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The Asian Vegetable Research and Development Center (AVRDC) is the international center with a mandate for the research and development of vegetable crops in the humid and subhumid tropics. Established in 1971, its activities include: germplasm collection, storage, and enhancement; varietial improvement; production technology improvement; environmental and nutritional studies; technology transfer; training for national program personnel; and scientific publishing.

AVRDC's research and support staff consists of some 353 persons from a dozen countries. The Center's budget, which totaled US$8.05 million in 1988 is provided by the governments of the Republic of China, the United States of America, Japan, the Federal Republic of Germany, the Kingdom of Thailand, the Republic of Korea, the French Republic, and the Commonwealth of Australia. Special project funds are provided by a variety of international donors including the Japan Shipbuilding Industry Foundation, the Council of Agriculture (ROC), the Agency for International Development (AID), the Asian Development Bank (AID), the International Development Research Centre (IDRC) of Canada, the OICD/U.S. Department of Agriculture, the German Ministry for Economic Cooperation (BMZ), the German Agency for Technical Cooperation (GTZ) and the Technical Centre for Agricultural and Rural Co-operation (CTA).

AVRDC is governed by an international board which represents the various donor nations as well as experts from collaborating organizations.

about the cover: Niger salad seller photographed by Jack Gershon

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ASIAN VEGETABLE RESEARCH & DEVELOPMENT CENTER 1971

AVRDC Progress Report Summaries 1988

About this Report

This report provides an overview of AVRDC's research and development activities in 1988. Readers who would like more detailed information are asked to utilize the attached request card for detailed reports of particular interest. Complimentary reprints of up to five sections of the report can be requested by sending the attached postcard to AVRDC's Office of Information Services. If more than five sections are required, please include US$1.00 for each additional section. Checks, drawn on a bank in the USA, should be made out to AVRDC. The reprints are grouped according to crop and discipline and correspond to the summaries found on the following pages.

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Foreword

AVRDC is in transition as these summaries go to press. The Center is in the process of renewing its directorship; the former Director General and Deputy Director General completed their assignments during the latter part of 1988. The search for AVRDC's fifth Director General has touched all corners of the globe; the new management team is expected to infuse AVRDC with the leadership it must have to meet the challenges of the 1990's.

The year 1988 was a watershed year for AVRDC's research and development activities. With support from the Asian Development Bank (ADB), AVRDC hosted the policymakers, research managers and researchers from the Southeast Asian countries, with which it has had cooperative programs, in a workshop to take stock of the accomplishments to date, gauge the present capability for vegetable research in the national programs, define the major constraints of the next decade, and develop a collaborative research program to meet the identified needs. As the national agricultural research systems (NARS) undertake more applied research, AVRDC will have the opportunity to shift a greater amount of its resources towards strategic research. With continuing generous assistance from ADB, the Center has entered this more mature relationship with the Southeast Asian NARS, to serve as the hub of the new collaborative research networks among its partners. The proceedings of this important gathering is available as *Vegetable Research in Southeast Asia*.

AVRDC is currently developing its vital road maps to the future – its new strategic plan. This centerwide strategic planning exercise promises to provide the international vegetable research and development community with a careful consideration of the research thrusts required to meet their needs into the 21st century. The role of women in vegetable production, genetic resource conservation and utilization, sustainability of vegetable production, and crop improvement techniques including biotechnology, are just a few of the future agenda examined in detail.

AVRDC's reason for being is to promote the contribution of vegetables in improving the welfare of the people in the developing world through more balanced diets, increased income, and enhanced employment opportunities. We welcome the endorsement in 1988 by the Technical Advisory Committee (TAC) of the need for a program of research on vegetables in the Consultative Group on International Agricultural Research system. As AVRDC prepares to step into the next decade and beyond, it remains committed to continue to serve as the focal point for research and development of vegetables for the tropics.

Paul C. Ma
Board Chairman and
Acting Director General

Abbreviations and Acronyms

-AARD - Agency for Agricultural Research and Development (Indonesia)
-ACCT - Agency for Cultural and Technical Cooperation (France)
-ADRC - Agricultural Development Research Center in Northeast Thailand
-a.i. - active ingredient
-AID - Agency for International Development (USA)
-AIT - American Institute in Taiwan
-AMV - alfalfa mosaic virus
-ARTT - advanced soybean rust tolerance trials
-ASET - AVRDC Soybean Evaluation Trials
-AVRDC - Asian Vegetable Research and Development Center (IARC)
-AYT - advanced yield trials

-BARD - Bangladesh Academy of Rural Development
-BARI - Bangladesh Agricultural Research Institute
-BORIF - Bogor Research Institute for Food Crops (Indonesia)
-BMZ - German Ministry for Economic Cooperation
-BW - bacterial wilt

-CAAS - Chinese Academy of Agricultural Sciences
-CARDI - Caribbean Agricultural Research and Development Institute
-CENARGEN - Centro Nacional de Recursos Genéticos (Brazil)
-CGIAR - Consultative Group on International Agricultural Research
-cfu - colony-forming units
-CIAT - Centro Internacional de Agricultura Tropical (CGIAR)
-CIMMYT - Centro Internacional de Mejoramiento de Maiz y Trigo (CGIAR)
-CINDE - Coalicion Costarricense de Iniciativas de Desarrollo (Costa Rica)
-CIP - Centro International de la Papa (CGIAR)
-CLS - Cercospora leaf spot
-CMS - cytoplasmic male sterility
-CMV - cucumber mosaic virus
-CRIFC - Central Research Institute for Food Crops (Indonesia)
-CTA - Technical Center for Agricultural and Rural Cooperation (EC)
-CUSO - Canadian University Service Overseas
-CV - coefficient of varriance
-CVMV - chili veinal mottle virus

-DAIS - District Agricultural Improvement Station (Taiwan)
-DAS - days after sowing
-DAT - days after transplanting
-DBM - diamondback moth
-DOAE - Dept. of Agricultural Extension (Thailand)
-DPI - Dept. of Primary industry (Australia)

-EC - European Community
-ELISA - enzyme-linked immunosorbent assay
-EMBRAPA - Empresa Brasileira de Pesquisa Agropecuaria (Brazil)

-FAO - Food and Agriculture Organization of the United Nations
-FCRC - Field Crop Research Centre (Thailand)
-FIRDI - Food Industry Research and Development Institute (Taiwan)
-FMV - feathery mottle virus

-GLA - green leaf area
-GRSU - Genetic Resources and Seed Unit (AVRDC)
-GTZ - German Agency for Technical Cooperation (Fed. Rep. of Germany)
-GYT - general yield trial

-HT - heat tolerant

-IARC - international agricultural research center

-IARI - Indian Agricultural Research Institute
-IBPGR - International Board for Plant Genetic Resources (CGIAR)
-IBSRAM - International Board for Soil Research and Management (IARC)
-ICAR - Indian Council of Agricultural Research
-ICARDA - Internattional Center for Agricultural Research in the Dry Areas (CGIAR)
-ICIMOD - International Centre for Integrated Mountain Development (IARC)
-ICIPE - International Centre of Insect Physiology and Ecology (IARC)
-ICLARM - International Center for Living Aquatic Resources Management (IARC)
-ICRAF - International Council for Research in Agroforestry (IARC)
-ICRISAT - International Crops Research Institute for the Semi-Arid Tropics (CGIAR)
-IDIAP - Instituto de Investigación Agropecuaria de Panamá
-IFAD - International Fund for Agricultural Development (UN)
-IFDC - International Fertilizer Development Center (IARC)
-IFPRI - International Food Policy Research Institute (CGIAR)
-IITA - International Institute for Tropical Agriculture (CGIAR)
-ILCA - International Livestock Center (CGIAR)
-ILRAD - International Laboratory for Research on Animal Diseases (CGIAR)
-IMMI - International Irrigation Management Institute (IARC)
-IMN - International Mungbean Nursery (AVRDC)
-INERA - Institut national pour l'étude et la recherche agronomiques (Zaire)
-INIA - Instituto Nacional de Investigacao Agraria (Cape Verde Is.)
-INIAP - Instituto Nacional de Investigaciones Agropecuarias (Ecuador)
-INRA - Institut nacional de la recherche agronomique (France)
-IPB - Bogor Agricultural University (Indonesia)
-IPB - Institute of Plant Breeding, UPLB (Philippines)
-IPM - integrated pest management
-IRAT - Institut de recherches agronomiques tropicales et des cultures vivrières (France)
-IRETA - Institute for Research, Extension, and Training in Agriculture
-IRRI - International Rice Research Institute (CGIAR)
-ISABU - Institut des sciences agronomiques du Burundi
-ISNAR - International Service for National Agricultural Research (CGIAR)
-ISRA - Institut sénégalais de recherches agricoles (Senegal)
-IYT - intermediate yield trial
-LEHRI - Lembang Horticulture Research Institute (Indonesia)
-MARDI - Malaysian Agriculture Research and Development Institute
-MARIF - Malang Research Institute for Food Crops (Indonesia)
-MMV - sweet potato mild mottle virus
-NAIR - National Institute of Agrobiological Resources (Japan)
-NARS - national agricultural research systems
-NIRS - near infrared reflectance spectroscopy

-OD - optical density
-OIS - Office of Information Services (AVRDC)
-OP - open-pollinated
-OYT - observational yield trial

-PARC - Pakistan Agricultural Research Council
-PDA - potato dextrose agar
-PE - polyethylene
-PeMV - pepper mottle virus
-PM - powdery mildew
-POP - Philippines Outreach Program (AVRDC)
-PVMV - pepper veinal mottle virus
-PVY - potato virus Y
-PYT - preliminary yield trial

-RCBD - randomized complete block design
-RDA - Rural Development Administration (Rep. of Korea)
-RTI - rust tolerance index
-RYT - regional yield trial

-SDI - selective dissemination of information
-SDP - selective dissemination of publications
-SP - stem and petiole
-SPFMV - sweet potato feathery mottle virus
-SPLC - sweet potato leafcurl
-SPVB - sweetpotato vine borer
-SPYDV - sweet potato yellow dwarf virus

-TADCO - Tabuk Agricultural Development Co. (Saudi Arabia)
-TARI - Taiwan Agricultural Research Institute
-TVDF - Tropical Vegetable Data File (AVRDC)
-TEV - Tobacco etch virus
-TMV - tobacco mosaic virus
-ToMV - tomato mosaic virus
-TOP - Thailand Outreach Program (AVRDC)
-TSWV - tomato spotted wilt virus
-TuMV - turnip mosaic virus
-TYLCV - tomato yellow leafcurl virus

-UPLB - University of the Philippines at Los Baños (Philippines)
-USDA - United States Department of Agriculture

-WARDA - West Africa Rice Development Association (CGIAR)

CROP IMPROVEMENT PROGRAM

CHINESE CABBAGE

INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 744 seed packets were distributed to 67 cooperators in 32 countries.

International Trials

China — TOP reported that the two AVRDC hybrids, Nos. 58 and 62, which were officially released in China in 1987, performed well during summer trials in the central and southern provinces except in Shanxi.

El Salvador — A cooperator reported that AVRDC hybrids 85202 and 85216 produced large, disease-free cylindrical heads in a winter trial.

Indonesia — During a lowland test conducted by Merdeca University at Bodag, Kecemantan Kare, East Java, an unknown yellow disease and Alternaria leaf spot greatly reduced the yield of four AVRDC hybrids.

Malaysia — Hybrid 59 obtained a heading rate of 68%, average head weight of 121 kg and yield of 41 t/ha in tests at the Agricultural Research Center, Tuaran, Sabah.
Of 11 entries from various sources, 4 AVRDC cultivars (77M (2/3)-43, 77M(2/3)-46, Hybrid 58 and Hybrid 62) were the top performers in a trial conducted at the Agricultural Research Center, Tenom, Sabah.

Nepal — Hybrid 62 was recommended for prerelease in 1987 and the Vegetable Development Division, Dept. of Agriculture attempted hybrid seed production and multiplication of the parental lines. Purity was within an acceptable range in both parents and the F_1 hybrid produced from the material line.

Philippines — From two trials with AVRDC entries in the lowlands, POP reported that generally maturity was later, soft rot incidence was lower, harvest rate was higher and head weight and yield were lower in the dry than in the wet season.
In trials conducted at the Mariano Marcos State University in Batac, Ilocos Norte, AVRDC's heat tolerant entries, particularly Hybrids 58 and 62, performed well.

Sri Lanka — In a wet season trial at the Agricultural Research Station, Maha Illuppallama, four AVRDC hybrids and three OP varieties yielded at least 30 t/ha, the incidence of soft rot was below 15%, and head quality, as well as uniformity, was good.

Thailand — AVRDC Hybrid 85216 yielded 62.6 t/ha, had an average head weight of 1.26 kg and a heading rate of 99% in a winter trial conducted at the Institute of Technology and Vocational Education, Chonburi.

BREEDING

Uniform Maturity of Open-pollinated Cultivars

To evaluate the improvement made so far, the previous four generations of maternal line selections of two Chinese cabbage open-pollinated cultivars (77M(3)-27 and 77M(3)-35) were grown together during the summer season. The coefficient of variance for days to maturity showed a clear but slow decrease in accordance with generation advancement. Maternal lines of MLS 3 generations were evaluated in the late warm season, from which selections were made to create the next cycle.

Heat-tolerant Cylindrical Head Shape

In order to develop heat-tolerant varieties with cylindrical head shape, crosses had been previously made between heat-tolerant, round-headed parents and heat-sensitive, cylindrical-headed parents. A total of 121 families belonging to BC_1F_3 and BC_2F_2 generations were evaluated in the latter part of the 1988 warm season. A considerable recovery of heat tolerance was noticed in the BC_2F_2 families of two combinations, B61 × E-9 and B61 × R1-3, but with slightly reduced frequency of cylindrical head shape. Sixty-six plants were selected from 34 families to be used in generation advancement and further back-crossing.

Inheritance of Resistance to TuMV

To elucidate the inheritance of resistance to turnip mosaic virus (TuMV), P_1, P_2, F_1, F_2 and BC_1F_1 generations of the crosses between a resistant line, 0-2, and each of three susceptible lines, E-7, E-9 and FL-9, were inoculated with two strains of TuMV. Segregation ratios obtained by visual reading and ELISA indicate that two recessive genes confer resistance to both TuMV-C_4 and TuMV-C_5.

ENTOMOLOGY

Establishment of DBM Parasite in Taiwan Highlands

Diadegma eucerophaga, a larval parasite of the diamondback moth (DBM) (*Plutella xylostella*) was imported from Indonesia and introduced in crucifer-growing areas in the highlands of central Taiwan in 1986. Surveys in 1988 revealed that this parasite is now established and has spread up to 60 km from the site of release. A parasitism of up to 50% by this parasite alone was found at certain locations. The DBM population has been reduced considerably and farmers reported very little need for insecticides.

Release of DBM parasites.

Biological Control of DBM

Biological control of the diamondback moth in the Taipei suburb of Yangminshan was attempted by release of a larval parasite, *Apanteles plutellae*, in crucifer-growing areas in the mountains. A total of 44,400 parasites were released at intervals during one season. Parasitism ranged from 12% to 55%. A cyclic pattern of the parasite and the host pest was observed. The farmers' use of nonselective chemicals resulted in the killing of parasites which, in turn, resulted in reduced parasitism and an increased diamondback moth population. Stringent efforts are needed to curb the unnecessary use of broad spectrum insecticides in order to achieve control of diamondback moth.

DBM Egg Parasite

An egg parasite, *Trichogrammatoidea bactrae*, was imported from Thailand to be introduced into Taiwan and elsewhere in Southeast Asia to combat diamondback moth on crucifers. Preliminary laboratory and field studies were conducted in 1988 to judge the potential of this parasite. The ideal temperature for parasitism was 20°C to 30°C. Parasitism occurred only during the day. Selective insecticides, such as a bacterial formulation, *Bacillus thuringiensis*, and teflubenzuron, an insect growth regulator, were nontoxic but broad spectrum chemicals such as deltamethrin were extremely toxic to *T. bactrae*. In the field parasitism of diamondback moth eggs ranged from 36.8% to 66.7%. This parasite, thus, has potential to control the diamondback moth in the farmers' fields.

Testing of *Bacillus thuringiensis* Formulations and Insect Growth Regulators

Insect growth regulators such as teflubenzuron, chlorfluazuron, PH70-23 and WL115110 provided good control of diamondback moth. These treatments increased yield significantly. There was no indication of diamondback moth resistance to any of these chemicals. All *Bacillus thuringiensis* formulations controlled diamondback moth but SAN415 was the most effective. Methanolic extract of the neem (*Azadirachta indica*) seed failed to control the diamondback moth in the field. The insect growth regulator and *B. thuringiensis* formulations are selectively toxic to the diamondback moth and other caterpillar pests and are not harmful to beneficial parasites. They are, thus, suitable for integrated pest management.

PATHOLOGY

Resistance to TuMV

Turnip mosaic virus (TuMV) is one of the most important viruses of Chinese cabbage in Southeast Asia. Infection often results in low quality heads. Five strains of the virus have been detected in Taiwan. All new Brassica accessions are routinely screened for resistance to strains C_4 and C_5 for which resistance is not commonly found. None of the 35 accessions screened this year by artificial inoculation were found resistant to these two strains.

MUNGBEAN

INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 434 seed packets were distributed to 40 cooperators in 21 countries.

Crop Releases

Laos — AVRDC lines VC 1168B, VC 2750A and VC 1560D were released because of their high yield, resistance to powdery mildew and ease for mechanical harvesting.

