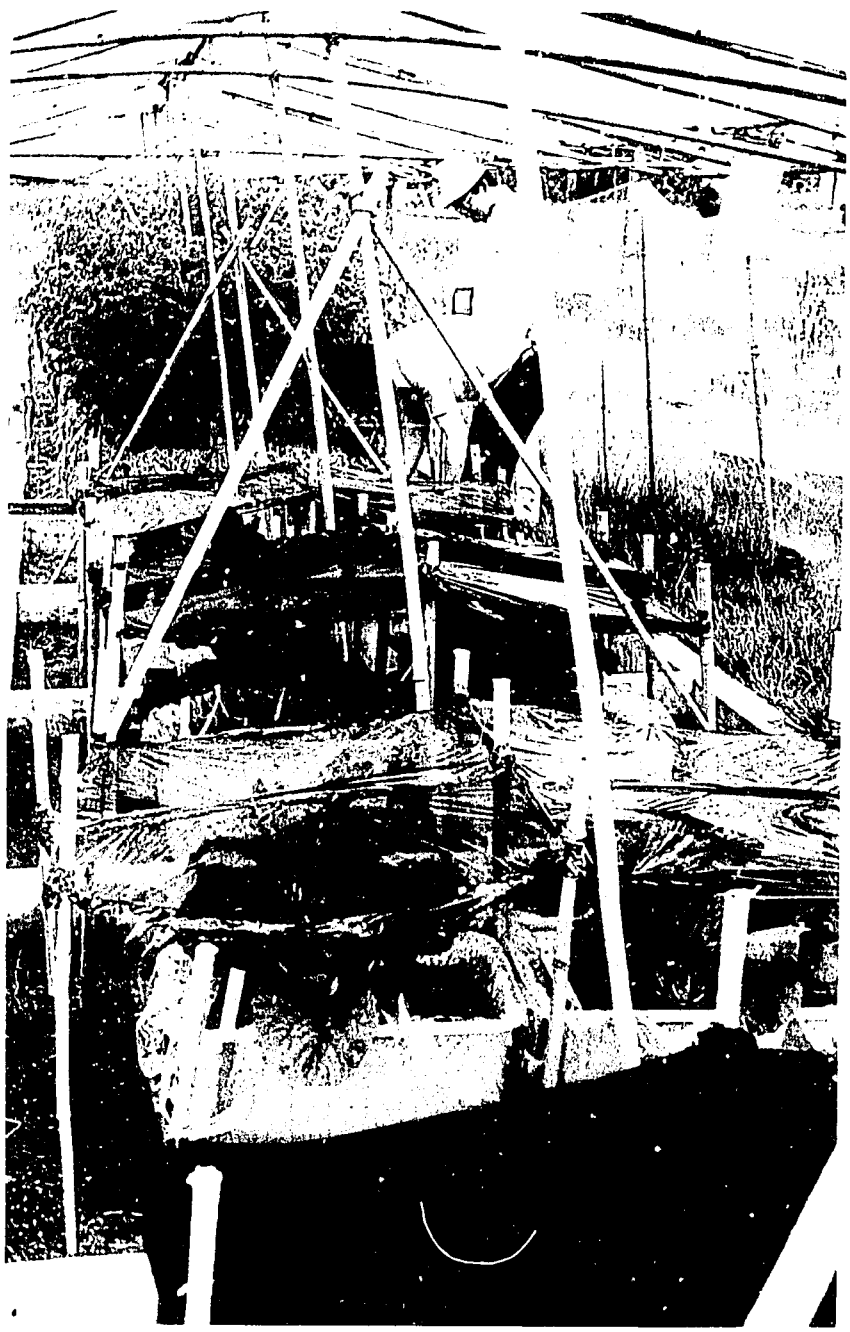
Two species of scarabid beetles, Anomala cupripes and A. expansa, infest soybean and other legumes at AVRDC during the spring season. A preliminary trial in 1983 indicated that A. cupripes consumed much less foliage of PI 229358 and that higher temperatures during foliage feeding reduced consumption much more drastically in PI entries than in check cultivar TKS.

In 1984 the three PI accessions from the previous experiment were sown at monthly intervals and feed to adult scarabid beetles. Accession PI 229358 conferred a strong antibiosis effect to scarabid beetle A. cupripes. The insects reared on foliage of this accession had significantly reduced longevity and consumed much less foliage than the insects reared on PI accessions or on check TK 5.

Screening for Limabean Podborer Resistance

An earlier study of the mechanism of resistance among the Limabean podborer (Etiella zinckenella) resistant accessions showed that the resistant accessions mature late and thereby escape podborer damage. These accessions were, therefore, of limited utility in breeding for podborer-resistant cultivars with wide adaptability. Fresh screening was initiated using 1,000 accessions planted twice: once in September and once in October. The ambient podborer population was enhanced by frequent release of laboratory-reared insects in the field and the damaged pods were counted and compared with accessions at both plantings and a susceptible check. Accessions G 98, G 111, G 584 and G 909 showed a moderate level of resistance at both plantings. These accessions will be further evaluated before utilization in the breeding program.

Nutrition, Environment and Management Program



Interviewing farmers

AGRICULTURAL ECONOMICS

Processing Tomato Production in Taiwan

Processing tomato production is concentrated in three south-central counties in Taiwan. A study was conducted by interviewing randomly choosen farmers to understand the problems and the economic significance of this crop's production.

Processing tomato was considered an important crop because it was profitable, had a higher expected income than competing crops, made better use of family labor, reduced risks by diversifying farming and provided a guaranteed market outlet and income.

Constraints to processing tomato production included: institutional malpractice in the contract farming systems; need for more heat tolerant varieties in order to extend cultivation period; less perishable cultivars capable of longer periods of field storage; and larger fruit size to reduce labor in the harvesting stage.

Farmers' Responses to Two Processing Tomato

In 1983 the Tainan District Agriculture Improvement Station introduced AVRDC's improved processing tomato Tainan Selection No. 2 (TS 2) to two townships: Tungshih and Shuilin. This case study was conducted in the two townships to evaluate farmers' responses to TS 2 and the popular TK 70 cultivar.

TS 2 was better accepted in Shuilin become it was less perishable, had satisfactory yield and had better market outlets.

Factories' Responses to Tainan Selection No. 2

Telephone interviews were conducted in October 1984 with 21 factories in Taiwan which processed tomatoes to determine the processing quality of Tainan Selection No. 2 (TS 2), its volume and the need for a better control of seasonal supply.

Forty-eight percent of the factories interviewed processed TS 2. It was used for peeled whole tomato, sliced tomato and assorted vegetables because of its firm flesh, ease of peeling, good shape, small stem and fewer seeds. An improvement in fruit color and resistance to diseases of the fruit top could enhance its processing quality.

The volume of TS 2 largely depends on such economic factors of Taiwan's share in the international market, the proportion dedicated to processing tomato in a canning factory and a reasonable solution to the competition between factories and fresh markets for the cultivar.

The improvement in heat tolerance would facilitate provision of processing tomatoes to factories throughout the entire year, thereby improving production scheduling.