Philippines — POP reported that the Philippine Seedboard released BPI Mg7 (AVRDC line VC 1973-3-B-3-B) because of its high yield, resistance to Cercospora leaf spot, rust and powdery mildew.

Thailand — TOP reported that AVRDC variety VC 2768A was released by the Prince of Songkla University as PSU 1 because of its high yield and high resistance to lodging and Cercospora leaf spot.

USA — Texas A & M University released Tex-sprout (AVRDC VC 1973A) because of its early maturity, high yield, superior sprouts, moderate resistance to PM, pod borers and aphids, and high resistance to both shattering and lodging.

International Trials

IMN — A total of 15 (15th and 16th) International Mungbean Nursery (IMN) trials were distributed to 16 cooperators in 12 countries. With limited results reported, VC 3301A appears to be adapted to both spring and summer seasons and VC 3300A is adapted to the spring season.

Argentina — The National Institute of Agricultural Technology found in initial trials that the yield performance of AVRDC lines VC 1973A, VC 2754A and VC 2764A warranted large-scale testing of this new crop.

Brazil — In a trial conducted by the Federal University of Viçosa, VC 3061A and VC 3828-1-1-1-1-B yielded 1,940 and 1,800 kg/ha, respectively and had 1000-seed weights of 52 and 61 g, respectively.

Malaysia — The Selama Research Centre reported that AVRDC lines VC 1973A, VC 3890A and VC 2768A substantially outyielded the local check and had a greater 1000-seed weight in sandy loam soil.

BREEDING

New Germplasm Evaluation

Six breeding lines were introduced from Tamil Nadu Agricultural University, Coimbatore, India with potential for bruchid resistance. One line, NARP-4, was found to have resistance to bruchids at AVRDC.

Hybridization

The objective of hybridization is to combine high yield, early and uniform maturity and resistance to diseases. The population improvement program initiated in the 1986-factorial design hybridization was continued either with or without selection. Single plants selected from the cycle 3 first segregating generation were advanced by selfing and crossed to VC 2991, VC 4080A, VC 4066A, VC 3737A and VC 3764A to combine the desirable alleles into the gene pool. The performance of each population will be evaluated in the advanced generation for desirable traits. Crosses were made between NARP-4 (bruchid resistant) and five promising V and VC lines.

Yield Trials

From preliminary yield trials, promising selections have been advanced to intermediate yield trials. A number of advanced yield trial selections have high yield (1.6-1.8 t/ha), higher percent of first harvest yield and better CLS and PM resistance than checks V 3726 (1.2 t/ha) and V 2768A (1.6 t/ha). The new improved selections will be made available to AVRDC's international cooperators through the IMN. Preliminary results from thinning and no thinning in advanced yield

Mungbean trial.

trials suggest that although there were significant differences between the two treatments (no thinning had higher yield than thinning) there was no interaction between genotypes and thinning treatment. Therefore, if further evaluation confirms these results during different seasons, a decision will be made to avoid thinning since it is labor intensive.

Progressive Improvement: Evaluation of V and VC Lines

One hundred and seventy-three AVRDC improved mungbean breeding (VC lines) developed over the past 15 years were compared against 20 promising germplasm selections (V lines) which formed the basis for the VC lines. A steady improvement in yield occurred over the years. Compared to the mean yield of V lines, the mean yield of VC lines increased by 55%, 11% and 16% between 1973-77, 1978-82 and 1983-87, respectively, during the summer season. Similarly in the spring season the increase in yield of VC lines was 26%, 20% and 16%, respectively, during the same three periods. The level of CLS resistance and 1000-seed weight has also improved. However, the percent of first harvest and PM resistance did not show any appreciable improvement. There is a strong seasonal influence on the percent of first harvest. Future research should emphasize on an in-depth study on the percent of first harvest and powdery mildew resistance.

ENTOMOLOGY

Beanfly Resistance

Six lines from crosses between high-yielding mungbean breeding lines and beanfly (*Ophiomyia phaseoli*) resistant mungbean accessions, selected on the basis of insect resistance and good agronomic characters based on single plant selection, were included in a yield trial with 65 other agronomic entries. None of the beanfly-resistant lines outyielded the check cultivar. Selection VC 4036-17 gave the best yield, 1.75 t/ha, among the six lines. Its yield potential is two to three times greater than the resistant parent, V 4281, and its level of resistance is similar. It has a moderate level of resistance to Cercospora leaf spot and it matures in 69 days in the summer. This breeding line is a useful source of resistance for breeding beanfly-resistant mungbean.

Asiatic Cornborer Resistance

In a trial in summer 1988, mungbean accession V 4701 was significantly less damaged than the susceptible check VC 1973A by the Asiatic cornborer, *Ostrinia furnacalis*. The larval damage was confined to stems only. In a related test, three *Vigna sublobata* entries, TC221129, TC221167 and TC221034, were significantly less damaged than the susceptible mungbean VC 1973A. All *V. sublobata* have distinctly thinner stems and viny growth habit; these are the characters that seem to be associated with insect resistance.

Asiatic Cornborer Infestation Characteristics

Infestation of mungbean by Asiatic cornborer was studied in relation to the distance of mungbean plants from the primary host, corn, which was infested by the pest. There was a significant linear decrease in insect infestation with increase in the distance of mungbean plants from the Asiatic cornborer-infested corn. In order to avoid infestation of mungbean, the crop should be planted at least 50 m away from corn fields.

Bruchid Resistance

Seeds of 500 mungbean accessions were screened for resistance to a bruchid storage pest, *Callosobruchus chinensis*. Ten accessions were least damaged. Two entries, V 2802B-G and V 1128B-BL, were free of bruchid infestation. V 2802B-G is a selection from accession V 2802 which is resistant to *C. chinensis*. In a related study, one progeny, BR-NARP4, obtained from India and derived from a cross between mungbean and black gram (*Vigna mungo*), was free from *C. chinensis* infestation. The mechanism of resistance is now under study before utilizing these sources in resistance breeding.

Mungbean seeds damaged by the bruchid *Callosobruchus chinensis*.

PEPPER

BREEDING

Germplasm Observational Trials

Two plantings of the GRSU, which included 368 accessions primarily for seed multiplication and characterization, were also utilized by plant breeders to identify promising genotypes. Forty-one accessions were preselected for high yield potential, dense fruit set, early maturity, high pungency or other promising characteristics to be further evaluated in replicated trials under different environmental conditions.

Germplasm Evaluation Trials

Preselected genotypes from previous observational trials and advanced commercial cultivars were evaluated in replicated trials during the 1987/88 cool season and in the summer of 1988. Summer plantings were destroyed by flooding in the middle of the trial period. Two sweet and four hot pepper entries were, however, selected for their high, early yield. Eight hot pepper entries showed survival rates above 50% after flooding, whereas no sweet pepper entries achieved a high survival rate.

New Crosses and Generation Advancement

Crosses made in 1986 were advanced to the F_2 generation through evaluation and selection in the F_1 generation in 1987-88. Thirty-four accessions identified to possess resistances to important diseases were selfed under field conditions. The development of new crosses was slowed because of technical needs and the flooding debacle of the major plantings of the summer of 1988.

Purification of Local Hot Pepper Varieties

To improve uniformity and enhance the mean performance of two local varieties, Ssuchuan and MC_4, pure line selection was applied. The selected families from P_1 of Ssuchuan showed a higher level of field tolerance to virus complex and the P_2 families showed improved uniformity in plant type. The performance of MC 4 was poor in all P_1 families which were evaluated. The selfed generation of the CVMV- or CMV-resistant plants has, therefore, formed a new source population.

PATHOLOGY

Pepper Viruses in Asia: Taiwan, Indonesia, Korea

Virus diseases are among the limiting factors for successful cultivation of peppers in the tropics and subtropics. However, knowledge about the kind of viruses and their distribution in these areas is scanty. Therefore a survey of the major pepper-growing areas in Asia was

initiated in 1986. The surveys of Korea, Taiwan and Indonesia are reported here. Four viruses, namely TMV, CMV, CVMV and PVY, occur most frequently in Taiwan and Indonesia. In Korea, TMV and CMV followed by AMV and TSWV are most important. In the AVRDC pepper improvement program, TMV, PVY, CVMV and CMV should be addressed since these viruses are most important in the tropics and subtropics of Asia. TSWV also needs to be addressed as it seems to be important not only in Korea, but also, according to literature reports, in Malaysia.

Resistance to PVMV, CVMV and PVY

Resistance to TMV and PVY is readily available in *Capsicum* sp. Therefore screening has been initiated to identify materials with resistance to CMV, CVMV and PVMV, a virus widespread on pepper in tropical Africa. Two hundred and ninety-one lines, including materials with reported resistance as well as randomly chosen AVRDC germplasm (primarily wild types), were screened by mechanical inoculation followed by an ELISA test of all plants. Several lines were identified with a high number (>50%) of individuals with resistance to PVMV, CVMV and CMV. Seeds of these plants were saved for confirmation screening.

Straintyping Pepper PVY Isolates

Potato virus Y (PVY) is known to occur on pepper worldwide. Resistance to strains 0, 1, and 1.2 is available in commercial cultivars bred mainly for production in temperate regions. Twenty-nine pure PVY isolates originating from pepper in Taiwan were straintyped, using a set of differential hosts. Twenty-five isolates belonged to strain 0. The other 4 isolates did not fall into any of the known strain groups.

Pepper infected by CMV, CVMV and TSWV.

Straintyping of TMV

A search for tobacco viruses and their strains infecting *Capsicum* sp. in Taiwan was initiated. TMV positive samples were identified by ELISA and further characterization was done by host range. A set of strain differentials was used for straintyping. All of the 22 isolates obtained by four successive local lesion transfers on *Nicotiana tabacum* Xanthi were found to be tomato mosaic virus (ToMV) strains 1 and 0. The search for pepper strains of TMV continues.

Seed Transmission of CVMV

Chili veinal mottle virus (CVMV), first described in Malaysia and later found in other Asian countries in the course of our surveys, is not reported to be seed transmitted in *Capsicum* sp. The high incidence in farmers' fields prompted us to reexamine the possibility of seed transmission. Results indicated that a high percentage of seed transmission is present in certain pepper cultivars.

Purification of Pepper Viruses

Five viruses (AMV, CMV, CVMV, PeMV and TEV) were purified and antisera produced for use in disease surveys and resistance screening.

Growth Characteristics of *Phytophthora capsici*

Pepper (*Capsicum* spp.) is affected by many diseases, some of which cause serious damage. Phytophthora blight, caused by *Phytophthora capsici*, is the major limiting factor in pepper production in the warm and rainy seasons. No effective chemical control measure for this disease is available. The objective of this study was to determine the most suitable temperature for the growth of the pathogen and the most suitable inoculum concentration. A temperature range from 28°C to 32°C was found to be optimum for the growth of the pathogen. The most suitable inoculum concentration was 10_3 zoospores/ml.

Effects of *Phytophthora capsici*

Six growth stages of hot (Ssuchuan) and sweet (Blue Star) peppers were studied to determine the effect of infection with two isolates (Yang-1 and Chuan-1) of *Phytophthora capsici*. Both isolates produced a susceptible reaction in each of the six growth stages of sweet pepper cultivar, Blue Star. A trend towards resistance was shown in 13-week-old plants and 3-week-old plants of the moderately susceptible cultivar, Ssuchuan. The most susceptible reaction was found at 5 and 7 weeks after planting in the cultivar, Ssuchuan. This period will be suitable for the evaluation of resistance to *P. capsici*.

Phytophthora Blight Resistance

A total of 678 entries were screened for Phytophthora blight resistance. Three accessions, C01175 (PM 702), C00352 (PM 217) and C01176 (PI 201234), were identified as highly resistant and eleven accessions were rated moderately resistant to the disease in the trials.

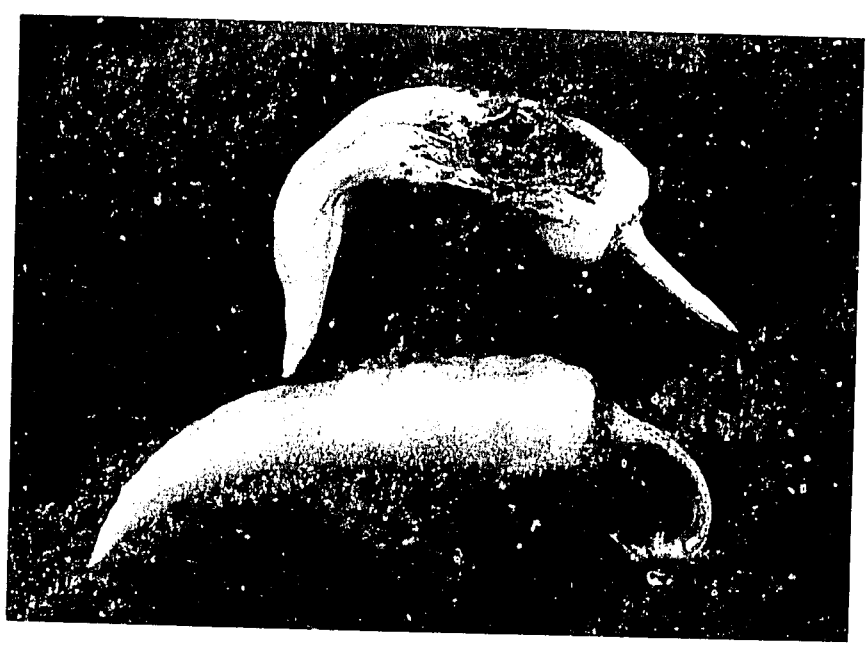
Growth Characters and Inoculation Methods of the Pathogens of Anthracnose

Anthracnose is one of the most serious diseases of peppers throughout the world. This disease is mainly caused by *Colletotrichum capsici* and *C. gloeosporioides*. In order to develop effective resistance screening techniques, experiments were conducted to understand the growth characteristics of the causal organism and the relationship between temperature and disease development.

Colletotrichum capsici grew more quickly than *C. gloeosporioides* in the temperature range of 28°C to 32°C on a potato dextrose agar (PDA) plate. This is the optimum temperature for the growth of *C. capsici*, whereas the optimum temperature for the growth of *C. gloeosporioides* is 28°C. The optimum temperature for the development of *C. capsici* on inoculated fruit was 28°C to 32°C in sweet pepper and 36°C in hot pepper. Therefore, 28°C to 36°C is the most suitable temperature range for the development of *C. capsici* in peppers. Spraying a conidial suspension on the fruit or soaking the fruit in the conidial suspension was the best inoculation method in the experiment.

Fruit Maturity and Anthracnose Development

One sweet pepper (Blue Star) and two hot peppers (Ssuchuan and PI 201234) were tested to identify the effect of fruit maturity on the disease development of anthracnose. It was found that the pathogens of anthracnose may attack both ripe and green fruit, but that the disease developed slower on the green fruit than on the ripe fruit. The fruit maturity affected the disease severity but not the incidence of infection.



Anthracnose on hot pepper (above) and healthy pepper (below).

Anthracnose Resistance

A total of 305 accessions were screened for anthracnose resistance. Two accessions, C01826 and C02220, were identified as very highly resistant. Lesions failed to develop in the fruit of these lines after artificial inoculation. Eight accessions, C00632, C00708, C00918, C01172, C01676, C01768, C01777 and C01807, were rated as highly resistant in the trials.

Race Distribution of *Xanthomonas campestris* pv. *vesicatoria*

Bacterial spot of pepper and tomato, caused by *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, is one of the most serious diseases worldwide. Different races have been found which differ in their pathogenicity on differential hosts of pepper. A total of 45 isolates from pepper and tomato have been collected from seven locations in Taiwan and identified. Of these, 27 were identified as race 1, five as race 2 and thirteen as race 3.

Screening Method for *Xanthomonas campestris* pv. *vesicatoria*

AVRDC recently selected bacterial spot and its causal organism (*Xanthomonas campestris* pv. *vesicatoria*) for intensive research because it is a serious foliar disease of pepper worldwide. In order to develop an effective resistance screening protocol, a suitable artificial inoculation method was studied. Four different inoculation methods, namely infiltration, puncturing, atomization and mechanical inoculation were investigated. The optimum inoculation concentration was 10^8 cfu/ml for the puncturing, atomization and mechanical inoculation methods and 10^5 for infiltration. Although susceptible pepper plants could develop bacterial spot symptoms by all of these inoculation methods, atomization seems to be more practical for mass resistance screening. The optimum inoculation pressure was 1.5 kg/cm^2 and the optimum inoculation plant age was the 5-7 true leaf stage. The different disease reactions in susceptible, incompletely dominant and completely dominant resistant varieties of pepper need further investigation.

Root-Knot Nematodes

Root-knot nematodes (*Meloidogyne incognita*) are reported to infect peppers worldwide, sometimes causing considerable yield loss. Resistant varieties are not yet available. Screening of germplasm for resistance to *M. incognita* was initiated. Of 112 accessions screened, 20 were classified as highly resistant, 7 as resistant and 12 as moderately resistant. The resistant lines will undergo a second confirmation screening.

PHYSIOLOGY

Generative Characteristics of *Capsicum* Plants

Forty-eight sweet peppers and 40 hot peppers were investigated for generative characteristics and fruit set under hot summer conditions.

The results obtained seem to indicate that most *Capsicum* plants are relatively tolerant to high temperature in terms of generative characteristics and fruit set. However, the overall growth of both *Capsicum* plants was sensitive to soil temperatures exceeding 30°C.

Water Uptake, Growth and Fruit Set of Peppers

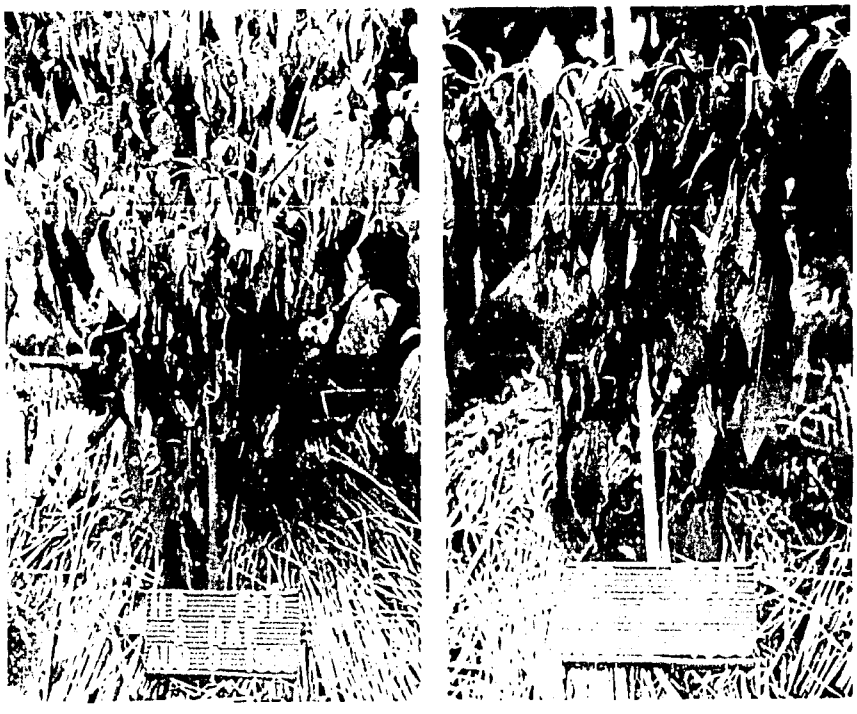
Capsicum plants were grown in three distinct seasons, and water uptake, distribution of dry matter and fruit set were examined during the 120 days of the growing period. High temperature reduced fruit set and caused less dry matter to be directed to the fruits but more to the stems. No apparent difference was found in water use efficiency between hot and sweet pepper.

Physiological Responses of Peppers to Flooding Stress

Flooding for three days reduced shoot growth much more in sweet pepper than in hot pepper. Flooding also reduced fruit yield, most likely through its detrimental effect on floral development in addition to its effect on growth. Flooding increased the activity of cellulase in the basal stem, and alcohol dehydrogenase and nitrate reductase in the fibrous root. There were less cellulase and nitrate reductase activities but greater alcohol dehydrogenase activities in hot pepper after flooding, indicating they may participate in flooding tolerance of hot pepper.

Growth Analysis and Distribution of Dry Matter

Hot and sweet pepper plants were grown in three spacings under hot summer conditions to evaluate growth and yield. There is a potential difference in dry matter production between hot and sweet pepper; hot pepper accumulated more dry matter with a large amount diverted to



Flooding damage was less severe in hot peppers (left) than in sweet peppers (right).

the fruit. The closer spacing of 30 × 50 cm^2 produced more dry matter and fruit yield per unit land area.

SOYBEAN

INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 13 sets of AVRDC Soybean Evaluation Trials (ASETs) and 1,924 seed packets were distributed to 105 cooperators in 45 countries.

International Trials

ASET — Thirteen ASET results were received from cooperators in seven countries.

Brazil — AGS 124, 217 and 324 appear to have resistance to *Pseudomonas syringae* and Septoria leaf spot in trials by EMBRAPA, CENARGEN.

Burma — In trials conducted by the IRRI/Burma program, AGS 268 (1.60 t/ha) and AGS 147 (1.43 t/ha) significantly outyielded the local check (0.53 t/ha).

Japan -- In trials at Kentsuji, Kagawa, AVRDC variety GC 84144-P-1-2-11 had a 100-seed weight of 37.5 g and a yield of 2.8 t/ha.

Liberia — The Low Land, N.C.R.D.P. Saclepea reported that six AVRDC entries significantly outyielded (from 2.9 to 3.5 t/ha) the local check (2.0 t/ha).

Malaysia — In vegetable soybean trials, yield and 100-seed weight of the leading AVRDC entries are AGS 190 (2.98 t/ha and 35.4 g, respectively) and G 9053 (1.78 t/ha and 37.2 g, respectively).

Nepal — In soybean rust screening trials, the Grain Improvement Program, Dept. of Agriculture reported that PI 200492, PI 230971, PI 459025 and TN No. 4 had no rust symptoms.

Sri Lanka — PLENTY Canada reported that AGS lines 164, 165, 184, 190, 191 and 185 had green bean yields of from 4.1 to 9.4 t/ha. AGS 292 and other entries are well accepted by the consumers.

Syria — The Ministry of Agriculture and Agrarian Reform reported that many AVRDC lines shattered badly. They require entries with a shorter maturity duration.

Taiwan, China — AVRDC soybeans AGS 129 (released as Kaohsiung No. 10) and AGS 66 (released as Tainan No. 1) constitute 41% and 9%, respectively of the total area planted to grain soybean and AGS 292 (Kaohsiung No. 1) occupies 51% of the total vegetable soybean hectarage.

Zaire — Because of the one year interval between shipment of the seeds and their planting, germination was poor and plant stand was irregular.

BREEDING

Hybridization

Continued back crossing and modified back crossing was used to develop productive, good quality vegetable soybeans. Crosses were also made to combine multiple disease resistance. Back crosses and intercrosses between selected progenies were undertaken to develop soybean rust tolerance. Specific crosses have been made to incorporate $1 \times_1$ or $1 \times_1$ and $1 \times_2$ genes into highly productive, multiple-disease-resistant genotypes.

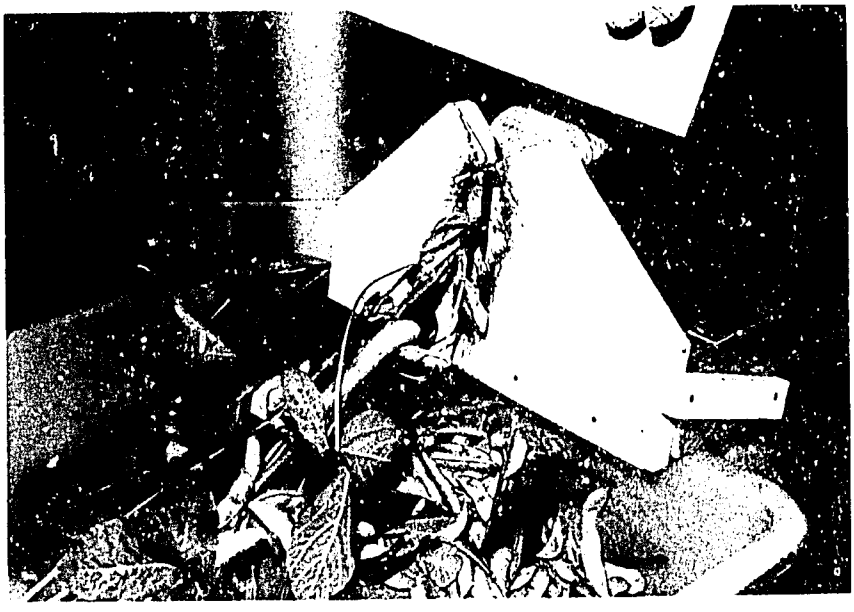
Yield Trials

The results of PYT-I and -II, IYT-I and -II with selected pedigrees and accessions during three seasons, and AYT-I and -II during the summer season are presented. Genotype 269 was consistently superior in both 1987 and 1988. Significantly higher yields than the check (AGS 129), with a combination of multiple disease resistance, has been incorporated in the improved selections. Diverse sources of resistance to bacterial pustule have been identified. The resistance reaction of all of the selected entries will be reconfirmed in 1989.

Vegetable Soybeans

Vegetable soybean varieties adapted to the tropics and subtropics are not available at present. By crossing the vegetable soybeans adapted to temperate regions with tropical grain types, through a back crossing program, vegetable soybeans adapted to tropical conditions are being developed at AVRDC. New breeding lines GC 83011-35, GC 84136-P-4-1-8 and GC 83005-9 appear to be adapted to all three seasons at AVRDC with a mean yield potential (graded pod) of 5.9, 5.6 and 5.5 t/ha, respectively. Variation in yield is attributable mainly to season (31%) and genotype × environment interaction (46%). However, variation due to genotype is predominant for 100-seed weight (56%). From the preliminary yield trial, 52 selections have a 100-seed weight (dry) of 35 g or more. They will be evaluated in IYT in 1989.

Kaohsiung DAIS, Taiwan and FCRC, Chiang Mai, Thailand cooperated in breeding vegetable soybeans. The superiority and stability of Yoshida 1, PI 85658, Vesoy No. 4, Kanrich, 7016 (check) and Nakhon Sawan No. 1 (check) was suggested among the 14 AVRDC accessions evaluated at 10 locations in Thailand. The major portion of the variation in yield (79%) is due to environment, specifically location. Variation due to genotype is only 6.3%. Therefore, selection of site, season and management practices should play a major role in increasing the yield of vegetable soybeans. The rainy season is better than the dry season for growing vegetable soybeans in Thailand. From the evaluation of 48 breeding lines, 15 selections have been chosen for further evaluation in 1989 at Chiang Mai, Thailand.



This simple labor-saving device strips the vegetable soybean pods in one operation.

Labor-saving Tools for Vegetable Soybean

The cost of production and processing is a major problem for vegetable soybean. Peeling the pod to shell the seed is a labor-intensive job. A simple tool consisting of a wooden handle with a nail head on one end has been developed to assist the laborer and enhance efficiency. Currently, the pods are stripped from the harvested plant individually. A wooden board with a 'V' slot mounted on a bench has been developed to strip the pods. Pods from the whole plant are stripped in one operation.

Soybean Rust Tolerance

The F_1 progeny of PI 459025 (a rust-resistant accession) and AGS 129 was backcrossed to AGS 129 for four cycles and all of the progenies from different backcross generations except BC_2, F_2 and F_3 were evaluated for soybean rust. Of the 1,439 pedigrees evaluated, 375 pedigrees were selected based on seed filling, yield and the percent of rust infection. All the selected entries will be evaluated in a replicated trial in 1989. Severe rust infection results in plants with empty pods. The frequency of such plants in the inbreeding generation is as high as 10%.

Among the AYT-1 and AYT-2, SRE-C-56A had the best rust tolerance but it is not the best yielder under a favorable environment. However, it has a low stable yield of around 2.0 t/ha. The tolerance is due to low rust infection consistent across seasons and years. A soybean rust tolerance index (RTI) is proposed. RTI is defined as the ratio between the yield without fungicide and with fungicide expressed in percent.

Bacterial Pustule and Downy Mildew Resistance

Of the 795 pedigrees selected in the 1987 summer season, 116 were selected based on bacterial pustule resistance, seed yield and downy mildew resistance. Screening during the 1988 summer confirmed that 11 of the 116 pedigrees were highly resistant to bacterial pustule while the rest were moderately resistant. Among the highly resistant selections, GC 86026-48 (AGS 29 × AGS 269) yielded 4.1 t/ha. These 11 selections will be further evaluated in various locations.

ENTOMOLOGY

Beanfly Resistance

All of the 306 advanced AGS soybean breeding lines were screened for resistance to beanfly (*Ophiomyia phaseoli*) in the greenhouse. Twenty-six lines in which there was no beanfly-caused plant mortality in the greenhouse were tested in the field by planting them under a large cage and releasing a large number of laboratory-reared beanfly adults. AGS 120 and AGS 122 were the least damaged. These AGS lines will be screened once again and their resistance mechanism will be studied.

In the autumn-winter of 1987-88, 2,106 soybean accessions, which had been added to AVRDC's germplasm collection during the past 2-3 years, were screened in the field for resistance to a beanfly species, *Melanagromyza sojae*, which is a major pest of soybean. Every week 300 accessions were planted in a nonreplicated trial and one-month-old seedlings were evaluated for *M. sojae* infestation. Based on the number of beanfly larvae + pupae inside the plant, 80 accessions were promising and will be screened once more in the field in a replicated trial in the 1988-89 season.

Insecticide Control of Beanfly

Among three insect growth regulators, i.e. cyromazine, BAS206538 and BAS166801, that were tested for their efficacy against *M. sojae* on soybean, cyromazine at rates of 75 to 150 g a.i./ha gave as good control of the pest as the standard insecticide, omethoate at 500 g a.i./ha. Cyromazine at 100, 125 and 150 g a.i./ha gave a significantly higher yield than the control plot where no insecticide was used. In a related, but separate test, an organophosphorus fungicide, pyrazophos, provided practically complete control of *M. sojae* on soybean when the chemical was sprayed at the rate of 0.5 kg a.i./ha per week during the seedling stage.

Biology of Stink Bug

Certain biological studies were conducted on a stink bug species, *Riptortus clavatus* (Thunberg), which is a serious soybean pest in tropical Asia, to understand its life table, feeding and reproductive behavior. Duration of the egg stage was reduced from 12.75 days at 20°C to

Stink bug (*Riptortus clavatus*).

4.13 days at 35°C and the nymphal stage from 35.47 days to 11.52 days, respectively, at the above temperatures. Among plant parts, most of the eggs were laid on the lower leaf surface of the foliage. The first instar larva did not feed but the next four instars did on soybean pods. The number of eggs laid was 25.67/female when the eggs were allowed to remain on the plant and hatch but the number increased to 72.67 female when the eggs were removed every day. Adults died in one week when they were maintained without food but lived for three weeks on the soybean plant and for four weeks when reared on dry seeds in the laboratory.

Resistance to Limabean Podborer

A total of 1,000 soybean accessions were screened by planting twice, once in September and October, for resistance to limabean pod borer (*Etiella zinckenella* Trietsche). Although certain accessions varied in their resistance rating between two plantings, five accessions were the least damaged and thus promising for future testing. In a second test in which 15 accessions were planted once each month from July to October, three accessions were less damaged in most tests. There was significant positive correlation between seed size or trichome density on the pods and podborer damage. Similar results were obtained when 24 entries from *Glycine max* and *G. soya* cross progeny were tested along with certain *G. max* accessions. Among the four insect-resistant plant introduction (PI) accessions, PI 227687 was consistently least damaged in four plantings. The higher the trichome density (between 200 and 320/6.25 sq. mm) on the pod, the greater was the podborer damage. Among the accessions with varying trichome densities on the pods, the higher the trichome density between 100 to 600/6.25 sq. mm pod surface, the greater was the podborer damage to the pods.

PATHOLOGY

Advanced Soybean Rust Tolerance Trials (ARTTs)

In the ARTT conducted at AVRDC in the spring of 1988, all eight lines tested had good yield potential, which was similar to the fungicide-protected high-yielding check cultivar, G 38. Six of the lines yielded significantly higher than AGS 181 (highly tolerant check) in nonfungicide-protected plots. Two of these lines, SRE-D-14C and SRE-D-14D, had high yields in both fungicide- and nonfungicide-protected plots.

In the ARTT at the Hualien DAIS in the spring of 1988, 4 of the 16 lines, i.e. GC 82021A, AGS 216, AGS 217 and AGS 299, yielded significantly greater than the local check cultivar, Hualien No. 1, in fungicide-protected plots. These four lines were very susceptible to rust. Two lines, SRE-C-56E and SRE-D-11A, yielded more than the local checks either in fungicide- or nonfungicide-protected plots. The percentage loss of 100-seed weight and yield loss due to rust was highly correlated (r^2 = 0.8168). The 1987 and 1988 trials indicated that line SRE-D-11A had a high level of tolerance to rust and had a high yield potential under the environment of the Hualien DAIS.

Effects of Soybean Rust Severity and Tolerance Levels on Rust-Induced Yield Loss

Four trials were conducted with rust-tolerant and -susceptible soybean cultivars in the fall of 1986 and 1987, and in the spring of 1987 and 1988. In the susceptible cultivar, TK No. 5, the loss of green leaf area (GLA) occurred earlier and was higher than that of the tolerant cultivar, SRE-B-15A, in each of four seasons. The percentage of the estimated total GLA was highly correlated to the yield potential of two cultivars in each season.

In the tolerant cultivar, SRE-B-15A, the greater GLA resulted in higher yields than in the susceptible cultivar, TK No. 5, in both seasons. This indicates a slower rate of disease development in SRE-B-15A than in TK No. 5.

The percentage of estimated total GLA loss due to soybean rust was correlated to the percentage of yield loss (r^2 = 0.8347) in the two cultivars in all four seasons. The susceptible cultivar, TK No. 5, showed a higher percentage of total GLA loss due to rust at each growth stage in each of four seasons than SRE-B-15A. Therefore, the yield loss of TK No. 5 was much higher than that of SRE-B-15A within the same treatment in the same season. The percentage of GLA of tolerant cultivars is the most important factor related to yield ability under rust epidemics.

Wild Soybeans for Soybean Rust Resistance

Soybean rust is one of the major constraints to soybean production in Southeast Asia and resistant soybean cultivars have not been identified. A total of 100 wild *Glycine* spp. accessions, received from

Wild *Glycine* sp. from Austrialia which is resistant to soybean rust.

Australia, were screened to identify sources of resistance. Fourteen accessions were rated as highly resistant based on two evaluations in two seasons. In the future these accessions may provide materials for interspecific soybean hybridization programs which may improve rust resistance.