Farmers' Representatives Role in Processing Tomato Production

Farmers' representatives were found to be active participants in the rural community in Taiwan because of their role in the processing tomato contractual production system. Their major work was to cultivate processing tomato seedlings provided by the canning factories and to assist the farmers in post-harvest handling. These representatives received a substantial income for their services.

Agroeconomic Factors of Summer Chinese Cabbage Production

In order to understand the agroeconomic factors involved in the summer production of AVRDC and Chang-pu Chinese cabbage, 52 farmers from the lowland production area in Taiwan were interviewed.

From the farmers' standpoint, the ideal characteristics for summer Chinese cabbage are good appearance, high yield, resistance to disease and heat tolerance. In the survey soft rot and rotting were the most severe diseases in the production of summer Chinese cabbage. Chang-pu was better accepted by farmers than the AVRDC Chinese cabbage because of higher market demand.

Market Price for Chinese Cabbage

Daily prices for summer AVRDC and Chang-pu Chinese cabbage were recorded at the Taipei Agricultural Products Marketing Company from August to November to understand seasonal price changes. Results indicated that AVRDC Chinese cabbage received a high market price only at the beginning of the summer season. When Chang-pu became available, the price for AVRDC Chinese cabbage was substantially lower.

In another study to determine the preference for Chang-pu over AVRDC Chinese cabbage in the wholesale and retail markets, AVRDC's Chinese cabbage had loose and sometimes detached leaves compared to Chang-pu which stayed fresh and firm for a longer period of time.

Consumer Preference for Chinese Cabbage

Two hundred and eighty shoppers in a supermarket were interviewed to learn the reasons behind their choice of lowland or highland summer Chinese cabbage. Although more expensive, lowland Chinese cabbage was more popular for its good taste when sauteed but when consumers planned to boil, highland Chinese cabbage was preferred in most cases.

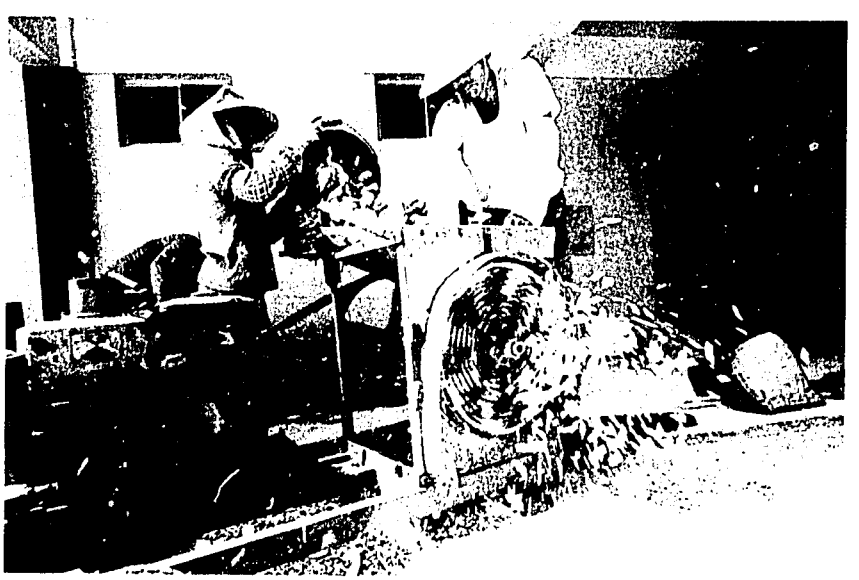
CHEMISTRY

Sprouting Properties of Small-Seeded Soybean

Sprouting properties of small-seeded soybean (AGS 2) were tested under laboratory conditions. It was found that small-seeded soybean had potential for higher sprout yield and softer cotyledon texture. The addition of calcium chlorate improved its texture and vitamin content without affecting yield. The sprouts produced were too long, however, and needed further improvement.

Sweet Potato Starch Digestibility

A feeding experiment using laboratory rats was conducted to confirm the previous finding on the superior digestibility of CN 1232-9 and C63-74 sweet potato lines.



Preparation of sweet potato for animal feed study

Digestibility and biological value (BV) observed with isolated sweet potato starch as carbohydrate source and casein as protein source supported previous findings that starch of CN 1232-9 and C63-74 were easily digestible. Protein efficiency ratio (PER) and feeding efficiency (FE) experiments using sweet potato flour and casein indicated, however, that the control, corn starch, was superior to CN 1232-9 and C73-74 although these two line were significantly better than the two check lines.

Analysis of Soybean, Mungbean and Sweet Potato Composition

A near infrared reflectance spectroscopy (NIRS) was used for compositional analysis of soybean, mungbean and sweet potato. Satisfactory results were obtained on moisture, protein fiber, sugar and starch content of sweet potato flour; moisture, protein and fat content of soybean; and moisture, protein and starch content of mungbean. The correlation coefficients (R^2) of calibration curves varied from 0.92 to 0.99. Constituents which have relatively lower R^2 are mungbean starch (R^2=0.92), sweet potato sugar (R^2=0.93) and sweet potato fiber (R^2=0.93). The lower correlation coefficient was partially due to the high coefficient of variance (CV) of the conventional method used for calibration.

Results suggested that checking with the conventional method was still necessary to ensure the accuracy of NIRS.

Preliminary Studies on Topie Processing Condition

Topie is a traditional oriental food, rich in protein and fat and without strong flavor. It can be stored for long periods of time without refrigeration due to its low moisture content.

In this experiment, conditions for topie processing with village-level technology were studied. Results indicated that carefully selected fresh seed ground with a bean-to-water ratio of 1:8, gently heated under 90°C with soybean milk depth of 2.0-2.5 cm should provide the basic condition necessary for making topie.

Scholars undertaking a sweet potato taste test

Sweet Potato Flatulence

Sweet potato-induced flatulence is a major cause of consumer resistance. The flatus-inducing property of sweet potato was further investigated in 1984. Starches isolated from rice, wheat, casein, sweet potato and potato were tested once again with laboratory rats for their flatus-inducing property. Sweet potato and potato starch were found to be strong flatulence inducers. Results of carbohydrate composition analysis were unable to correlate the flatulence property of sweet potato lines.

CROP MANAGEMENT

Chinese Cabbage Leaf-tying and Chemical Spraying

Leaf-tying in summer greatly increased heading rate of all moderate heat tolerant cultivars tested. Daminozide application of 2000 and 4000 ppm also greatly increased heading rate of Ping-Luh. Marketable yield and head weight were higher in 2000 ppm daminozide application than in the 4000 ppm. The optimum time of leaf-tying laid between 35 and 40 DAT, however, it should be decided according to plant growth.

Chinese Cabbage Herbicide Evaluation

Additional grass herbicides were tested. Pendimethalin (stomp) at the rate of 1.00 kg ai/ha satisfactorily controled grass and broadleaf weeds in the spring and autumn. In summer, however, it should be used together with grass killing herbicides such as furore, illoxan, onecide and nabu.