Soybean Seed Deterioration

The deterioration of soybean seed is a major constraint to soybean production in the lowland tropics of Southeast Asia. This study was designed to determine the factors responsible for soybean seed deterioration. High temperature and relative humidity during the reproductive stage of soybean affected seed deterioration. The percentage of seeds which were nongerminated and noninfected by microorganism had a much higher negative correlation (r^2 = -0.945) to the percentage of seeds that germinated; there was a lower correlation for nongerminated seed (r^2 = -0.592) to the percentage of seeds that germinated. The effect of accumulated precipitation on seed germination was much more important than the accumulated daily average temperature. A high percentage of microorganisms, including species of *Alternaria*, *Cercospora*, *Colletotrichum*, *Fusarium*, *Macrophomina*, *Penicillium*, *Phomopsis*, and some types of bacteria were found on the seeds.

Germination of Soybean Seeds

Significant differences in germination were observed among two varieties, TK No. 5 and AGS 129, and one line, PI 459025, in two trials planted on 1 and 21 March 1988. Seed deterioration by environmental factors and by seed-borne microorganisms were the two major factors which caused poor germination of seeds harvested from the 1 March planting. Higher temperature and humidity were the major causes of poor germination in the later planting. Most of the seeds from the

March planting that did not germinate had a high level of microorganisms associated with them. Fungicide application increased seed germination of TK No. 5, but not AGS 129 in both plantings.

Bacterial Pustule Resistance

Bacterial pustule is one of the most serious diseases of soybean in Southeast Asia during the warm, rainy season. In order to confirm bacterial pustule resistance, 116 AVRDC breeding lines were inoculated in the field during the 1988 summer season. All 11 breeding lines which rated highly resistant to bacterial pustule had AGS 269 as one of their parents.

PHYSIOLOGY

Drought Stress on Vegetable Soybean

Drought stress influenced vegetable soybean yield and quality, especially pod color and blemish. Drought stress could reduce dry

matter production which resulted in low vegetable soybean yield and leaf area, and provoked poor quality pod due to light exposure. The latter possibility, however, requires further investigation, including the effect of light on chlorophyll degradation, sun burn, or senescence of pod shells.

Spacing and Quality of Vegetable Soybean

Intrarow spacings affected vegetable soybean yield differences; a close spacing at 10 × 50 cm^2 produced the highest graded pods of AGS 292, G 9053 and G 10134. The soybean plant compensated for wide spacing by increasing the number of pods. However, the increased pod was not necessarily associated with filling seed. The difference in blemish and pod number was due to variety rather than spacing. Further investigations of the physiological aspects of pod filling, and light-blemish interactions on the pod shell could provide important information about how to increase vegetable soybean yield and decrease blemish.

SWEET POTATO

INTERNATIONAL COOPERATION

Safe Germplasm Exchange

International exchange for testing of improved sweet potato breeding materials has always been restricted by strict quarantine regulations. To overcome this constraint, a virus-indexing scheme was instituted at AVRDC and an initial group of 22 AVRDC-improved lines were virus-indexed and became available for international exchange in 1987. In December 1988, eight more clones completed the procedure and are now ready for international distribution.

Germplasm Distribution

A total of 805 tubes of 22 clones of virus-indexed material were distributed to 29 cooperators in 19 countries.

International Trials

China — In trials conducted by the Jiangsu Xushou Institute of Sweet Potato, AVRDC's light orange-fleshed clone, CN 1028-15, yielded comparably to the local check. This check, Xushu 18, is a recently released, award-winning Chinese national sweet potato variety.

Kampuchea — Church World Service reported that Tainung 66, CN 1028-15 and CN 1232-9 provided the same level of yield as the local check, Loeal, in a dry season trial at Kbal Koh Research Station, Phnom Penh. Although the AVRDC clones had smaller roots, most were accepted in the market. However, CN 1232-9 was not well accepted because of its wet texture. Tainung 66 was the sweetest and CN 1038-16 had a powdery texture after cooking.

BREEDING

Hybridization Program

In the 1987-88 crossing project, priority was given to improvement of dry matter yield, eating quality and resistance to sweet potato scab.

Wet Season Yield Trials

One of the major objectives of the sweet potato improvement program is the development of sweet potatoes which are well adapted to the humid tropics. The series of wet season trials are conducted in spring and summer to select clones with tolerance to hot-wet conditions.

A total of 129 selections were entered in the preliminary yield trials and 27 selections were evaluated in the advanced yield trials. Stable high yield in both seasons and high dry matter yield were the most important selection criteria for both dessert and feed types. Among the promising selections in the advanced trials, CN 1489-89 appeared to have very stable and good performance under hot-wet conditions. It also has a dry matter content of 33%.

Utilization of Interspecific Hybrids

To explore the possibility to utilize the wild relatives for practical breeding, 5 × hybrids, obtained from the cross between 4 × *Ipomoea trifida* and sweet potatoes, were evaluated in 1986-87 at AVRDC. In order to improve the yield, the first backcross to the 5 × hybrids was conducted in 1986 and the progenies (BCF_1) evaluated in the 1987 OYT. The selections from the OYT were entered into the 1988 spring and summer PYTs.

Under excess moisture condition of this summer season, BCF_1 progenies, particularly CN 1868-6 and CN 1872-8, showed good yield performance compared with the check cultivars and indicated that they would be a promising gene source for excess moisture tolerance.

Germplasm Evaluation in Wet Season

To develop sweet potatoes which have better adaptability to hot-wet conditions, exploration of the tolerant gene source is an essential procedure to hasten or strengthen the breeding program. A total of 215 germplasm were evaluated in spring and summer trials. Thirty-three clones were selected as promising lines for their tolerance to excess moisture under tropical conditions.

ENTOMOLOGY

Search for Sweetpotato Weevil Resistance

Two sets of sweet potato germplasm accessions were screened for resistance to sweetpotato weevil (*Cylas formicarius formicarius*) in the field. In the first test a wide variation in insect infestation was observed and certain test entries were far less damaged than the

susceptible checks. However, there was significant positive correlation between root yield and weevil damage. The lower damage to certain accessions was mainly due to small root size, an undesirable agronomic character. In the second test, the accessions that were least damaged in the 1986-87 screening were also significantly less damaged than the control but there was a strong tendency for poor yielders to have less weevil damage than the high yielding accessions. Despite 15 years of continuous research, a reliable source of resistance to sweetpotato weevil has not yet been found.

Interspecific Cross Progeny Screening

Twenty entries from a progeny derived from crosses between sweet potato and *Ipomoea trifida* and which were free of sweetpotato weevil damage in 1985-86 and 1986-87 tests were screened for resistance to the sweetpotato weevil in the field. Three entries: WT57, WT59 and WT325 were free of weevil. The lesser damaged entries were the poor yielders. There was significant positive correlation between root yield and weevil infestation. Roots of the poor yielders are not as easily exposed to weevil as those of high yielders. This association of less weevil damage with poor yield is not condutive to breed agronomic cultivars with weevil resistance.

Alternate Hosts of Sweetpotato Weevil

During the past 15 years of observations at AVRDC and in Penghu Island, five species of *Ipomoea*, in addition to sweet potato, that harbor sweetpotato weevil, i.e. *I. accuminata*, *I. aquatica*, *I. hederacea*, *I. obscura and I. sinensis*, have been found. All species, except *I. hederacea*, are new records of alternate hosts of the sweetpotato weevil.

Sweetpotato weevil larva feeding inside the stem of *Ipomoea acuminata*.

Root Characters and Weevil Infestation

Because of our inability to develop a cultivar resistant to sweetpotato weevil, sweet potato accessions with varying levels of dry matter content were tested to determine whether this constituent of the sweet potato root has any correlation with weevil infestation. Thirty accessions, differing in dry matter content ranging from 15% to 42% were tested for weevil infestation. There was no statistically significant correlation between dry matter concentration and weevil infestation, however, entries with higher dry matter tended to be lesser damaged by the weevil. A similar correlation was observed in our past tests with a limited number of accessions. No such tendency was apparent between sugar or protein content and weevil infestation but accessions with higher beta carotene tended to have greater weevil damage.

Integrated Pest Management of Weevil

An integrated pest management (IPM) technique, based on the use of crop rotation, cuttings free of sweetpotato weevil for planting a new crop, control of alternate *Ipomoea* hosts, stirring of soil to cover cracks, and continuous trapping of weevil males in sex pheromone-baited traps, was utilized to control sweetpotato weevil in farmers' fields in Penghu Island. The details of the technique were explained to the farmers from two villages who participated in this test. During the season, a total of 21,129 males in Jungtwun village and 16,348 in Husyi village were captured in pheromone traps that were set in the farmers' fields. The weevil damage in Jungtwun ranged from 0 to 46.4% of roots with a mean of 3.65% and 47 out of 55 farms had less than 10% root damage. There was no weevil damage in the sweet potato harvest of 31 farms. The weevil damage to roots in Husyi varied from 0 to 4% and 31 out of 38 farms had no weevil infestation at all. These results show considerable reduction in weevil infestation due to the adoption of IPM techniques developed by AVRDC.

Sweetpotato Vine Borer Resistance

Eight promising progenies from crosses between an accession resistant to sweetpotato vine borer (*Omphisa anastomosalis*) and high yielding breeding lines were screened along with AVRDC's elite clones for resistance to the vine borer. Three entries, CN 1759-47, CN 1759-330 and CN 1759-635, were among the least damaged and had yield potentials substantially higher than the resistant checks but still lower than the standard agronomic breeder line. One entry showed tolerance to vine borer. Among elite clones, CN 1367-2 was the least damaged but its damage was substantially higher than the resistant checks.

Sex Pheromone Studies with Sweetpotato Vine Borer

Synthetic sex pheromones of eight species of closely related insects were tested to determine the response of sweetpotato vine borer to these chemicals. The sex pheromones of pyralids *Ostrinia nubilalis*, *Chilo suppressalis*, *Galleria mellonella*, *Anagasta kuehniella*, *Ephestia elutella*, *E. figuliella*, *E. cautella* and *Plodia interpunctella* were not effective against the sweetpotato vine borer which is also a pyralid. The sex pheromone of the vine borer appears to be a new compound.

Sweetpotato Vine Borer Alternate Hosts

In a survey of alternate hosts of the sweetpotato vine borer, insect larvae were found feeding inside the stems of *Ipomoea pes-caprae*, a convolvulus plant that grows on sandy seashores. This plant is very sturdy and has a hard woody stem inside of which the vine borer larvae feed.

PATHOLOGY

Virus Elimination and Indexing

The present virus-elimination scheme, a modification of the one described in the *1987 Progress Report*, uses a two-month heat treatment (37°C) followed by meristem tip (0.3 mm) culture for virus elimination. For virus indexing, two ELISA tests are conducted on young plantlets using antisera to FMV, YDV, LV, SPV II and MMV and two graftings of mature plants to *Ipomoea setosa* and *I. nil* (as the graft recipients). Ninety-one lines from Thailand, 8 AVRDC breeding lines (set 2) and 18 AVRDC accessions underwent these procedures in 1988. The Thailand lines were heavily infected with virus and only 45 virus-free lines have been produced so far. Similarly, only 12 virus-free AVRDC accessions have been obtained. However, all AVRDC breeding lines are now virus free. All virus-free lines are ready for distribution in tissue culture form.

Virus symptoms caused on *Ipomoea setosa* after grafting with a scion infected by SPYDV and SPFMV.

Comparison of Meristem-derived and Field-propagated Plants

Stem cuttings of meristem-derived and field-propagated sweet potato plants were planted at AVRDC in a nonreplicated trial to obtain an indication of the vigor of the meristem-derived plants and of possible mutation of morphological characters which might have occurred as a result of tissue culturing. The meristem-derived plants did not differ in overall morphology from nonmeristem-derived plants and generally had higher yields than the field-propagated plants. A few of the meristem-derived clones were found to have become reinfected with virus (primarily FMV) in this first planting.

Efficiency of DAS ELISA

The DAS ELISA test which is presently used for virus indexing at AVRDC was examined for its efficiency in separating healthy from virus-infected sweet potato plants. The distribution of OD values was not bimodal. The values of healthy sweet potatoes were generally clustered around 0, tailing off to the right, particularly in the case of MMV and SPYDV. The OD values of diseased sweet potato were scattered over a wide absorbance range, possibly indicating different virus concentrations ranging from very low to very high in the host plant. The OD values of virus-infected plants overlapped or were very close to the values of the healthy plants. In order to avoid false negatives, a negative/positive threshold of 2 × OD healthy plants was adopted.

Virus Antiserum Production

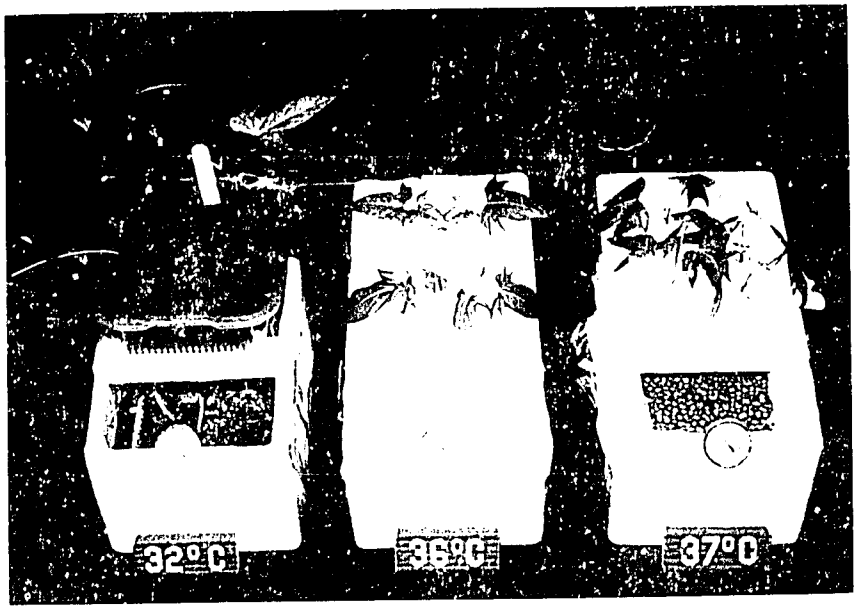
Three sweet potato viruses were purified for antiserum production. The virus yields were 1.4-3.4 mg, 1.5-3.5 mg and 2.4-2.5 mg per 100 g of infected leaves for MMV, SPLV and SPYDV, respectively. Virus-infected plants could be clearly separated by DAS ELISA from healthy plants with these antisera.

Virazole and Heat on SPLC

Sweet potato leafcurl (SPLC) is a disease for which viral etiology has been implicated even though virus particles have not been found so far. Antiserum is thus not available and indexing by ELISA is not possible. Several treatments were investigated which might reduce the incidence of SPLC. Meristem tip culture, which is routinely used in the present scheme, was found to be effective in eliminating SPLC symptoms in 80% of the treated plants. When stemtips were treated with 500 mg/l virazole, 86% of the resulting plantlets showed no SPLC symptoms. The results of the heat treatment were not conclusive.

Improvement in Heat Treatment for Virus Elimination

Treatment at 37°C for 2 months has been recommended for the elimination of certain sweet potato viruses. However, according to our experience, potted sweet potato plants (in sand or 1:1:1 sand:soil: vermiculite) showed poor growth and often dried and wilted. The potting



Supporting media for heat treatment (37°C) of sweet potato. Temperature of nutrient solution is indicated beneath apparatus.

substrate became dry easily. Three different hydroponic systems using 1/2 strength nutrient solution (either alone or amended with hydroponic pellets) in styrofoam containers covered with styrofoam lids or with fitted baskets containing rice husks were tried as an alternative of soil or sand potting mixture. The temperature of the nutrient solution covered by baskets containing burnt rice husks averaged 5.4°C lower than the room temperature and good plant growth was achieved. This support medium has now been adopted for routine use.

Media for Meristem Tip Culture

The recently proposed Gamborg B-5 medium was compared with the AVRDC standard medium (Love and Rhodes 1985) followed by Kuo et al. (1985) medium. On Gamborg B-5 medium, 27% of the meristems regenerated into plantlets compared with 55% on the AVRDC standard medium. Callus formation on Gamborg B5 medium was, however, less than on the AVRDC standard medium.

Different Media for Growing Out Tissue-cultured Plantlets

In the present virus elimination and indexing scheme, regenerated plantlets are routinely transferred from the test tubes to Jiffy pellets before being planted in pots containing the standard potting medium (1:1:1 sand:soil:vermiculite). Different growing-out media i.e. 1/2 and 1/4 strength nutrient solution with rice husks (natural or burnt), 1:1 sand:soil, and 1:1:1 sand:vermiculite:soil, were tested to find a growing medium superior to Jiffy pots. The 1/4 strength nutrient solution with rice as the supporting medium and the 1:1 sand:vermiculite medium were found to give the lowest values for fresh root and whole plant.

weight. The Jiffy pellets were found to give the highest values, followed by the 1/2 strength nutrient/burnt rice and 1:1:1 sand:vermiculite:soil media.

Seed Transmission of Viruses in Indicator Hosts

The absence of seed transmission of sweet potato viruses in indicator hosts used for virus indexing must be guaranteed and has never been verified previously. Therefore, seeds of the indicator plants *Ipomoea nil* and *I. setosa*, infected with the sweet potato viruses by mechanical inoculation or by grafting, were collected and grown out in an insect-proof screenhouse. Seedlings were visually observed for symptoms and tested by ELISA. Seed transmission could not be detected.

Improvement of Sweet Potato Scab Resistance Screening in Greenhouse

The stem and petiole (SP) percent disease area rating system (described in the *1987 Annual Report*) was adopted for greenhouse screening for scab resistance. However, this rating system is complex and time consuming. Disease severity, using a 0-8 scale, was compared this year with the SP rating and it was consistent with the resistance levels evaluated previously. The method is more convenient because of less time and effort involved in the rating procedure.