Tomato Plant Spacing

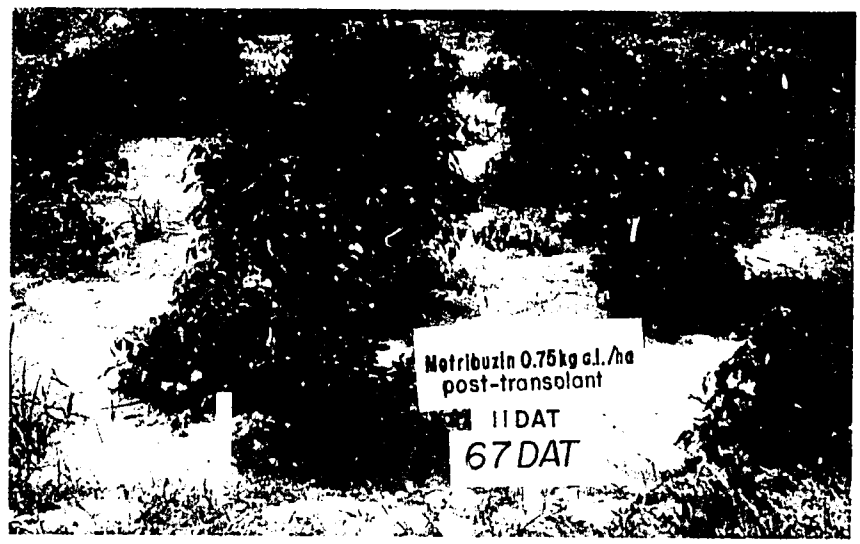
After the release of AVRDC's improved cultivar Tainan No. 2, farmers adapted narrower spacing than AVRDC recommended. This project was conducted to determine the best planting space. The population density for the Tainan No. 2 processing tomato should be more than 16,600 plants/ha and 1.2 x 0.4 m is recommended for spacing.

Tomato Herbicide Screening

Although metribuzin had been confirmed as the most effective herbicide, additional grass herbicides were tested for effectiveness in the latter growth stages of tomato. In the spring metribuzin should be combined with any of the grass herbicides: furore, illoxan, onecide and nabu. In summer, the heavy rains washed away the herbicides necessitating a herbicide stability study for this hot-wet season.

Soybean Plant Spacing

Recent studies on row width and plant density have generally shown that soybean has a remarkable ability to



Metribuzin (above) controlled broadleaf weeds, Nabu (below) did not

compensate for wide differences in seeding rates, and that yield increases can be achieved by narrowing row width. This study attempted to clarify the effects of row spacing and plant population density on AVRDC soybean selection AGS 19.

Row spacing and low plant density had no significant effect on grain yield. However, a plant density of 400,000 plants/ha was recommended to avoid a decrease in plant number in case of unfavorable climate during the growing season. Plant spacing of 25 cm between rows was most appropriate for AGS 19.

Soybean Herbicide Trial

Post-emergence herbicides furore, illoxan, onecide and nabu were compared with pre-emergence herbicides metolachlor and oxyfluorfen. Either post-emergence application of

furore (0.5 - 1.5 kg a.i./ha), nabu (0.2 - 0.4 kg a.i./ha), illoxan (1.08 kg a.i./ha) and onecide (0.45 kg a.i./ha); or pre-emergence application of metolachlor (2.0 kg ai/ha) controlled grass weeds in the summer season and increased soybean yield by 149% when the infestation of broadleaf weeds was relatively low.

Mungbean Herbicide Evaluation

Post-emergence herbicides furore, illoxan, onecide and nabu were compared with pre-emergence herbicides metolachlor and oxyfluorfen.

Post-emergence application of furore, or a high rate of illoxan, onecide or nabu, as well as pre-emergence application of metolachlor were effective in controlling heavy grass infestations in mungbean during the summer season.

GARDEN PROGRAM

School Gardens

The school garden concept is based on the idea that small gardens grown by students can add vitamins, minerals, and proteins to the students' school lunches, as well as teach gardening skills that the students can use at home. The specific objectives of the AVRDC school garden program are to assess the feasibility of developing these types of gardens in Southeast Asia and to determine their ability to provide 100 school children with 113 g (½ cup) of cooked vegetables, five days per week, throughout a 260-day school year.

In 1984 trials, the school gardens grown at AVRDC produced a daily average yield of 16.09 kg of vegetables, enough to supply 142 children with 113 g of cooked vegetables throughout a 260-day school year. This figure also represents substantial quantities of an adolescent's recommended daily nutrient (RDA) allowance for protein (8.5%), iron (88%), Vitamin A (58%), Vitamin C (100%) and calcium (30%).

Home Gardens

The AVRDC home garden program is designed to provide the urban and rural poor with a method of supplementing their diets with nutritious vegetable crops. Such gardens have been developed for the cultural requirements and growing conditions found in Indonesia, the Philippines and Thailand, and have been tested at AVRDC since 1981.

In 1984 the year-round average yield of all three national gardens ranged from 0.94 to 1.03 kg/day. Garden output contributed significantly to the daily nutrient requirements of a family of five in all seasons. Nutrient production targets for all gardens in all seasons were met. A family of five's RDA ranged from 11-18% for protein, 55- 82% for iron, 100% for Vitamins A and C, and 32-41% for calcium.

The AVRDC home gardening technologies and methodology for assessing their on-farm impact, were transferred this

year to Thailand, where gardens were established in small-family farming systems in a three-village pilot project 100 km from Bangkok. The project is being carried out in collaboration with Kasetsart University.

An urban home garden was also established this year, growing green leafy vegetables in eight wooden boxes totaling 3 m^2. Daily edible output was 0.24 kg 326 days of the year, providing small amounts of essential micronutrients to urban families.

Market Gardens

The objective of the market garden is to increase the income of small-farm families in developing countries by developing small-income generating gardens. These gardens are designed to grow vegetable crops that are in demand at local markets and that can be sold by family members who have no other opportunity for employment.

The market garden demonstrated that it could increase the annual met income of a small-farm family by more than 30%. This percentage could be increased by selling produce directly to the consumer instead of to wholesalers. This type of garden is viable in developing countries where availability of vegetables at local markets is low, an unemployed rural labor pool exists, and certain mulnutrition problems persist.

New Gardens

A **mandate crop garden** was added in 1984 to take advantage of planting materials such as indeterminate tomato varieties, small-headed open-pollinated Chinese cabbage, vegetable soybean, sweet potato for nutritious leaf production and mungbean for sprouts which are unsuited for commercial farming but are desirable for garden production in the hot-wet season.

A **dryland garden** was also initiated in 1984 in which AVRDC's 52 garden crops were subjected to water-stress conditions to find vegetables tolerant to semi-arid conditions. Although few crops produced reasonable yields, the unique design of a new composting garden allows for a minimum use of water (see Soil Microbiology report) and may provide the opportunity to develop this concept in 1985.

SOIL MICROBIOLOGY

Organic Composting for Garden Vegetable Production

Realizing the importance of maintaining organic matter in the soil in the tropics, AVRDC designed a modified sheet composting method in which beds were constructed once and then maintained with the addition of household organic wastes, in order to eliminate the intensive labor requirements which caused abandment of earlier efforts.

Although results were tentative, this composting bed concept appeared viable. It reduced labor and water requirements and could be planted to high density crops throughout the year. Potential problems which must be addressed in transferring this technology are: the availability of enough organic material to build growing beds; provision of enough water initially for proper breakdown of organic material; and analysis of raw materials within a country to determine meaningful carbon to nitrogen ratios.