Scab Confirmation Screening Under 'Seminatural' Field Conditions

Disease resistance, once identified from greenhouse screening and field observations, needs to be confirmed to verify if resistance is stable. Thirteen clones previously rated as highly resistant, were again identified as highly resistant. One introduced cultivar from Tonga, I 1189, which was reported as resistant to scab elsewhere, also was rated as highly resistant. The cultivar I 55 was rated more susceptible than the previously used highly susceptible check cultivars and should be used in future resistance screening.

Preliminary Screening for Scab Resistance in Field and Greenhouse

In the past, preliminary screening for resistance to scab was only conducted under field conditions using 'seminatural' infection. This year, the preliminary screening was conducted in two steps: seminatural field screening at AVRDC followed by a confirmation screening of all lines in the greenhouse under inoculated conditions. From cuttings of 136 lines; 55 were rated as highly resistant and 43 as highly susceptible under field conditions. When these same lines were inoculated in the greenhouse, only 16 were confirmed as resistant.

Confirmation Screening for Scab Resistance in the Field

Eleven breeding lines and 15 accessions were rated as highly resistant when evaluated by two rating methods.

Sweet Potato Scab Development Under *In Vitro* Conditions

The potential of screening sweet potato in tissue culture for sweet potato scab resistance was investigated using two highly susceptible and two highly resistant lines. Under test tube conditions, the two reaction types could be clearly differentiated. A significantly higher infection percentage was found on the two susceptible lines than on the two resistant lines. On the susceptible lines, callus symptoms were observed which were absent in the two resistant lines. Callus formation was most pronounced at 28°C. Judging from these observations, callus formation may be a useful characteristic when rating cells for resistance. Further testing of this method is needed before being adopted.

PHYSIOLOGY

Growth Analysis in Different Seasons

Ten improved sweet potato clones were planted in four distinct seasons to examine the effect of environmental conditions on elements which contribute to yield. Two major determinants were total dry matter production and partition of assimilate to the storage root. The partition of assimilate seemed to play a decisive role. The inclined diversion of dry matter to the storage root was related to sink strength. This trend was subjected to change with environmental conditions: most likely high temperature and flooding.

Temperature Effect on Rooted Leaf-cuttings

The effects of temperature on storage root yield and growth of rooted leaf-cuttings were investigated. The early growth of rooted leaf-cuttings exposed to high temperature resulted in both poor storage root formation and yield of I 424 and CN 1108-13. The late growth of rooted leaf-cuttings exposed to high temperature resulted in poor bulking of the storage roots of CN 1108-13, CN 1028-15 and CN 1517-139. There was varietal difference in the thermoperiodic requirement for storage root formation in sweet potato.

Growth Regulator Effects

Brassinolide and epi-brassinolide are effective in promoting growth of plantlets under *in vitro* conditions, whereas BAS 106 is effective in retarding growth. They may be utilized in manipulating plantlet growth under *in vitro* conditions for the purpose of storage/distribution of plantlets. The role of these growth regulators in the formation of storage roots and the sink strength is less clear.

TOMATO

INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 2,405 seed packets were distributed to 168 cooperators in 65 countries.

Crop Releases

Thailand — Thai scientists bred two new varieties, Seedathip I (AVRDC's CL 1131-0-0-13-0-6 × local Seeda) and Seedathip II (CL 1131 × Seeda) which have been officially released by Thailand. Seedathip I is heat tolerant and early maturing and Seedathip II is also heat tolerant and tolerant to Cercospora leaf mold.

Western Samoa — IRETA, University of the South Pacific reported that the Dept. of Agriculture, Forests and Fisheries has released Alafua Early (CL 2729-0-2-1-12-0), Alafua Winner (CL 5915-93D4-1-0) and Alafua Large (CL 5915-206D4-2-2-0). These three cultivars are resistant to bacterial wilt, do not require pruning and their taste, texture and firmness are acceptable for eating fresh or cooked.

International Trials

Costa Rica — CINDE reported that AVRDC PT 4165 and PT 4172 combined very high yields with fairly good processing qualities in hot, dry area trials at Guancaste.

Indonesia — In hot season trials at Blendung, Kulonprogo, AVRDC lines CL 5915-206-2-2-0 and CL 5915-153-3-3-0 provided marketable yields of 66 and 53 t/ha, respectively, compared to only 20 t/ha for the commercial cultivar, Peto 86.

Fiji — The Sigatoka Research Station reported that PT 862, PT 913, PT 3025 and PT 870 were preliminarily selected in a bacterial wilt/heat tolerance test.

Saudi Arabia — The Qassim Agricultural Research Center reported that all 12 AVRDC lines and hybrids significantly outyielded the check. CLN 363DC1F2-344-0-0 and FMTT 32, with marketable yields of 80 and 79 t/ha, respectively, are suitable for local cultivation.

Senegal — The Institute for Agricultural Research reported selection for advanced trials of AVRDC's CL 5915-93-1-0-L-2-0 and CL 5915-206-2-2-0-4 because of good yield and medium fruit size and CLN 229-4-1-4-1-1 and CLN 236-26-3-3-15 for high yield and nematode resistance.

Sri Lanka — The Dept. of Agriculture at Peradeniya selected five AVRDC breeding lines for further testing because of their good marketable yield, ranging from 20 to 31 t/ha, excellent resistance to bacterial wilt, good to excellent fruit setting ability and resistance to fruit cracking.

BREEDING

Crosses and Breeding Populations

A total of 248 crosses were made to further improve the most advanced tropical breeding lines for various traits such as fruit-set, fruit size, firmness and additional resistance to diseases, especially black leafmold (*Cercospora fuligena*), which has been reported in the past by our Southeast Asian cooperators and which has become serious at AVRDC and in the farmers' fields in the last two years. In addition, 8 double cross and 20 backcross families for the tropical tomato and 7 crosses for resistance to potato virus Y (PVY), were developed in 1988.

New biparental combinations were made to develop hybrid cultivars with varying objectives in mind. On the processing tomato, we continued to look for hybrids with high yield, good concentrated set and firm fruits for once-over mechanical harvesting, heat tolerance, resistance to the major diseases such as bacterial wilt (BW), tomato mosaic virus (ToMV) and nematode and acceptable processing quality. The fresh market hybrid combinations aim to combine disease resistance (BW, ToMV and nematode) with heat tolerance and desirable horticultural traits such as improved fruit size, firmness, crack resistance and good fresh taste. The cherry type hybrid combinations attempted to combine disease resistance (as in the above), heat tolerance, crack resistance, and desirable cherry tomato characters such as large number of fruits of uniform small size per cluster, nice round shape, firm fruits, thick pericarp with relatively tough skin and sweet taste.

In addition to the above, the program advanced and/or selected desirable progenies from 91 breeding populations originating from different sources: backcrosses, single seed descent families, double crosses, triple crosses and F_4-F_6 lines from single crosses.

Performance of New Germplasm

Four evaluation trials of newly introduced genetic materials were carried out in 1988.

None of the introduced processing cultivars outyielded the best AVRDC processing hybrids. PT 4026 (79 t/ha) and PT 4172 (74 t/ha) showed the most concentrated maturity and substantially outyielded the check varieties TK-70 (9 t/ha) and TN-3 (46 t/ha) at first harvest. Their final yields, however, were statistically similar.

Two determinate fresh market introductions, E 334 and Celebrity, showed the best performance with marketable yields well over 100 t/ha, slight to no fruit cracking and good to excellent vine cover. However, fruits of these cultivars were generally soft.

Among the indeterminate fresh market introductions, Bermuda, GC 775 and Jackpot were the best, all yielding over 100 t/ha and outyielding the check cultivar, KY 301, by about three to four times. In general, the best introduced cultivars had large fruits weighing over 200 g apiece. One entry, GC 775, had very firm fruits. The best entries also showed good foliage cover, affording better potential protection from sun scorch damage to the fruits.

With the exception of differences in lycopene (which controls external color) and β-carotene contents, the Beta gene-carrying derivatives of some fresh market cultivars did not differ appreciably in performance from their normal counterparts indicating that the Beta gene has no eminent undesirable effect on productivity.

Bacterial Wilt Resistance

Two advanced breeding lines showed high levels of resistance to bacterial wilt and were also selected for good performance under hot, humid conditions in a separate trial. These lines are also already homozygous for rootknot nematode resistance, thus giving them broader protection to soil-borne diseases.

Although one of the parent stocks among the processing hybrids is usually BW susceptible, the levels of BW resistance obtained in the ensuing hybrids were as good as in the highly resistant stocks, L 285 and CL 65-349, partly indicating nonadditive action of the gene(s) for resistance

The most resistant fresh market hybrids were from crosses among BW-resistant parent stocks. Two of these hybrids, FMTT 114 and FMTT 95, are also resistant to rootknot nematode and had fair marketable yields during the hot summer season, with fruit sizes at least twice as large as the best heat-tolerant tropical tomato could typically produce during this period.

The mortality rates due to BW infection among the cherry tomato hybrids were generally higher than in other materials tested in 1988. Only one combination, CH 108, compared favorably with the highly resistant checks.

FMTT 95 fresh market tomato which is resistant to bacterial wilt and rootknot nematode.

Tropical Breeding Lines

Five new breeding lines were chosen for further evaluation in the 1989 summer season. The advantages of the new selections over the heat-tolerant checks included improved fruit firmness and nematode resistance.

A number of promising cherry tomato hybrids carrying acceptable levels of heat tolerance were selected from the observational trial. The best ones ranged in yield from 22 to 26 t/ha, greatly outyielding the check hybrid, Girl Sweet, which yielded only 8 t/ha; they also had lesser or no fruit cracking tendencies. These hybrids also carry resistance to tomato mosaic virus, some levels of resistance to bacterial wilt and also some discernible resistance to bacterial leafspot.

None of the nematode-resistant determinate lines in the preliminary yield trial outyielded the check line, CL 5675, although one line did outyield the other check, CL 5915-153, previously the most heat-tolerant line in the breeding program.

The best nematode-resistant indeterminate tropical lines did not outyield the heat tolerant check, CL 915-206-2-2-0-4, but were better than King Kong, a fresh market hybrid whose seeds are commercially available to the tropical farmers. The new selections are also firm-fruited, crack-resistant and carry excellent levels of bacterial wilt resistance.

The best relatively large-fruited fresh market hybrids yielded from 29 to 32 t/ha during the hot wet season. The most outstanding entry, FMTT 138, also showed better apparent resistance to bacterial leafspot and good foliage cover.

New Processing Tomato Hybrids

The best new hybrids in the 1987 and 1988 observational trials showed better concentrated maturity, total marketable yield and fruit firmness compared with the check cultivars. However, with the exception of a few hybrids, most had shortcomings in fruit size and solid content. The best of these new hybrids are currently undergoing further evaluation.

Three hybrids showed comparable heat tolerance as the heat tolerant check, TN-3, in the 1987 late summer preliminary trial. PT 4121 appears to be the most promising of the new high-yielding hybrids because of its firm and large fruits and good vine cover.

PT 4121 and PT 4172, both outstanding entries in the 1987 late summer preliminary trials, and PT 4026 were the best entries in the 1987 Batch I advanced trial. They had advantages over the checks in terms of higher final yield, better concentration of maturity, improved firmness (except when compared to TN-2), fair to good vine cover, good vine compactness and generally acceptable processing qualities. Again, PT 4121 produced the largest fruits among the outstanding hybrids.

In the Batch II advanced trial conducted towards the cooler period, none of the best hybrids outperformed TN-2 in concentration of maturity although their final marketable yields were significantly higher than the latter's. Other advantages of TN-2 over the new hybrids were better fruit firmness, larger fruit size, better color and higher soluble solids.

ENTOMOLOGY

Tomato Fruitworm Resistance

Nineteen families of a BC_3F_4 population, derived from a cross between a high-yielding tomato breeding line and a fruitworm (*Heliothis armigera*) resistant *Lycopersicon hirsutum* f. *glabratum* parents, were screened for resistance to tomato fruitworm. The fruit damage ranged from 14.0% to 53.3%. Eleven plants having good horticultural characteristics and fruitworm resistance were selected for evaluation of yield potential.

Tomato Fruitworm Control

Three insect growth regulators, chlorfluazuron, BAS 166801 and WL115110, and one *Bacillus thuringiensis* formulation, SAN415, gave excellent control of tomato fruitworm. All these formulations are toxic to the pest but are nontoxic to beneficial parasites and predators. They are, thus, suitable for an integrated control of tomato fruitworm.

PATHOLOGY

Resistance to CMV and Leafcurl Virus

Five viruses, TMV, PVY, CMV, tomato leafcurl virus and TSWV are important on tomato in the tropics. Resistance to TMV is being routinely incorporated into AVRDC breeding lines; resistance to PVY has been

CMV-infected (shoe-string) tomato leaves (right) and healthy leaves (left).

found in two *Lycopersicon hirsutum* accessions and is being investigated by the breeders. A total of 113 lines were screened for resistance to CMV and five lines for resistance to leafcurl virus. The lines consisted mainly of those with reported resistance to these two viruses and of wild types. None of the lines were found to be resistant.

Further Characterization of Leafcurl Virus

By using C-DNA hybridization, the Taiwan tomato leafcurl virus was tested for its relationship with the tomato yellow leafcurl virus (TYLCV) prevalent in the Near East. The Taiwan probes reacted, although weaker, with the TYLCV probes, indicating a certain percentage of nucleic acid homology and thus a close relatedness of these two viruses.

PHYSIOLOGY

Growth Analysis of Tomatoes Applied with Growth Regulator

Application of growth regulator at anthesis or two weeks after anthesis increased fruit yield of heat tolerant CL 5915-206 and FMTT 3. The pronounced effects were observed on clusters of high order position. CPA application increased harvest index. There was a balanced effect of the fruit number and the fruit size due to different timings of CPA application; CPA application at anthesis produced large but less fruits without seeds, whereas CPA application at two weeks after anthesis produced more but small fruits with some seeds.

PRODUCTION SYSTEMS PROGRAM

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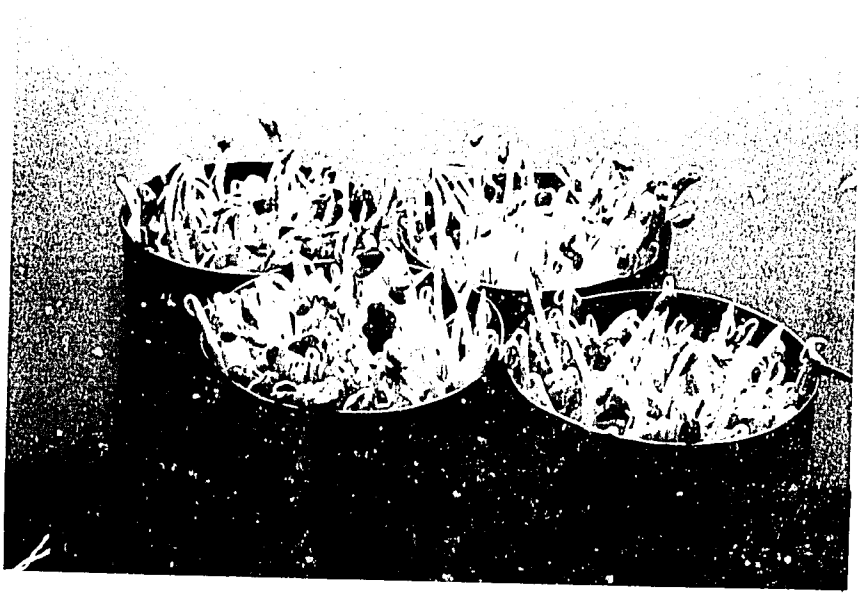
CHEMISTRY

Sweet Potato Starch Digestibility

The traditional practice of sweet potato-based feed for hog raising generally requires cooking to improve the feeding efficiency. A screening method based on CO_2 gas production by yeast fermentation of sugars obtained from pancreatic digestion of sweet potato starches was developed. This method is promising for detecting easily digestible varieties. Two additional AVRDC improved lines, CN 1108-13 and CN 1448-59, were found to be easily digestible by this method. Analysis of sweet potato samples harvested from different seasons revealed that roots produced during wet seasons are generally lower in starch digestibility. A significant interaction between genotypical and seasonal effects was also noted.

Methionine for Mungbean Sprout Production

The application of DL-methionine for mungbean sprout production was studied. Methionine treatment was found to be effective to improve the quality, and to obtain a shorter root length and higher hypocotyl diameter of mungbean sprouts. Unlike the physical pressure method of sprout production, methionine treatment also promotes the growth of mungbean sprouts and may shorten the required growth period. Genotypical differences in response to methionine treatment were observed. Thus, information on sprouting properties of mungbean varieties can be useful for processors. For practical purposes, it is recommended to add methionine only in the soaking water. Since mungbean sprouts respond differently to methionine than to physical pressure, it is speculated that methionine may play a biological function, other than serving as an ethylene precursor, during the sprouting process.



Mungbean sprouts.

Compositional Analysis of Vegetable Soybean

Near infrared reflectance spectroscopy (NIRS) was used to estimate the major constituents of vegetable soybean. This technique was useful for the determination of moisture, protein and oil contents but not accurate enough for starch and sugar contents of vegetable soybean samples without branding. Modification of the determination procedures indicated that NIRS could be used as a primary screening technique to select samples of interest. The selected samples, however, need to be analyzed by conventional methods for confirmation.