Inexpensive Production Method for Small Quantities of Legume Inoculant

Since legume inoculant imports are costly in developed countries, an inexpensive production method for small quantities was developed. The experiment proved unsuccessful until a standard air pump was used to provide adequate oxygen for maximal growth. Although requiring refinement this method produced small batches of inoculant.

Soybean: Fast-growing *Rhizobium Japonicum*

Isolates of Rhizobium japonicum made from reportedly fast-growing nodules collected in Vietnam by INTSOY, were tested on the pouch method to verify their fast-growing characteristic. Results were inconclusive. Additional tests will be conducted to determine the status of the Vietnam isolates.

Soybean: *Rhizobium Japonicum* and *Azotobacter* Spp.

Using the pouch method, a search for strains of Azotobacter spp. which would enhance nodulation and plant growth in interaction with Rhizobium japonicum was undertaken. Results of the experiment were too variable to draw conclusions. The pouch technique was not appropriate for this type of study.

SOIL SCIENCE

Effect of Nitrogen Fertilization on Soybean Growth

This experiment was designed to determine the nitrogen concentration for both optimum and maximum soybean yield.

The amount of nitrogen fixed by nodule bacteria is not large enough to support the healthy growth of soybean. Although nitrogen application supressed nodule formation, an adequate application of nitrogen is required for high yield, as well as the healthy growth of soybean. The optimal nitrogen concentration for economical high yield lies at about 40 ppm.

Symbiotic Nitrogen Fixation Evaluation of Soybean

To evaluate quantitatively the contribution ratio of symbiotic nitrogen fixation to total nitrogen uptake by soybean with isolines, an experiment was conducted in spring of 1984.

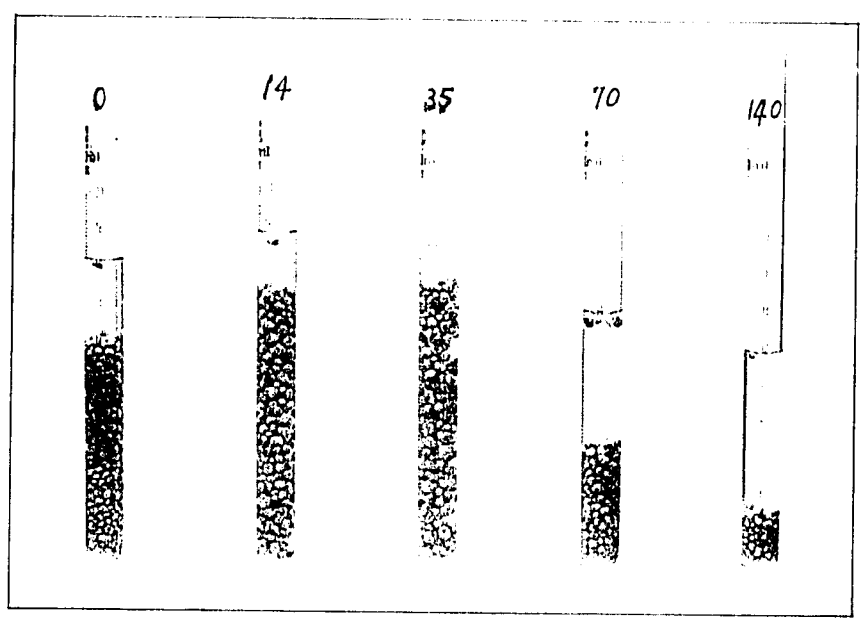
Logistic curves gave the best fit to each experimental point in the seed production and nitrogen uptake by isoline T201 and T202. For T202, nodulating genotype, potential yield and nitrogen uptake to attain this yield were estimated to be 8.50 t/ha and 710 kg N/ha, respectively. Nearly 60% of total N uptake was accumulated in the seed.

The addition of low level nitrogen resulted in vigorous nodulation and nitrogen fixation, but contribution ratio of symbiotic nitrogen fixation to total nitrogen uptake sharply decreased with increasing nitrogen application. The proportion of 35 ppm N gave the economical maximum yield of soybean and the contribution ratio exceeded 50%.

Rational Nitrogen Fertilization for Soybean

Both basal and top dressing of nitrogen at 30 days after germination (DAG) are very important to greatly increase pod number of soybean. Hundred seed weight is governed mainly by nitrogen status at a later growth stage, i.e., pod initiation stage.

To obtain high soybean yields, the combination of a relatively high rate of nitrogen application of both basal and



Measuring nodule formaton

top dressing at 30 DAG, or application of relatively low rate of nitrogen at each critical time, i.e. basal, flower initiation (30 DAG) and pod initiation (45 DAG), is highly recommended.

Chinese Cabbage Tipburn

Soil science research at AVRDC confirmed that ammonium toxicity was a primary factor in the cause of Chinese cabbage tipburn. This phenomenon was further studied to find a rational soil and fertilizer management for Chinese cabbage cultivation in the wet-hot season.

The head formation stage is most sensitive to tipburn, hence application of NH_4-N should be avoided at this stage. Countermeasures to decrease transpiration from outer leaves were effective for minimizing tipburn, but less effective to combat marginal rot and absolutely ineffective against internal rot. Foliar spray of Ca-citrate and $CaCl_2$ did not cure marginal and internal rot, but citrate spray had some effect on yield increase and in the decrease of hazards. Split application of liquid nitrogen gave the heaviest head without any tipburn symptoms.

To avoid tipburn and internal rot hazard in summer, an adequate cultural practice to meet the following requirements should be taken:

1. Secure enough soil volume for each plant;
2. Increase water holding capacity of the cultivated soil;
3. Avoid vigorous initial growth of plant in terms of split nitrogen application and water management;
4. Eliminate excess soil moisture in terms of high bed or high pot; and
5. Avoid increasing salt concentration in soils due to fertilizer application.

High Bed Cultivation of Tomato and Chinese Cabbage

The practice of cultivating Chinese cabbage and tomato on higher than normal beds in the rainy season was evaluated. Seventy cm raised beds with clear plastic roofs were very effective in minimizing tomato diseases, such as southern blight and bacterial wilt. Fruit weight on the high bed was four times as much as that of the low bed. It was also confirmed that a cultural practice using 12-15 cm long seedling pot exerted a similar effect on the high bed cultivation. The high bed also dramatically decreased soft rot infection of Chinese cabbage in the summer cultivation.

Yield Potential of Major Soil Groups in Tropics

Tolerance and high yielding abilities are dependent on soil conditions, therefore, the characterization of soil groups in the tropics according to their yield potential was undertaken. It was confirmed that acid and alkalimetric curves of

soils could be used for the characterization of tropical soils according to their yield potential.

Effect of pH, EC and Nutrient Status in AVRDC Soil on Crop Yield

Initial results indicated that soil pH and EC had a great effect on soybean yield with increases of 0.5 and 0.4 t/ha per unit increase in pH value for AGS 129 and KS 6, respectively. Experiments on physical properties and chemical analysis of soils and plant tissues are not yet completed and will be reported in 1985.

NEW VEGETABLE PROJECT

Of the 400 vegetables consumed in Southeast Asia, only about 115 are routinely cultivated. Fewer than 40 of these are suitable for commercial production. Most modern cultivars of these vegetables were developed in temperate countries and can only be produced in the limited highland areas or during the cool-dry months in Southeast Asia.

AVRDC's New Vegetable Program was established in 1981 with the objectives of (1) screening commercial varieties of selected vegetables prior to their use by national programs and (2) identifying crops that might warrant future research at AVRDC. By the end of 1984, 62 separate trials, including 45 observational and 17 replicated trials, had been conducted since the beginning of the project. Of the five crops tested, cauliflower (Brassica oleracea var. botrytis) and hot pepper seemed to have the most potential.

Cauliflower

The outstanding cauliflower lines included "Chia Thai No. 1" from Thailand, "F_1 451" from Taiwan and "Mikado 40 Days" from Japan. The cultivars tested were, however, susceptible to black rot and soft rot.

Hot Pepper (*Capsicum annuum* L.)

The best cultivars were a Taiwanese hybrid known as "Passion", the American variety "Hungarian Yellow Wax", and the Korean cultivars "Twist Hot" and "Hong Shan Ho." Viral diseases, southern blight and bacterial wilt were the major constraints.

Mustard (*Brassica juncea*)

Mustard in its leafy form was more promising than the heading type for lowland production in the tropics because it was less susceptible to bolting. Turnip mosaic virus, soft rot, and bolting seemed to be the major constraints of this crop.

Radish (*Raphunus sativus*)

Several useful Chinese cultivars had adequate heat resistance, but the right management practices and soil type are needed for them to perform normally in the wet season.

Snap bean (*Phaseolus vulgaris*)

This vegetable did not perform well as a bush type. The pole bean performed slightly better, however, the major problems were rust and the difficulty of maintaining seed viability.

Sweet Pepper (*Capsicum annuum*)

This type of pepper was less promising. Most test cultivars lacked heat tolerance, although "Gypsv," an American cultivar yielded high. Viruses seemed to be the foremost problem for production in the tropics.

Training

AVRDC provided an articulated training program in 1984 with 64 scholars trained at Headquarters and 19 trained through the TOP/AVRDC program in Thailand.

At AVRDC Headquarters trainees from the Federal Republic of Germany, Guatemala, Indonesia, Republic of Korea, Liberia, Malaysia, Nepal, the Philippines, Sierra Leone, Taiwan, Thailand and the United States underwent training in two five-month courses and one two-month summer course. Table 1 provides a breakdown of the areas studied by crop.

Training sponsors in 1984 included: the MARDI/AVRDC Research Program, the USAID Garden Program, the University of Illinois, the Heung Nung Seed Company, the Bayer Thai Company, Ltd., the ROC Ministry of Foreign Affairs, the ROC Vocational Assistance Commission for Retired Servicemen, the German Agency for Technical Cooperation (GTZ) and the FELDA Agricultural Services Corporation.

At the TOP/AVRDC training program 19 scholars from Bangladesh, China, Indonesia, Pakistan, Sri Lanka and Thailand were trained in Thailand (see Table 1) during 1984.

Table 1. 1984 training by crop.

Crop	Headquarters	TOP/AVRDC
Chinese cabbage	11	3
Sweet potato	5	4
Tomato	12	4
Mungbean	4	4
Soybean	6	2
Others	28	2
Total	66	19

Scholar (right) learning about nematode resistance in tomato

Packaging seeds in the new facility

Genetic Conservation

The responsibilities of the Genetic Resources and Seed Unit include the characterization, maintenance, regeneration and distribution of AVRDC's five mandate crops.

- New Facilities - During 1984 a new structure was built to house the Genetic Resources and Seed Unit. The entire facility - which provides 115 m^3 of long-term (-20°C frost-free), 193 m^3 of medium-term (2-5°C, 40-45% RH), 254 m^3 of short-term (15°C, 40% RH) and 87 m^3 of tuber (15°C, 80-95% RH) cold store, 399 m^3 of laboratories, 600 m^3 of seed conditioning rooms, 49 m^3 of seed drying chambers, and 106 m^3 of germination and preparation rooms - was constructed with a capital outlay of just over US$500,000; $275,000 for building and $229,000 for equipment.

- Germplasm Collections - AVRDC holds the world's base collection for mungbean and the Asia and the Pacific regional collection for sweet potato in the IBPGR's international conservation network. Table 2 provides specific information on the holdings on a crop basis.

- Germplasm Regeneration - A total of 84 accessions of Chinese cabbage, 177 accessions of mungbean, 27 accessions of rice bean, 202 accessions of soybean and 41 accessions of tomato were regenerated.

- Germplasm Distribution - A total of 20,572 seed samples were distributed to cooperators in 107 countries/territories (see Table 2 and following listing of "Germplasm Recipients").

- Germplasm Duplication - In 1984, 63 accessions of the Chinese cabbage collection were multiplied and sent to the IBPGR-designated base collection at NVRS, Wellesbourne, UK. An additional 188 accessions remain to be regenerated.

- Germplasm Characterization - Chinese cabbage: By the end of 1984, 23 accessions had been characterized for both vegetative and reproductive characters, 123 accessions for vegetative characters and 40 for reproductive characters.

  Mungbean - After considerable adverse weather, the collection was multiplied and characterized for 24 characters using the IBPGR descriptor list.

- Germplasm Purification - It was ascertained that the AVRDC soybean collection contains 2,672 accessions not of USDA origin. Before duplicates of these accessions can be deposited in the IBPGR-designated collections (NSSL, Colorado, USA and NIAR, Tsukuba, Japan), it was determined that only five percent of the accessions contained more than one type.

  Purification of the mungbean collection has proceeded during 1984. Accessions with mixed seeds have been sorted into four characters: lustre, color, size and shape.

- Germplasm Introduction - In conjunction with the construction of the new facilities, a new scheme for germplasm introduction was developed. This will serve to centralize germplasm work.

Table 2. AVRDC germplasm collections and distribution in 1984.

	Acces-sions	Suspected duplicates	Missing*	Samples distributed
Soybean	10,544	2,111	1,180	7,254
Mungbean	5,112	983	165	3,665
Tomato	5,350	40	138	7,052
Sweet potato	1,200	9	31	832
Chinese cabbage	822	-	42	1,769
Total	23,028	3,143	1,556	20,572

* Missing accessions are being sought from original sources.

Germplasm Recipients 1984

Anguilla, British

Corito Trading Company, Ltd.

Antigua

Caribbean Agricultural Research & Development Institute

Argentina

Facultad de Ciencias Agrarias de Rosario

Australia

Commonwealth Scientific and Industrial Research Organization
Department of Agriculture
Department of Primary Production
Redlands Horticultural Research Station
Seed Testing Station

Bahamas

Department of Agriculture

Bangladesh

Bangladesh Agricultural Research Institute
Institute of Nuclear Agriculture
International Agricultural Development Service

Barbados

Hi-GRO Gardens, Ltd.