CROP MANAGEMENT

Climatic Effects on Sweet Potato Yield

Field experiments were conducted to evaluate the importance of air temperature, solar radiation and precipitation on root yield and yield components of sweet potato, and to identify optimum planting dates for the different sweet potato varieties, i.e. Tainung 66, CN 1108-13 and CN 1345-8. Planting was done year-round, except in June and July, commencing on 15 January and at 10-day intervals thereafter. The results showed that temperature had significant effects on root size, number of roots per plant and plant survival rate; whereas, solar radiation had a positive relationship with root size only. Precipitation showed a significant effect on root size and number of roots per plant. Multiple nonlinear regression analysis indicated that 81% of the total variation in yield was explained by the variation in these three climatic factors. In general, the optimum planting date for the crop was between 16 and 26 March. Planting the crop during this period provided the plants with cool weather in March and early April during the root formation stage, and with warm weather in late April and May during the root enlargement stage. These climatic conditions enhanced root formation and stimulated root enlargement which resulted in high yield.

Spacing Effects on Sweet Potato

Many improved sweet potato varieties have been bred and released by various research institutes, including AVRDC. Due to difference in plant growth habits, the AVRDC standard planting space of 0.3 m intrarow and 1.0 m interrow may not be suitable for these improved varieties. A program has been initiated to identify the optimum spacing for the improved varieties grown in different seasons.

Solarization Against Soft Rot in Chinese Cabbage

Bacterial soft rot, caused by *Erwinia carotovora*, is one of the most destructive diseases of Chinese cabbage in the hot and humid season. At present there is no reliable chemical control measure and not a single variety of the crop is resistant to the disease. By using a solarization method, in which the Chinese cabbage beds were covered and solarized by clear plastic sheets for 4 to 14 days, the soft rot incidence was

suppressed at the early growing stage, for the first four weeks after transplanting.

Mulching and Shading Effects on Sweet Pepper

The most common mulching materials in Taiwan, i.e. black and silver-coated polyethylene (PE) sheets and rice straw, were used for sweet pepper (*Capsicum annuum* L.) during winter and summer trials. In the winter trials, both rice straw and PE mulch produced a highly significant marketable yield, total fruit yield and fruit size over the check. However, in the summer trials the PE mulch resulted in stunted plant growth and plant mortality whereas the rice straw mulch produced a highly significant marketable yield, total fruit yield and fruit size compared to the check.

Sweet pepper plants shaded with purple plastic sheets and green nylon net produced significantly higher marketable and total fruit yields compared to the check. The high yield of the shaded plants was attributed to the good plant development and larger fruit size.

CROPPING SYSTEMS

New Vegetables

This study gathers additional information on vegetables under tropical conditions for AVRDC's nutrition garden project, cooperative programs, and for the Center's international cooperators. The second set of 15 new vegetables was selected in 1986. A total of 595 varieties of these new crops have been collected through December 1988. Observational trials of some of these crops were conducted during 1988. Results showed that 7 broccoli; 5 big-fruited and 6 small-fruited cucumber; 10 eggplant; 8, 12 and 12 lettuce for summer, autumn, and spring planting seasons, respectively, and 8 spinach entries outperformed other entries. These entries will be included in advanced yield trials for further confirmation and nutritional studies.

Garden Program

Garden research has focused on the information on individual crops and the possible interactions between crops since 1987. The characteristics which might be used in the garden design from 146 varieties of 49 vegetables have been recorded from the school and home gardens and placed in the Tropical Vegetable Data File (TVDF). The noncirculating hydroponic system was adopted for urban home garden use, and 57 varieties of 29 vegetables have been tested and were found to be suitable for this system. A pesticide-free garden and an aquatic garden were initiated in 1988 to evaluate vegetables under these garden production systems.

Vegetable Grouping Methods for the Tropics

In order to compile the information collected from the Garden Program in a form to be easily applied for choosing a crop for a particular locality or purpose, the methods for vegetable grouping based on their attributes for the tropical areas were studied. A rating method was tested for heat tolerance levels of vegetables and their varieties grown in the Garden Program based on the season's temperature range. The results showed that this kind of classification should be detailed to the varietal level, due to the substantial varietal differences. However, there is a need for information on a dry and hot environment which is lacking at AVRDC to build up a complete vegetable data base for the tropics.

Intercropping Sweet Potato and Soybean

This study was the second of a series of trials which examine the effects of genotype, spatial arrangement and relative planting time of sweet potato and soybean on competition between these two crops in intercropping, in order to minimize this competition and to increase the intercrop productivity. Two soybean varieties (AGS 66 and AGS 129), two sweet potato entries (TN 66 and TN 67), and two soybean spacings (50 × 10 cm with one plant per hill and 100 × 10 cm with two plants per hill) were studied in the autumn trial. The results indicated that the effects of these agronomic management practices on yields of sweet potato and soybean in intercropping differed from those of the summer trial. Sweet potatoes TN 66 and TN 67 had similar performances and soybean AGS 129 was more suitable than AGS 66 for intercropping. The row number of soybean per bed did not affect the yield of either sweet potatoes or soybeans in intercropping. Sweet potatoes seemed to dominate in this trial, however, they were also affected by the

Urban noncirculating hydroponic gardens.

associated soybean. Hence, it appears that the potential for improving the total productivity of this combination in the autumn planting season is not great. Nevertheless, the vigorous growing type of soybean could be more suitable for this intercrop in the autumn planting.

N Balance in Cropping Systems

Nitrogen is one of the most important elements affecting plant growth. Hence the nitrogen input-output analysis was included in the study of cropping patterns to develop the principles for efficient utilization of nitrogen through different crop sequences and management practices. Results of the Improved Cropping Systems study from 1985 to 1987 were analyzed and compared for N balance in different cropping patterns. It was found that soybean had a better N-fixation ability than mungbean. However, mungbean seemed to make a greater contribution to the N balance for the following crop. The summer planting of sweet potato contributed a great amount of N to the successive Chinese cabbage crop. This could be an important role for the sweet potato in cropping systems under tropical conditions and warrants further study. The management techniques needed for vegetable production, namely compost application and rice straw mulching, might have improved the fertility of the soil. Therefore, incorporating vegetables in cereal-based cropping systems could be one of the effective methods to achieve sustainability in agricultural production.

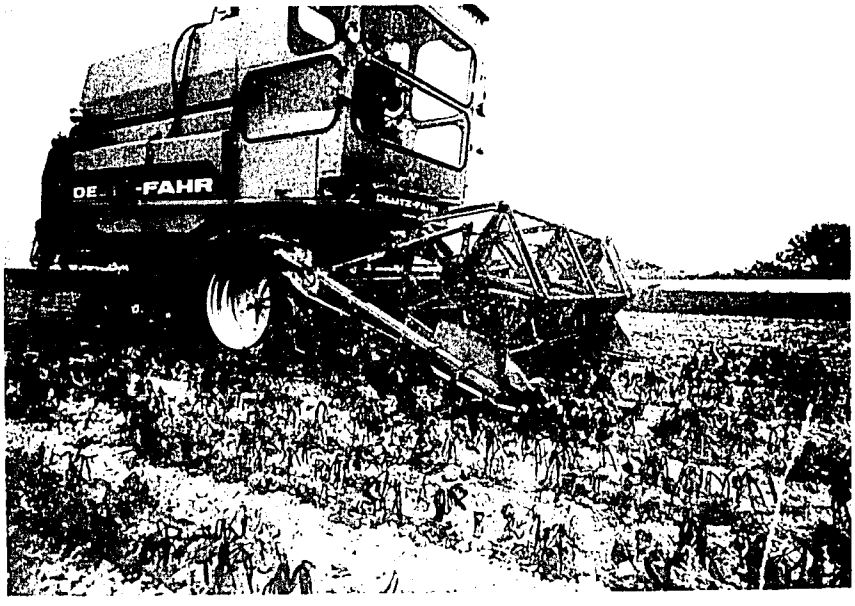
ON-STATION TESTING

Cooperative Projects with Local Institutes

AVRDC's promising material, and the selected varieties of new vegetables (including cauliflower and snap bean) were tested under different environments in Taiwan, in cooperation with the national programs, through Regional Yield Trials (RYT). In 1988 vegetable soybean AGS 292, which was released as Kaohsiung Selection No. 1 through this process, made up 51% (3,919 ha) of the total vegetable soybean hectarage and soybean AGS 129 (Kaohsiung Selection No. 10) constituted 41% (3,690 ha) of soybean hectarage in Taiwan. Entries which outperformed the check entries in the RYT during 1987 and 1988 are: soybeans — AGS 208 and AGS 215; mungbeans — VC 3738A, VC 3890A, VC 3853A, VC 3901A and VC 3737A; processing tomatoes — PT 4121, PT 4165 and PT 4172, fresh market tomatoes — FMTT 22, FMTT 33, and FMTT 3; Chinese cabbage — AVRDC 82-156; sweet potato — CN 1489-89; sweet pepper — Gypsy; cauliflower — F1 451; and mustards — Chinhsingly and Tender green.

Vegetable Soybean Seed Production

To improve the quality and secure the supply of vegetable soybean in Taiwan, seed production techniques, including plant population density, seed drying and storage conditions, size of seed sown on pod, and seed yields, were studied. It was found that a density of 40 plants



Mechanical harvester for mungbean.

per square meter should be maintained in all seasons, the seed drying temperatures of 30°C or 45°C did not affect the germination rate, seeds should be stored under low temperature (10°C) and it is not necessary to select the large-size seeds within the same variety for vegetable soybean seed production.

Mechanical Harvesting of Mungbean and Processing Tomato

To reduce the high cost of labor in harvesting mungbean and processing tomato in Taiwan, mechanical harvesting is the obvious direction in the future. This project studied the management techniques required for mechanical harvesting of these crops. These included evaluating suitable defoliants and dosages for mungbean and proper population densities for tomato. It was concluded that 99% sodium chlorate, diluted to 300 times the volume, should be sprayed on mungbean at the stage of 80% pod maturity for mechanical harvest, and that one meter row width was better than two meters for tomato to be harvested once-over during the winter planting season.

SOIL SCIENCE

Soybean Continuous Cropping

Since the autumn of 1983, soybean has been cultivated continuously two or three times a year in the spring, summer and autumn seasons on the same land. Total soybean yields per year of AGS 129

and KS 8 reached 10.6 and 9.0 t/ha, respectively, in 1987 without continuous cropping hazards. But in the cropping of spring 1988, charcoal rot disease developed in all the experimental plots. Yield in spring, therefore, decreased compared to the last spring cropping, particularly KS 8 which was severely affected by charcoal rot.

Evaluation of Soybean Yield Increase

The soybean yield at AVRDC increased gradually every year from 1983 to 1987 and reached 4.6 t/ha in the spring of 1987, which was more than 240% compared with the 1.9 t/ha yield in the spring of 1983. The objective of this experiment was to evaluate the contribution of various elements such as variety, fertilizer and disease-pest control in increasing the soybean yield at AVRDC. It was clearly evident that varietal improvement at AVRDC was the most significant factor affecting the increase in soybean yield.

Effects of Silicate Potassium, Uniconazole and Methionine on Soybean Yield

The effect of slow-releasing potassium fertilizer K_2Si_2 compared with KC1 was tested by soybean yield in the spring of 1988. There were no significant differences between the two fertilizers.

Uniconazole as a growth retardant was tested on growth and yield of soybean in the spring of 1988. Uniconazole retarded plant height of soybean and effectively prevented lodging. Although soybean yield was increased by uniconazole treatment, there are still no significant differences.

The effect of methionine as an ethylene precursor on the growth and yield of soybean was tested in the spring of 1988. There were no significant differences between treatments.

Effect of Methionine on Tomato Yield

It was clearly demonstrated that methionine application at four weeks after transplanting in processing tomatoes promoted a greater number of fruits on the primary tillers with increasing cluster number. Therefore, processing tomato yield was increased by methionine, as a precursor of ethylene, application.

DEVELOPMENT PROGRAM

1988 Fall Field Day of trainees.

TRAINING

In 1988, 121 training participants were enrolled at AVRDC under six categories of training. These training scholars constituted an aggregate training time of 386.25 man-months or 32.18 man-years. When the participants are grouped into the three major AVRDC programs, the Development Program registered the highest enrollment (60%) with the Crop Improvement Program (23%) and the Production Systems Program (11%). The remaining trainees undertook studies in the support units, i.e. the Experimental Farm and the Genetic Resources and Seed Unit.

The trainees came from 12 countries: i.e. the Fed. Rep. of Germany (1), Hong Kong (3), India (1), Indonesia (15), the Rep. of Korea (4), Malaysia (1), Malawi (1), Papua New Guinea (1), the Philippines (49), Taiwan (34), Thailand (10) and the USA (1). There were 15 training sponsors who provided financial support to the trainees, in addition to AVRDC. The four major donors were the Japan Shipbuilding Industry Foundation (111.0 man-months), the Development Innovations International/ADB (90.0 man-months) the Second Laguna de Bay Irrigation Project/ADB (59.5 man-months), and the Asian Vegetable Research and Development Center (57.0 man-months).

TROPICAL VEGETABLE INFORMATION SERVICE

The Tropical Vegetable Information Service (TVIS) is a multidisciplinary, multicomponent information activity, supported by the

International Development Research Centre (IDRC) of Canada. A total of 24 publications were prepared under the project and provided a wide range of information, i.e. bibliographies, directories of researchers, technical bulletins, state of the art reviews and newsletters with current research information on Chinese cabbage, mungbean and soybean. TVIS publications have constituted 40% of AVRDC's entire publication program (1985-88). At project end, the TVIS literature data base consisted of 7,949 computerized records of which 4,271 are abstracted. During 1988, over 3,500 copies of AVRDC's TVIS publications were distributed worldwide and 114 documents were delivered by the library on request and during the project, a total of 135 individuals and institutions in 38 countries/territories received SDIs on three crops covered by the project. The TVIS project permitted AVRDC to establish contact with 237 individuals/institutions and TVIS documents were made available to the over 5,000 addresses from 160 countries/territories in the Center's mailing list.

AVRDC-INDONESIA VEGETABLE RESEARCH PROGRAM

Chinese Cabbage Trials

Chinese cabbage currently is cultivated only in the highlands in Indonesia. The purpose of this trial was to identify varieties adapted for lowland cultivation. Eleven hybrid/OP varieties and two hybrid parents were evaluated in three lowland and two midelevation trials during the 1987 wet and 1988 dry seasons.

In general the entries performed better in the dry than the wet season and better at midelevations than in the lowlands. Based on yield potential and head weight, Hybrids 58, 82-46, 62 and 82-57 were the best performers and will be submitted for release in 1989. Other entries which outperformed the check, Talaud, but require further testing are Hybrids 59 and 82-156 and 77M(3)-27, 77M(2/3)-43 and 77M(3)-35.

Tomato Trials

Ten promising tomato lines, consisting of four local selections, four AVRDC selections and two checks were tested in five midelevation and lowland trials in the 1987 wet and 1988 dry seasons. In general the lines performed better in the lowlands than at midelevation locations. Cr 4210, CL 1131-0-0-7-20-11, CL 1131-0-0-43-8-1 and Berlu-6 demonstrated the greatest yield potential and CL 95-280-D5-4-0 achieved the heaviest fruit weight.

AVRDC-KOREA BILATERAL PROGRAM

Chinese Cabbage

Breeding for Heat Tolerance. Every year promising combinations of Chinese cabbage for lowland summer cultivation are selected based

on heading form, disease resistance and harvest ratio. Despite heavy rain and high humidity during the field stage of the 1987 summer trials, two combinations with high harvest ratio and good performance were selected.

In the summer of 1988, 13 combinations crossed with 8 inbred lines were tested at 2 different sowing times. Some of the selected combinations demonstrated resistance to soft rot but not to virus disease. Thus, heat tolerant hybrids must have resistance to both soft rot and viruses to provide a stable harvest ratio.

Cytoplasmic Male Sterility (CMS). The seed yield of CMS and recurrent lines increased in 1988 over 1987, especially for CMS Daehyeong karack. The germination ratio of each CMS line was still lower than their recurrent parents.

Processing Tomatoes

Because of generally unfavorable meteorological conditions such as long rainfall followed by high temperature and humidity in the harvest stage, processing tomatoes have not been grown in Korea in the past. In 1987 different culture methods were tested and in 1988 a yield trial with three different culture methods was undertaken. An AVRDC introduction, TN No. 3, obtained a high yield regardless of culture methods and had a relative uniformity for yield characteristics. This selection will be tested in regional adaptability trials in 1989.

AVRDC-MALAYSIA MARDI VEGETABLE RESEARCH PROGRAM

Intermediate Tomato Yield Trial

A total of 21 AVRDC tomato lines (15 for processing and 6 for fresh use) selected in earlier yield trials were tested against two local check varieties at the Jalan Kebun Peat Station to determine their potential under local environments. Four lines, namely PT 862, PT 870, PT 858 and PT 913, had been observed to meet selection criteria for processing and five others, CL 5915-206 D4-2-2, CL 5915-206 D4-2-5, CL 5915-136 D4-1-0, CL 5915-223 D4-2-1 and CLN 95-280 D5-1-1, had been short listed as promising lines for fresh consumption. All these lines showed acceptable survival rates (55.0% to 67.7%) and very good yields under lowland conditions.

Intermediate Chinese Cabbage Yield Trial

A trial was conducted at the Jalan Kebun Peat Station with 10 varieties selected from the 25 varieties evaluated in the 1987 preliminary yield trial. Green Sun, Autumn Pride, Autumn Queen, 77M (2/3-46) and No. 82-156 outyielded the control varieties, Saladeer and Hybrid 62. Green Sun produced the highest heading efficiency ratio as well as large, compact and heavy heads. Green Sun and 77M (3)-27 showed relatively higher tolerance than the other varieties to incidence of soft rot diseases.