Belgium

University of Ghent

Belize

Carribean Agricultural Research & Development Institute

Bolivia

Comite Central Menonita
Est Experimental "Green Chaco"
Moxos Experimental Station

Brazil

Centro de Pesquisa Agropecuaria Tropico Umido
Centro Nacional de Recursos Genéticos
CEPLAC
Programa De Pesquisa, OCEPAR

Brunei

Pusat Latihan Pertanian Sinaut
Sinaut Agricultural Training Center

Burkina Faso

Institut de recherche pour les huiles et oléagineux
Centre d'experimentation du riz et des cultures irriguees

Burma

IRRI - Burma

Cameroon

IRA Nkolbisson Center

Canada

Agriculture Canada
King Grain, Ltd.
Ridgetown College of Agricultural Technology
Smithfield Experimental Farm
Stocks Seed, Ltd.
University of Guelph

Caroline Islands

Agriculture Division, Truk
OISCA I.D.M.

Colombia

Centro Internacional de Agricultura Tropical
Coordinador Nal. Leguminosas de Grano y Oleaginosas Anuales
Federacion Nacional de Cafeteros de Colombia
Institute Colombiano Agropecuario
Instituto Linguistico de Verano

Comoros

CEFADER

Congo

Universite Marien Ngouabi

Cook Islands

Ministry of Agriculture and Fisheries
Tokoitoku Research Station

Costa Rica

Centro Regional UCR

Macap, S. A.
Ministerio De Agricultura y Ganaderia
Palm Research Program
Proyecto Agroforestal
ROC Technical Mission
Universidad de Costa Rica

Cyprus

Agricultural Research Institute

Denmark

J. E. Ohlsens Enke A/S

Dominican Republic

Centro de Desarrollo Agropecuario
ROC Technical Mission

Egypt

Agricultural Research Center
Ministry of Agriculture

El Salvador

Centro Nacional de Tecnologia Agricola

Ethiopia

International Livestock Centre for Africa
Ministry of Agriculture (Add)
Nazareth Agricultural Research Station
UNDP/FAO

Fiji

Legalega Research Station
Sigatoka Research Station

France

Union des cooperatives agricoles Armagnac - Bigorre

Gambia

St. Augustines High School

Ghana

Crops Research Institute
Dodowa Cooperative Multi-Purpose Society, Ltd.

Guatemala

Instituto de Cinecia y Tecnologia Agricolas
Personero del Jefe de Estado
ROC Technical Mission

Guadeloupe (France)

Institut national de la recherche agronomique

Guam (USA)

University of Guam

Guinea

United Nations Development Program

Haiti

A Christian Outreach of the Baptist Haiti Mission
Catholic Relief Services Haiti Program
Instituto Interamericano de Cooperación para la Agricultura
ROC Technical Mission

Kampuchea

Mr. Ed Motzenbocker, Phonom Penh

Honduras

Ministerie de Re Cursos, Naturales Honduras

India

Andhra Pradesh Agricultural University
Ankur Agricultural Research Laboratory
Bhabha Atomic Research Centre
Central Agricultural Research Institute
College of Agriculture & Technology
CYB Institute
FIPPAT
G. B. Pant University of Agricultural and Technology
Haryana Agricultural University
ICAR Research Complex for N.E.H. Region
IFFCO
India Institute of Horticultural Research
Indian Agricultural Research Institute
J. N. Agricultural University
Kerala Agricultural University
Khadut Samakari Jin, Ltd.
Merryweather Food Products, Ltd.
National Bureau of Plant Genetic Resources
National Pulse Research Station
Nimbkar Agricultural Research Institute
Orissa University of Agriculture & Technology

Punjab Agricultural University
Soya Production and Research Association
Tamil Nadu Agricultural University
The Atul Products, Ltd.
The Cochin Malabar Estates and Industries, Ltd.
University of Agricultural Science
University of Agricultural Science & Technology
Yantra Vidyalay Punjab Agricultural Univ.

Indonesia

Agricultural Training Center
Akademi Farming Semarang
Bali Ganti Sena Foundation
Bogor Agricultural University
Bogor Central Research Institute for Food Crops
Central Research Institute for Food Crops
Central Research Institute for Horticulture
Dinas Pertanian Tanaman Pangan
Lembang Research Inst.
M. A. C. S. Research Institute
MARIF
Maros Research Institute for Food Crops
NAEA, Pasar Jumat Research Centre
NTT Livestock Development Project
Pilot Project on Integrated Soya and Food crop Production
P. T. Melati Gambir Mas
P. T. Uniroyal Sumatra Plantations
ROC Technical Mission
Subbalai Penelitian Tanaman Pangan Sumani
Sukamandi Research Institute for Food Crops
Sukarami Research Institute for Food Crops
SURIF
TAD Seed Improvement
Transmigration Area Development Project
Universitas Jambi
Universitas Sriwijaya

Iran

Seed & Plant Improvement Institute
University of Isfahan
University of Tabriz

Italy

Consiglio Nazionele delle Ricerche
UN Food and Agricultural Organization

Jamaica

Ministry of Agriculture

Japan

Association for International Cooperation of Agriculture & Forestry
Chiba University
Kikko Foods Corporation
Kirin Brewery Co., Ltd.
Kyushu University
Nagasaki Agricultural & Forest Experiment Station
Nagoya University
Okinawa Tropical Agriculture Research Center
Okinawa Federation of Agricultural Crops
Shizuoka Agricultural Experimental Station
Takii and Company, Ltd.
T. Sakata & Company
Tsukuba International Agricultural Training Center

Jordan

Jordan Valley Agricultural Project

Kenya

Agricultural Office Dept.
Bombolulu Coast Workshop for the Handicapped
Dryland Farming Research and Development Project
Institute for Rural Development
International Centre for Insect Physiology and Ecology
Karamoja Development Programme, Moroto Headquarters
Ministry of Agriculture and Livestock
National Horticultural Research Station

Kiribati

Kiribati Field Office

Korea, Republic of

AVRDC Korean Sub-Center
Breeding Institute of Houng Nong Seed Co.
Gyeongsang National University
Jeonnam National University
Korean Advanced Energy Research Institute
National Agricultural Cooperative Federation
Office of Rural Development

Lesotho

Plenty Agriculture Project

Liberia

Central Agricultural Research Institute
Ministry of Agriculture NCRDP
United States Aid for International Development

Malawi

Bumbwe Research Station
Chitedze Research Station
Lilongwe Agricultural Development Division
Smallholder Sugar Authority

Malaysia

Agriculture Research Centre
AVRDC Malaysian Outreach Program
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Malaysian Agricultural Research and Development Institute
National University of Malaysia
Tarat Experiment Station
Universiti Pertanian
Westech Sdn. Bhd.