A combined analysis of the data over the two seasons indicated that there were significant yield differences among varieties, between seasons and significant interaction between season and varieties. Chinese cabbage varieties Autumn Queen (33.4 t/ha) and Green Sun (32.4 t/ha) significantly outyielded the local check, Saladeer (23.3 t/ha) and the AVRDC check, Hybrid 62 (24.3 t/ha). There was no significant difference in solidity of heads although Green Sun was rounder and more compact than Autumn Queen.

Sweet Potato Yield Trial

A total of 32 superior varieties from AVRDC and MARDI and 1 local variety were tested in a yield trial at Serdang in 1988. Four varieties, CN 1181-32, CN 1232-19, AIS 0122-2 and CN 1229-16, had the highest fresh tuber yields. CN 1232-19 and CN 1229-16 also produced the highest dry matter. Varieties AIS 0122-2 and CN 1229-16 were also among the highest yielders in trials conducted in the previous two seasons.

Vegetable Soybean Yield Trial

Two vegetable soybean lines from AVRDC which had been previously short listed on the basis of dry seed yield, were tested in a replicated trial at the Jalan Kebun Peat Station. Line G 81083-63 was found to be superior in terms of green pod and green seed yields. The pods of this line were also attractive and tasted good when boiled and eaten as a snack, or when the green seeds were prepared in a soup.

Cauliflower Evaluation

Eleven commercial varieties from Japan, Taiwan, the Netherlands, the USA and Thailand were selected from tests in 1987. There were no significant differences in yield between varieties. The five best yielding varieties were Green Harmony, Mikado (Meigetsu 45 days), Snow Top, Snow Queen and Chai Tai No. 1. Three varieties, i.e. Snow Top, Snow Queen and Chai Tai No. 1 were also among the top performers in the 1987 trial. However, Snow Queen and Chai Tai No. 1 are preferred because of their shorter maturity.

Other Vegetable Research

Research on breeding and selection for vegetables focused on the screening of varieties to evaluate their performance in the lowlands and highlands. Among the vegetables tested were chili, potato, tomato, asparagus, cabbage, Chinese cabbage, cucumber, vegetable soybean, shallots, okra, long bean, French bean and eggplant.

Ten accessions of chili showed potential for use as dried chili, having yields comparable to MC 4 and MC 5, while displaying conversion rates from fresh to dry ranging from 15.9% to 28.7%.

After four seasons of testing in the highlands, asparagus lines CAS 85106 and No. 81085 were higher yielding (6.1 – 6.6 t/ha) than Poletum and Mary Washington.

Multilocational trials on four selected cabbage varieties showed Autumn Hero and Good Season to be the highest yielders (39.7 to 47.6

t/ha) on peat in Pontian while Best Watanabe was best on the mineral soils in Bertam.

The F_1 cucumber hybrid of MTi 2 × Hokoshin had improved shelf life (4-7 days) and higher yield than the checks; it also had a crispy texture. However, it is not well accepted because of its dark green color and slightly rough skin surface.

AVRDC-PHILIPPINES OUTREACH PROGRAM (POP)

Chinese Cabbage General Yield Trial (GYT)

Five hybrids and two open-pollinated lines were compared to the check Reyna Elena (AVRDC Hybrid 62) during the dry and wet seasons. Hybrids 85-202 and 85-216, both with 20.17 t/ha, outyielded the check (17.80 t/ha) during the dry season but the difference was not significant. Meanwhile, during the wet season, there was little difference in yield between entries except for 77M (3)-40. Five entries with 13.21 t/ha to 15.92 t/ha outyielded the check (10.98 t/ha).

Chinese Cabbage General Yield Trial (GYT)

Further evaluation of four promising selections was conducted during the dry and wet seasons. Hybrid 58 (15.87 t/ha) outperformed the check, Reyna Elena (15.08 t/ha), but with no significant difference. In general, the test entries were comparable to the check in terms of marketable head yield and almost all other parameters measured.

AVRDC Mungbean Breeding Lines

The 135 stable mungbean lines which were previously purified and selected at POP were evaluated in nonreplicated trials during the 1987-88 wet and dry seasons. The most promising lines selected from the wet season trial were from the crosses VC 4195-B, VC 4180-B, VC 4169-B, VC 4146-B and VC 4310-B. Bean yields ranged from 102% to 247% over the check, BPI-Mg5.

Mungbean Preliminary Yield Trial (PYT)

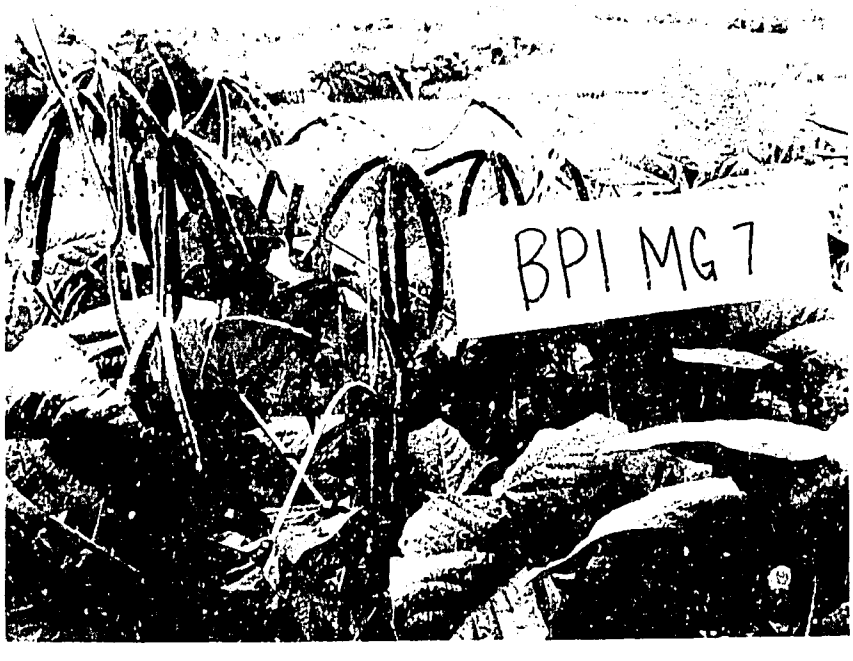
The study was conducted to identify mungbean lines with high bean yield potential, desirable agronomic characters and disease resistance.Two sets of entries were evaluated for the wet season. The average bean yields were 1,013 kg/ha and 1,098 kg/ha for Set I and Set II, respectively. For Set I, no test entry outyielded the highest yielding check entry Pag-asa 5 (1,256 kg/ha) while for Set II six AVRDC breeding lines with yields ranging from 1,370 to 1 590 kg/ha outyielded the check cultivar, BPI-Mg5 (1,348 kg/ha). However, the mean differences were not statistically significant. Further evaluation of both trials will be conducted.

Mungbean Genearal Yield Trial (GYT)

The study was designed to further screen and select PYT lines for yield potential, adaptability to local agroclimatic conditions and reactions to common pests and diseases. A total of 51 entries were evaluated in 3 sets of trials during 1987-88. The highest yielding entries during the wet season were VC 3738A, VC 3890-B-2-1-1-B and VC 3827-2B-2-1-B with yields ranging from 1,442 to 1,760 kg/ha. During the dry season, VC 3890-2B-B-1-B and VC 3738A were the highest yielders with 718 and 825 kg/ha, respectively. From the previous GYT, lines VC 3121-2B-1-1-B, VC 3108-2B-1-2B, VC 3061-7-1-1-1-B and VC 3102-B-2-2B were selected for inclusion in the RYT.

Mungbean Regional Yield Trial (RYT)

The RYT is a component of the National Crop Improvement Program and is conducted to determine the seasonal and regional adaptabilities of new strains/varieties of crops. The results from the RYT become the basis of releasing new varieties by the Philippine Seedboard for commercial use. For the mungbean improvement program, 4 of the 10 entries evaluated in 1987-88 were AVRDC lines. The entries that ranked first in terms of yield across location were EGM 2307 during the wet season and EGM 2768 during the dry season. Due to the outstanding performance of line VC 1973-3-B-3-B in the RYT from 1985-87, the Philippine Seedboard approved its release in June 1988 for commercial production as variety BPI-Mg7.



AVRDC mungbean VC 1973-3-B-3-B was released as BPI-Mg7 in 1988.

IMN

Twenty IMN entries were evaluated during the 1987-88 dry and wet seasons. The dry season data were not valid due to adverse weather conditions during the trial resulting in a low grand mean yield (441 kg/ha) of the 20 entries and a high CV of 36%. During the wet season, five entries with bean yields of from 1,519 to 1,913 kg/ha outyielded the check Pag-asa 1 (V 3476) which produced 1,680 kg/ha. The differences, however, were not significant. So far entries VC 3888A and VC 2768A showed better CLS resistance and bigger seed size compared to the check, Pag-asa 1.

Soybean Preliminary Yield Trial (PYT)

The study aimed to evaluate and identify soybean lines with high bean yield potential, resistance to common pests and diseases and other desirable attributes. Nineteen promising lines/accessions from AVRDC and other sources were evaluated during the dry and wet seasons of 1987-88. Each entry was planted in 5 and 6 square-meter plots during the dry and wet seasons, respectively, and distributed in RCBD with three replications. The entries were evaluated using the AVRDC procedure for soybean trials.

During the dry season, five entries outyielded the highest yielding check, BPI-Sy4, but the yield differences were not statistically significant. During the wet season, seven lines surpassed the highest yielding check, but only lines G90086 with 2.75 t/ha and G90050 with 2.65 t/ha showed significant differences over the check.

Soybean General Yield Trial (GYT)

The lines selected from the PYT were elevated to the GYT to further verify their yield potentials, resistance to common pests and diseases and identify their desirable agronomic characters. Low bean yields were obtained during the dry crop season due to severe drought. However, G50095-7-0-9 with 0.79 t/ha significantly outyielded the highest yielding check BPI-Sy4 (0.51 t/ha). Of the 18 entries evaluated against the 2 standard checks during the wet season, 3 entries with yields ranging from 2.46 to 2.71 t/ha outyielded the highest yielding check, BPI-Sy4, with 2.41 t/ha, but the difference was not significant.

Soybean Regional Yield Trial (RYT)

Eight and 10 promising lines were evaluated in the RYT against 2 standard checks during the dry and wet seasons, respectively. The study was designed to verify bean yield potentials and reactions to major pests and diseases of the promising strains/varieties under the different regions of the Philippines.

Results from the Economic Garden showed that during the dry season, only TGX 888-48C with 950 kg/ha significantly outyielded the highest yielding check, BPI-Sy4 (830 kg/ha), and AGS 208 ranked third. During the wet season trial, 4 out of 10 test entries evaluated significantly outperformed the highest yielding check, BPI-Sy4, with 1.93 t/ha. Line AGS 208 ranked first followed by AGS 133 with bean yields of 3.06 and 2.93 t/ha.

Sweet Potato Germplasm Collection

A total of 130 sweet potato lines/accessions from local and foreign sources (mostly from AVRDC) are maintained at the station. This gene pool serves as a source of research materials for POP and other research organizations, both private and government agencies.

Sweet Potato PYT and GYT

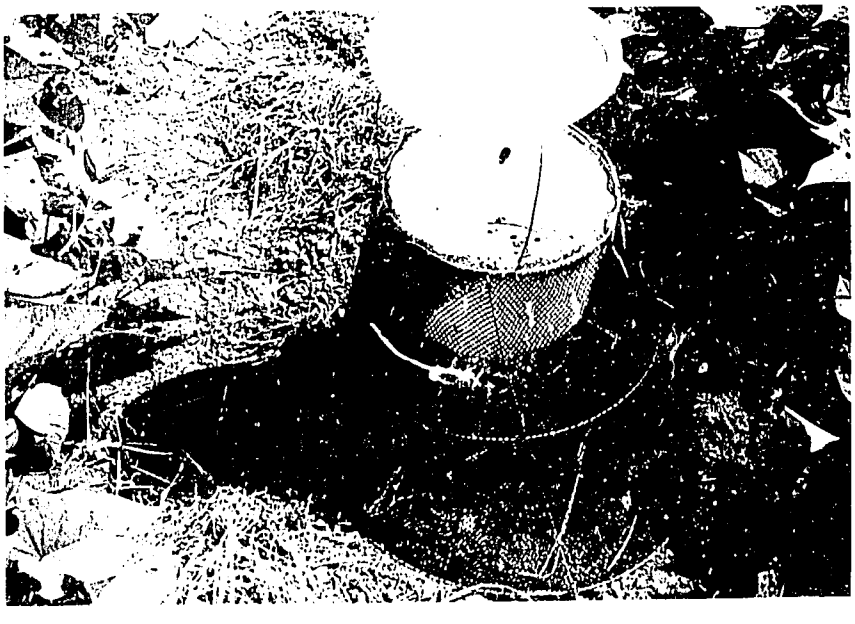
Promising potato lines/accessions selected from the germplasm study were further evaluated in the PYT, and later the GYT, to determine their marketable yield potentials, reactions to scab, and dry matter contents.

Twenty-five entries in the PYT and 16 in the GYT were evaluated against the check BPI-Sp2 during the 1988 dry and wet seasons. No valid results were obtained from the dry season trials due to the unusually heavy rainfall that prevailed in June and July before the crops were harvested. The adverse conditions caused most developing roots to rot, thus affecting the yield. The wet season trials will be reported upon completion in 1989.

IPM for Sweetpotato Weevil Control

A new practical IPM approach developed by AVRDC was conducted to determine the effectiveness of using sex pheromone for sweetpotato weevil control. The field, cleared of sweet potato debris and alternate hosts of the weevil, was planted to insecticide-treated BPI-Sp2 cuttings on 14 September 1988, on sub-plots of 5 × 6 m each, distributed in RCBD and replicated three times.

Three sex pheromone traps were placed in the field two weeks after planting to capture male weevils. Daily counts of trapped weevils were



Sweetpotato weevil sex pheromone trap made of indigenous materials.

made. Initial results showed that 2,527 weevils were trapped after 25 samplings. The study is in progress and weevil counts will be made from the root samples at harvest.

Tomato Single Seed Descent Trial

In 1987-88, 91 AVRDC lines/hybrids were evaluated during the dry season and 29 F_1 hybrids during the wet season. The F_1 processing tomato, PT-4052, significantly outperformed the check, Mapula; and several F_1 fresh market tomatoes significantly outyielded the check variety. All lines evaluated under the single-seed descent trial in both seasons were very susceptible to bacterial wilt, TMV and Cercospora leaf spot diseases.

Tomato Preliminary Yield Trial (PYT)

During the 1987-88 dry season, 10 F_1 processing, 10 F_1 fresh market and 12 open-pollinated fresh market lines were evaluated. The yields of F_1 processing tomatoes were comparable to the check, Mapula. Eight F_1 fresh market lines performed better than the check and 12 open-pollinated fresh market lines significantly outyielded the check.

The wet season preliminary trial, composed of 66 open-pollinated fresh market lines were planted in 5 sets. Of the 66 lines, 13 showed better yield performance over the check, Pope. The general low yield of the test lines was attributed to the high incidence of CLS, excessive rain during the crop season and not mulching the trial.

Tomato General Yield Trial (GYT)

Fourteen AVRDC open-pollinated fresh market tomatoes were evaluated during the dry and wet seasons of 1987-88. The yield varied significantly in both seasons with CL 5915-223 (G) D4-2 and CL 5915-206 (G) D4-2 producing the highest yield during the dry and wet seasons, respectively. The entries flowered in 24 days and matured at 59 days during the dry season, while during the wet season, flowering was observed at 24.5 days and maturity at 66.4 days. Fruit setting was higher during the dry season (4.3 score) with bigger fruits (31.2 g/fruit). Entries showed various reactions to sunscald, cracking and bacterial wilt incidence.

AVRDC-THAILAND OUTREACH PROGRAM (TOP)

Chinese Cabbage On-farm Trials

On-farm trials demonstrated that commercial cultivars grown in the lowlands during the summer and rainy season did not form heads and yielded only 4-10 t/ha. However, during the cool season the commercial cultivars yielded up to 40 t/ha. On the other hand, the AVRDC-developed heat-tolerant Hybrid 62 variety yielded 25-30 t/ha during the off season.

In order to aid adoption of Hybrid 62, TOP initiated and coordinated F_1 hybrid seed production in the highlands at Doi Ang-Kang, Chiang Mai, at the Pakchong Research Station in the Northeast Region and at the AVRDC-TOP station in Kamphaeng Saen, Nakhon Pathom.

Plant Density and Chinese Cabbage Yield

Trials were conducted to determine the most suitable spacing for Hybrid 62 during both the warm and cool seasons. The optimum spacing for Hybrid 62 during the warm season was 40 × 40 cm^2 and 30 × 30 cm^2 or 30 × 40 cm^2 during the cool season. The commercial cultivar, Elephant Brand, which has larger plant size and is late maturing, should be planted at the closest spacing of not less than 40 × 40 cm^2.

New Tomato Release

A new tomato variety named Seedathip II was officially released. It is a cross between AVRDC's CL 1131 and a local cultivar, Seeda. Seedathip II is of determinate type, takes 22 days to flower, is pear shaped with pink fruit of 30g weight, and is tolerant to Cercospora leaf mold.

Heat-Tolerant Tomato Combinations

The newly released Seedathip I and II varieties are open pollinated and as a consequence they still have some variations and do not yield as high as hybrids. Seven F_1 hybrids were produced and tested in the cool, summer and rainy seasons. The F_1 hybrids showed better adaptation to different conditions and had higher yield than the open-pollinated heat-tolerant cultivars. Hybrid 110 and 115 showed promise with their rather large and pinkish fruit.