Martinique (France)

Institute du recherches agronomiques tropicales et des cultures vivières

Mauritius

Ministry of Agriculture, Fisheries, and Natural Resources
Sugar Industry Research Institute
Union Sugar Estate, Ltd.
University of Mauritius

Mexico

Alimentos del Fuerte, S. A. de C. V.
Jefe Del Depto Agronomico
National Institute for Agricultural Research
The Rockefeller Foundation

Morocco

Institute of Agronomy Hassan II
Institut national de la research agronomique

Nepal

Institute of Agriculture and Animal Science
Vegetable Development Divison

Netherlands

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Deruiter Zonen B. V.
Enza Zaden de Enkhuizer Zaadhandel B. V.
International Service for National Agricultural Research
Nickerson - Zwaan B. V.
Nunhems Zaden B. V.
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Sluis & Groot

New Zealand

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Horticultural Research Centre
Ministry of Agriculture & Fisheries

Nicaragua

ROC Technical Mission

Nigeria

Ahmadu Bello University
Ekiti-Akoko Agricultural Development Project
International Institute of Tropical Agriculture
Korokorosei P/A
Ministry of Agricultural & Natural Resources
National Horticultural Research Institute
Oloro Properties Limited

Oman

Oman Modern Farm

Pakistan

Agricultural Research Institute
Atomic Energy Agricultural Research Centre
National Agricultural Research Center
Nuclear Institute for Agriculture and Biology
Technical Services Assoc.

Panama

Barro Colorado National Monument ISTRI
Instituto de Investigacion Agropecuaria de Panama
Smithsonian Tropical Research Institute

Papua New Guinea

Department of Primary Industry, Laloki

Paraguay

Servicio Agropecuario, Chaco Central

Peru

Exportadora Pumas S. A.
Nacional Leguminosas de Grano
Universidad Nacional Agraria

Philippines

Abra Irrigation Project
Ateneo de Davao University
AVRDC Philippine Outreach Project
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Botanique Philippines Inc.
Bureau of Plant Industry
Cagayan State University
Carcon Development Corporation
Diocesan Adult Training Center
IRN Agricultural Services (Phil.) Inc.
Institute of Plant Breeding
International Rice Research Institute
Isabela State University
Mountain State Agricultural College
Ministry of Agriculture
Mindanao State University
Mariano Marcos State University
Negros Magnesium Co., Ltd.
Northern Mindanao State Institute of Technology
Palawan National Agricultural College
Philippines Council for Agricultural and Resources Research and Development
Philippine Packing Corporation
Philippine Root Crop Research & Training Center
Philippine Rural Life Center Inc.
Pure Food Corporation
Ramon Magsaysay Award Foundation
RAM Food Products, Inc.
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Technology Resources Center
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University of Southeastern Philippines
Visayas State College of Agriculture

Puerto Rico

Tropical Agriculture Research Station

Qatar

Industrial Development Technical Center

Reunion (France)

Institut de recherches agronoiques tropicals et des cultures vivrieres

Saipan (Mariana Islands)

Commonwealth of the Northern Marianas Islands

Samoa, West

American Samoa Community College
Pacific Agricultural Consultancy Service Limited
Samoan-German Crop Protection Project

Saudi Arabia

Department of Agriculture and Water
King Saud University
Ministry of Agriculture and Water
Qassin Agriculture Research Center
U. S.-Saudi Arabian Joint Commission on Economic Cooperation

Senegal

Institute senegalaid de recherches agricoles

Seychelles

Grand Anse Exptal Food Production Center
Ministry of National Development

Sierra Leone

Agricultural Syndicates Development Project
Ministry of Agriculture & Forestry
Tikonko Agricultural Extension Center
University of Sierra Leone

Singapore

Coleman Transport Corporation
Primary Production Dept.
Sembawang Field Experimental Station

Solomon Islands

ROC Technical Mission

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Grain Crops Research Institute
Horticultural Research Institute
SARCCUS
University of Fort Hare

University of Stellenbosch

Sri Lanka

Agricultural Research Station
Agricultural Settlement Project
Central Agricultural Research Institute
Department of Agriculture
East Coast Rehabilitation Project
Halgashena Estate & Dairy
Lanken Ceylon Limited
Regional Agricultural Research Centre
Soybean Food Research Centre
University of Peradeniya
Yahapath Endera Farming Centre

St. Kitts & Nevis

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ROC Technical Mission

St. Lucia

Caribbean Agricultural Research and Development Institute
ROC Technical Mission

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University of Swaziland

Tahiti (France)

Groupement d'études et de recherches pour le développement de l'agronomie tropicale

Taiwan, ROC

ACE Seed Company
Asian Exchange Center, Inc.
Chiayi Agricultural College
Formosa Seed Company
Fu Jen University
FFTC/ASPAC
Hualien District Agricultural Improvement Station
I-Chang Food Company
Kaohsiung District Agricultural Improvement Station
National Chung Hsing University
National Taiwan Univ.
Tainan District Agricultural Improvement Station
Taiwan Seed Improvement Station
Taiwan Pineapple Corp.
Taiwan Sugar Research Institute

Tanzania

Ilonga Agricultural Research Institute
Ministry of Agriculture
Regional Agricultural Development Office, Tanga
University of Dar Es Salaam

Thailand

AVRDC Thailand Outreach Program
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Agricultural Cooperative Association
Bayer Thai Co., Ltd.
Chiang Mai Field Crops Research Center
Chiang Mai University
Department of Agriculture
Hangchart Horticultural Experiment Station
ICRC
Kasetsart University
Khon Kaen University
Mae Joe Institute of Agricultural Tech.
Ministry of Agriculture & Cooperative of Thailand
Phitsanulok Field Crops Expt. Station
Prince Songkhla University
Puwin & John Limited Partnership
Royal Food Processing Factory
Universal Food Co., Ltd.
Watershed Development Project

Trinidad and Tobago

Caribbean Chemicals and Agencies, Ltd.
Santana Services, Ltd.

Tunisia

Ministry of Agriculture

Turkey

Ziraat Fakültesi

Tuvalu

Agricultural Station
Ministry of Commerce & Natural Resources

United Kingdom

Charles Sharpe & Co. Plc.

Gunson's Sortex, Ltd.
Kasaka Limited
National Vegetable Research Station

USA

A. L. Castle, Inc.
Agrichem Industries, Inc.
Agrigenetics Corporation
Alf. Christianson Seed. Co.
Asgrown Seed Company
BHN Research
Brigham Young University
Calgene, Inc.
Education Concerns for ECHO
Incorporation Hunger Organization
Ferry Morse Seed Company
Goldsmith Seeds, Inc.
H. J. Heinz Co.
IPDO Graduate School
Joseph Harris Co., Inc.
Kansas State University
Keystone International Seed Co.
Land O'Lakes, Inc.
Louisiana State University
Michigan State University
Mississippi State University
Moran Seeds Inc.
Nickerson IPB Seeds
Ohio State Univeristy
Oklahoma State University
Peto Seed Co., Inc.
Purdue University
Smithsonian Tropical Research Institute
Texas A & M University
US Department of Agric. United States Aid for International Development
University of Arizona
University of California
University of Florida
University of Georgia
University of Hawaii, Hilo
University of Hawaii, Manoa
University of Illinois
University of Missouri, Columbia
University of Wisconsin, Madison

Uruguay

Centro de Investigaciones Agricolas "Alberto Boerger"
ROC Technical Mission

Virgin Islands

Virgin Island Cooperative Extension Service
Water Isle Botanical Garden

Yemen Arab Republic

Elkod Research Center
Ministry of Agriculture & Fisheries
Seiyun Research Centre

Zambia

National Irrigation Research Station
The National Food and Nutrition Commission

Zimbabwe

Chiredzi Research Station
Department of Agricultural, Technical & Extension Services
Horticultural Research Centre
Rattray Arnold Research Station

Seminars

The following seminars were presented in 1984 by Center staff and guest speakers. Please note that seminar papers are not available for distribution.

January 6 - Vegetable Industry in the Netherlands, D. V. Castro, Training Specialist, AVRDC.

January 12 - The Improvement of Tropical Tomato through Backcrossing, Kozo Toshimitsu, Research Fellow, AVRDC.

February 9 - Breeding Goals for Sweet Potato in Asia and the Pacific, Steve Lin, Sweet Potato Breeder, AVRDC.

February 19 - The Relationship between NH_4-N and Chinese Cabbage Tipburn, Chin-Hua Ma, Principal Research Assistant, AVRDC.

March 15 - INTSOY Microbiology: The Past, Present, and Future, Chris Stearn, AVRDC Soil Microbiologist, AVRDC.

March 22 - Plant-Plant Interaction in Taiwan Agro-ecosystems, C. H. Chou, Institute of Botany, Academica Sinica.

April 12 - The Effect of Leaf Tying and Shading on Summer Chinese Cabbage, Adisak Sajjapongse, Crop Management Specialist, AVRDC.

April 19 - Plant Tissue Applications in Agriculture, Huang Li-chun, Academia Sinica.

May 3 - Farming System Research, Linnea Karlsson, AVRDC.

May 31 - Action of Clostidium perfringens phospholipase C on tumor cell membranes, M. H. Lee, National Taiwan University.

June 7 - A Computerized System for Field Experiments, M. Nagai, Biometrician, AVRDC.

June 14 - Seed Production and Storage of Some Brassica campestris Subspecies at AVRDC, A. M. Dourado, AVRDC.

July 2 - Vegetable Production and Management in Western Australia, Terry Hill.

August 16 - Chemical & Nutritional/Agricultural Studies of Sweet Potato and Other Root Crops in the South Pacific, J. Howard Bradbury.

September 4 - Theoretical Research and Applied Research - A Review of My Research Method, Chang-chi Chu.

October 18 - Nematodes Predispose Plants to Bacteria, Niramit Pratoomrat.

November 1 - Vegetable Research and Production in West Malaysia, Chang-Chi Chu.

November 6 - Incorporation of Multiple Disease Resistance in Mungbean through Interspecific Hybridization, B. A. Satyan.

November 8 - Hormonal Studies on the Bud Dormancy Problems in Subtropical Viticulture, Cheng-Yung Cheng, National Taiwan University.

November 22 - Down on the Farm. A Documentary on Farming Practices in the US, Chris Stearn, AVRDC.

December 13 - Sexual Barrier of Crops in Post-Pollination, Chou-Tou Shii, Associate Professor, National Taiwan University.

December 17 - Physico-Chemical Properties of Volcanic Ash Soils in Japan, Shingo Iwata.

Publications Available

How to Order

The publications listed below can be ordered from the AVRDC Office of Information Services (OIS). Most are available free of charge and will be posted upon request via surface mail. If airmail delivery or multiple copies are required, please check the price list located below.

Some charge is required for publications marked with an asterisk (*), i.e., symposium proceedings and progress reports (starting 1983). Again, please consult the price list. All charges should be paid with a US dollar check (payable by a bank in the US) made out to AVRDC.

Notice to Librarians

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Mungbean Proceedings	$10.00	$8.00	$3.75	$ 6.00
Tomato Proceedings	$10.00	$8.00	$4.50	$ 7.25
Chinese Cabbage Proceedings	$15.00	$12.00	$7.50	$13.00
Sweet Potato Proceedings	$15.00	$12.00	$8.20	$13.00
Soybean, Tropical & Subtropical Cropping Systems	$18.00	$14.00	$8.20	$13.00
Progress Report (before '83)	Free	$ 3.00	$2.00	$ 3.00
Progress Report (after '83)	$10.00	$ 8.00	$7.50	$11.50
Agromyzid Flies in Java	$ 5.00	$ 4.00	$2.00	$ 3.00
Monographs	Free	$ 2.00	$1.00	$ 1.00

* Library copies free; libraries listed on the AVRDC mailing list receive all AVRDC publications automatically.

Journal Paper Reprints

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1979 Report
1981 Report
1982 Report
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Progress Report Summaries

1982 Progress Report Summaries
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Crop Reports

1975 Chinese cabbage
1976 Chinese cabbage
1976 Sweet potato

Symposium Proceedings

[z]Vegetable Technology in Asia. Proceedings of the workshop on pre- and post-harvest*

[z]Mungbean: Proceedings of the first international symposium*

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1611 North Kent St.
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Centerpoint - This quarterly bulletin on the AVRDC provides up-to-date information on its research, training, publications, etc.

Soybean Rust Newsletter - This annual newsletter is published by the International Working Group on Soybean Rust through TVIS.

TVIS News - Prepared by the Tropical Vegetable Information Service through AVRDC and published twice a year. It provides a platform of exchange of information for scientists working with mungbean, soybean and Chinese cabbage.

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AVRDC's projected budget for 1984 was US$ 4,750,000, compared with an actual income of US$ 4,336,727 and expenditures of US$ 4,518,249. Core funding was provided by the governments of the Republic of China, the United States, the Philippines, the Republic of Korea, Japan, Thailand and the Federal Republic of Germany.

Grants and other forms of assistance were also received from:

- The Asian Development Bank
- The International Development Research Centre (Canada)
- The International Board for Plant Genetic Resources
- The ROC Council for Agriculture
- The ROC National Science Council
- International Soybean Program (INTSOY)
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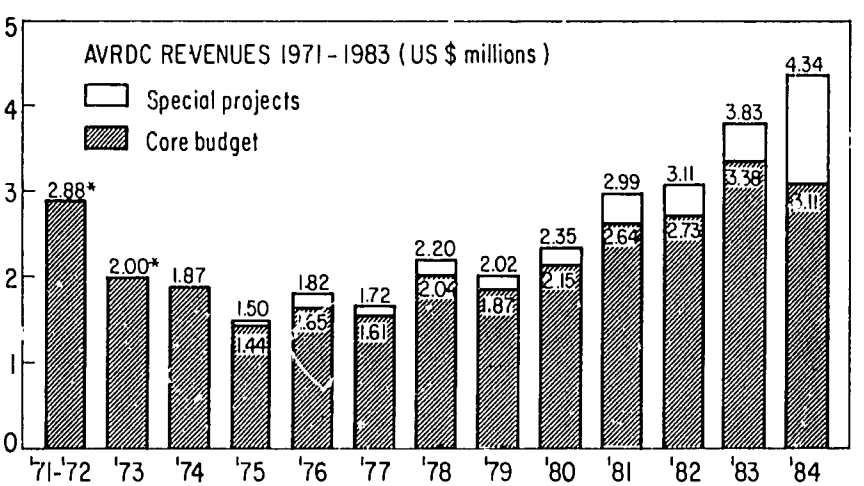

*US $ 4.3 million for capital expenditures 1971-73