Improvement of Seedathip I

Seedathip I is popular for summer planting but its pink-orange colored fruit is not as popular as the pink fruit of the local Seeda variety. The breeding program to improve the fruit color of Seedathip I by backcrossing with a variety that has pink-colored fruit has completed the F^4 generation.

Heat Tolerant Table Tomato Combinations

A program has been established to produce an F_1 hybrid table tomato which is both heat tolerant and has pink-colored fruit. Forty-five F_1 hybrids and some open-pollinated commercial cultivars were evaluated in the summer season. Although all hybrids achieved high fruit yield, they had orange fruit with thin walls. More cultivars with pink-colored fruit for both male and female parental lines will be utilized in the future.

Pepper Germplasm Collection

Twelve pepper varieties from China, Thailand and the USA have been included in the germplasm collection.

Sweet Potato Germplasm Collection

Sixty-six varieties/cultivars from AVRDC, China, Japan, Sri Lanka, Thailand and Vietnam are currently maintained in the field genebank.

Production of Mungbean Breeder's Seed

AVRDC-TOP's annual production of KPS 1 and KPS 2 breeder's seed is about one ton per cultivar. These two recently released AVRDC mungbean varieties are popular among growers. During the 1987 late rainy season these two cultivars obtained a 36% higher market price per kilogram than other cultivars.

New Mungbean Release

AVRDC variety VC 2768A has been officially released as PSU 1 (after the Prince of Songkla University which spearheaded the evaluation and screening tests) for use in southern Thailand. PSU 1 was released because of its high yield (average of 1,588 kg/ha), and high resistance to lodging and Cercospora leaf spot.

Effect of Leaflet Shape and Number on Mungbean Yield

Several crosses were made using lines with high yield characters to further improve the physiological characters of mungbean lines. The lobed, multiple leaflet mungbean yielded the lowest and plants with 3-5 lobed leaflets yielded similarly to normal mungbean.

AVRDC mungbean VC 2768A was released as PSU 1 in Thailand.

Soybean: Downy Mildew Resistance

The officially released Nakhon Sawan 1 (NW1) soybean variety is susceptible to downy mildew, caused by *Peronospora manshurica*. A backcross program was established at AVRDC-TOP to transfer the downy mildew resistant gene from AGS 129 to NW 1. The BC_4 progenies carried up to 96.875% of the recurrent parent NW1 and maintained resistance to disease. If these backcross progenies are agronomically the same as NW1, they can be used for extension in 1989.

Vegetable Soybean

The Nakhon Sawan 1 (NW1) variety has been accepted as a vegetable soybean by the domestic Thai market but it has too small seeds and a low palatability rating. Fifteen vegetable soybean cultivars introduced from AVRDC were evaluated with NW1 as the check. Additional tests are required to find a vegetable soybean cultivar which meets both the local and international market qualifications.

Home Garden

A maximum of 23 different vegetables were grown in each home garden. Bigger garden plots were established for seed production for farmers. Home garden trials were also established at Chiang Mai University to compare the adaptability and profitability of various cropping patterns and crop combinations of introduced and indigenous vegetables.

REGIONAL PROGRAMS

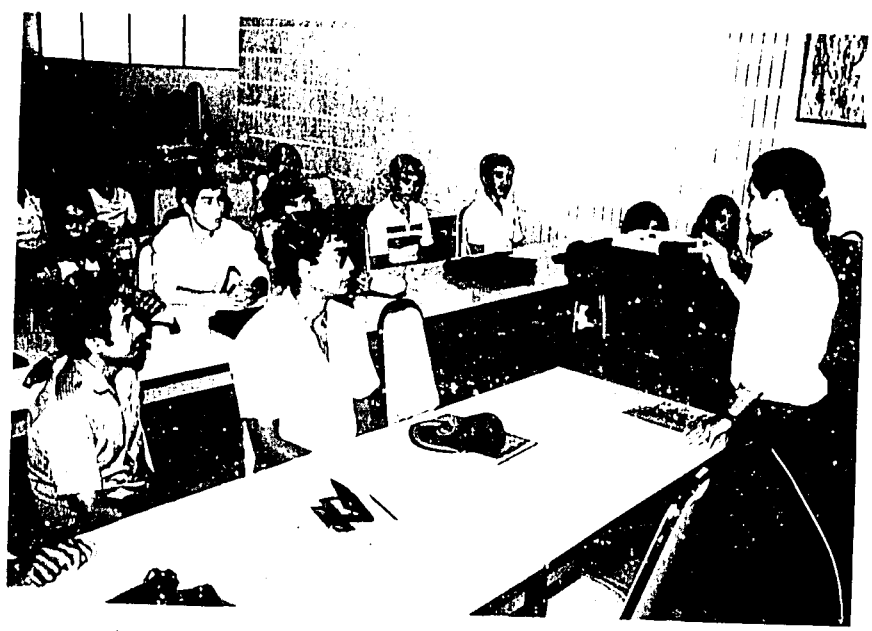
THAILAND REGIONAL TRAINING AND RESEARCH PROGRAM

6th and 7th Regional Training Courses

A total of 20 training scholars, consisting of 6 Chinese, 7 Filipinos, 2 Thais, 3 Sri Lankans and 8 Vietnamese, completed the Sixth AVRDC-TOP Regional Training Course held from Oct. 1987 to Feb. 1988. Twenty-seven training scholars, 8 Chinese, 1 Filipino, 3 Nepalese, 4 Sri Lankans, 4 Thais and 7 Vietnamese, were enrolled in the Seventh AVRDC-TOP Regional Training Course held from Oct. 1988 to Feb. 1989.

In-country Workshop

The first of a series of workshops was conducted in cooperation with the Department of Agricultural Extension (DOAE), Ministry of Agriculture and Cooperatives, Thailand. The workshop on "Vegetable Production Under the Net and Production of Asparagus in the Tropics" utilized a resource person from AVRDC who drew on the experience of Taiwan in this area. Workshop participants were extension workers and subject matter specialists from DOAE and representatives from private agencies involved in vegetable production.



Instruction during the Sixth Regional Training Course.

AVRDC COLLABORATIVE GARDEN/ VITAMIN A PROJECT

In its first year of operation in Niger the project: (a) conducted an assessment of existing gardening practices in the Sahel for both rainy and dry seasons; (b) identified locations in some Sahelian countries where vitamin A deficiency is a problem, and where gardening might help to alleviate the problem; and (c) planned the best approaches for conducting appropriate gardening research, workshops and training programs. From the assessment, other activities followed:

- Networking and collaborating with AVRDC headquarters and numerous organizations in the Sahel which are involved with production/consumption of vitamin A crops;
- Initiating observation and variety trials of culturally acceptable vitamin A garden crops at AVRDC's Niger facility;
- Conducting the project's first regional workshop on Gardening/ Vitamin A in Sahelian West Africa; and
- Planning for the project's first training program.

GENETIC RESOURCES AND INFORMATION SERVICES

GENETIC RESOURCES AND SEED UNIT

Goals

The goals of the GRSU are to build AVRDC into an important genebank for vegetable species popular in the tropics and to promote the use of good quality vegetable seeds in developing countries.

Germplasm Activities

In 1988 the GRSU introduced a total of 431 accessions of the six principal crops and 361 accessions of other crops. It maintained 31,484 accessions, of which 7,784 accessions have been transferred into long-term storage. The sweet potato field genebank was severely affected by a flood which resulted in the loss of a few accessions. Efforts were concentrated on the characterization of the pepper, sweet potato and tomato collections. A total of 1,808 pepper accessions and 1,750 accessions of tomato have been characterized. In 1988, 14,293 seed samples of both germplasm and breeding lines were distributed to 91 countries and territories.

Information Management System at AVRDC Genebank

The routine operation of the genebank generates a vast amount of data which must be kept for future reference. An efficient computerized information management system is, therefore, necessary to facilitate seed handling procedures and germplasm retrieval.

The GRSU is presently building up a computerized information management system. The system covers both data bases on germplasm (passport, characterization, evaluation), seed storage and seed distribution. The data base structure is designed to facilitate the data management on the conservation of many species within the working environment of the software package used. Passport, inventory, and distribution data are common in all species and, therefore, are all put into a single data base. However, characterization and evaluation data are crop specific, and these data bases are, therefore, set up for each individual crop.

The software package is MINISIS which has been developed by the International Development Research Centre of Canada and runs on a Hewlett Packard, HP 3000 series minicomputer. It works on a modular basis and the functions can be classified into information entry, modification, sorting, query and retrieval, construction of data bases and printing.

Appraisal of Seed Production Technology Workshop

The workshop on seed production technology (the third to be organized by the GRSU and the Training Office) attempted to provide

Practical instruction during the "Seed Production Technology Workshop".

basic knowledge on seed production technology to the vegetable production trainees. The workshop consists of a week of subject matter presentations and demonstrations by both resource persons and training participants, followed by field trips to seed production sites and facilities of both the public and private sector. An appraisal of the training activity was carried out using a 33-item questionnaire and improvements needed to make future workshops even more effective were identified.

Sweet Potato Germplasm Introduction and Distribution

The introduction, virus-indexing and conservation of the Asian and Pacific sweet potato germplasm are on-going. Until now 264 accessions have been introduced. A total of 456 accessions have been successfully derived by meristem and maintained. In 1988, 33 clones, consisting of 30 breeding lines and 3 accessions, were released from the virus-indexing program for international distribution. To date, 805 tubes have been distributed to 22 countries.The distribution method was described.

Soybean Seed Quality and Storage

An experiment was conducted to study the seed quality of different AVRDC-improved soybean lines produced in the summer and fall seasons, corresponding to seed ripening in the wet and dry season, respectively. It also aimed to derive a method to predict soybean seed quality and viability under different storage conditions. The soybeans, AGS 65, 66, 124, 129, 160, 162, 208, 217, 270 and 299, and G 2120-M8, were subjected to four different storage regimes. The seed quality produced from different seasons, responses to the different storage regimes, and success in predicting the storage life of soybean seed lots were analyzed and reported. The implications for formulating a soybean seed program in tropical countries was discussed.

Germplasm Recipients 1988

Argentina

Agrotećnica Trebol Sur S.R.L.

Australia

CSIRO Division of Tropical Crops and Pastures
DPI, Gatton
Department of Primary Industries
Pacific Seeds
Redlands Horticultural Research Station
South Australian Seed Growers Co-operative Limited

Bahamas

Department of Agriculture

Bangladesh

BARD, c/o AID
BARI

Barbados

CARDI

Belgium

Koninklijk Museum voor Midden-Afrika

Bhutan

IFAD Project, Dept. of Agriculture

Botswana

Botswana Development Corporation Ltd.

Brazil

EMBRAPA-Centro Nacional de Pesquisa de Hortalicas
Estacao Experimental de Anapolis
UFRRJ — Inst. Biologia-Fitopatologia
Universidade Estadual Paulista
Universidade Federal de Viçosa

Brunei

Agriculture Department
Ministry of Development
Sinaut Agricultural Training Centre

Burma

Agricultural Research Institute

Burundi

Institut des sciences agronomiques du Burundi (ISABU)

Canada

King Agro Inc.
Stokes Seeds Ltd.

Cape Verde Islands

Instituto nacional de investigacao agraria (INIA)

China

Chinese Academy of Agricultural Sciences (CAAS)

Colombia

CIAT
Instituto Colombiano Agropecuario
Instituto Linguistico de Verano

Congo

University Marien Ngouabi

Cook Island

Ministry of Agriculture

Costa Rica

ANAI
CINDE
Universidad de Costa Rica

Dominican Republic

Industrias Asociadas, C. por A.

Ecuador

Estación Experimental "Boliche", INIAP
Estación Experimental "P"

Egypt

Ministry of Agriculture

Ethiopia

Agricultural Development Department
Agricultural Research Centre
Institute of Agricultural Research, Bako Research Center
Nazreth Research Center

Fiji Islands

H.E. the President of the Republic of Fiji
Sigatoka Research Station
South Pacific Commission
Teidamu Central Nursery
Vuda Garden Ltd.

France

Andre Blondeau, Slectionneur-Obtenteur
INRA
IRAT
le Maulin Berra, le Landreau

Gambia

C.R.S. Il Marina Patade
Department of Agriculture
Gambia Freedom From Hunger Campaign

Germany, Federal Rep. of

Biologische Bundesanstalt für Land und Forstwirtschaft
Institut für Biochemie
Institut für Viruskrankheiten der Pflanzen
Max Plank Institute

Ghana

Ministry of Agriculture
Nkawkaw Agriculture and Vegetable Centre

Guatemala

Instituto de Nutrición de Centro America, Panamá

Hong Kong

P.H.K. Trading Limited
Pillsbury Company
University of Hong Kong

Hungary

Hortus Botanicaus Universitatis

India

Allahabad Agricultural Institute
Central Agricultural Research Institute
Coonor Tea Estate
Hexamar Agricultural Research and Development Foundation
Himachal Pradesh Agriculture University
ICAR
ICAR Research Complex for N.E.H. Region, Shillong
Indian Agricultural Research Institute (IARI)
Kerala Agricultural University
Krishi Vigyan Kendra
Main Pulse Research Centre
Nath Seeds, Pvt. Ltd.
National Bureau of Plant Genetic Resources
Navalakha Group
New Hope, Rural Leprosy Trust
Osmania University
PAK-College of Agriculture
Pioneer Overseas Corporation

Punjab Agricultural University
Shri A.M.M. Murugappa Chettiar Research Centre
Shri Girivanavasi Pragati Mandal
Tamil Nadu Agricultural University
University of Delhi
Vijay Seeds Co., Pvt. Ltd.
YSP University of Horticulture and Forestry

Indonesia

Bogor Agricultural University
Bogor Research Institute for Food Crops (BORIF)
Chinese Agricultural Technical Mission
Central Research Institute for Food Crops (CRIFC)
Lembang Horticultural Research Institute (LEHRI)
MARIF, Kendalpayak
Organization for Rural Development
Winrock International, Balittan Sukarami

Iran

Agrosoy International
Seed and Plant Improvement Institute

Iraq

Agriculture and Water Resources Research Centre

Israel

Israel Gene Bank for Agricultural Crops
Levi Eshkol School of Agriculture
Volcani Centre

Jamaica

Biochemical Equipment and Services Ltd.

Japan

Agricultural Research Center
Kagome Co., Ltd.
Kagoshima Agr. Exp. Station
Kaneko Seeds Co., Ltd.
Kyoto University
Kyushu University
Mikado Seed Growers Co., Ltd.
Nagano Chushin Agriculture Experiment Station
National Institute of Agrobiological Resources (NIAR)
Sakata Seed
Takii Seed Co., Ltd.
Tokita Seed Co., Ltd.
University of the Ryukyus
University of Tokyo
Watanabe Seed Co., Ltd.
Yonoza Farmers Association

Korea, Republic of

Choong-Ang Seed Co., Ltd.
Dan Kook University
Hung Nung Seed Company
Kyungpook National University
Rural Development Administration (RDA)
Seoul National University

Lesotho

AID

Liberia

AVSPP/NCRDP
Catholic Mission
Southeastern Liberia Rural Development Programme

Madagascar

Département de recherches agronomiques, FO.FI.FA.
Opération de développement agricole intégré
S/C FAO/PUND MAG 82/016

Malawi

Bvumbwe Research Station

Malaysia

Agricultural Chemicals (M) Sdn. Bhd.
Agricultural Research Centre

Department of Agriculture
Divisional Agriculture Office
MARDI
Perunding Bersatu Sdn. Bhd.

Maldives

Ministry of Atolls

Marshall Islands

Chinese Agricultural Technical Mission
Peace Corps

Mauritius

Mauritius Sugar Industry Research Institute
Ministry of Agriculture, Fisheries and Natural Resources

Mexico

CSAEG
Instituto Nacional de Investigaciones Sobre Recursos Bióticos
Sede (CIAPAN) Campo Agrícola Experimental del Valle de Culiacań

Nepal

Department of Agriculture, Ministry of Agriculture

Netherlands

Deruiter Seeds B.V.

Niger

Projet horticole vitamine A en Afrique

Nigeria

Ahmadu Bello University
Bamol Nigeria Limited
Hensmor Agro Allied Industry Limited
Ministry of Agriculture and Cooperatives
Oipuala Cooperatives
Vegifarms Limited

Oman

Ministry of Agriculture and Fisheries

Pakistan

Agricultural Research Station
Conimplex Hatchery and Breeding Farms
Nuclear Institute for Agriculture and Biology
Pakistan Agricultural Research Council (PARC)

Panama

IDIAP
Chinese Agricultural Technical Mission
Nestlé Panamá, S.A.

Papua New Guinea

Division of Primary Industry, Food Crops

Peru

Autoridad Autónoma de Majes
Bayer Perú, S.A.
Fundación Contra el Hambre
Programa de Investigación Amaranthus
Programa Nacional de Kiwicha
Universidad Nacional Agraria

Philippines

Central Mindanao University
Department of Agriculture
Hortanova Vegetable Farm
Institute of Plant Breeding (IPB)
Intenseed Agriculture
International Rice Research Institute (IRRI)
Isabela State University
Litton Agro-Marine Co., Inc.
Mariano Marcos State University
Palawan National Agricultural College
Panay State Polytechnic College
Pangasinan State University
Philippine Coconut Producers Federation

POP/AVRDC
Quirino State College
Second Laguna de Bay Irrigation Project — Vegetable Component
University of the Philippines at Los Baños (UPLB)

Runion (France)

IRAT

Saipan

Northern Mariana College

Samoa, Western

Office for Tokelau Affairs

Saudi Arabia

Ministry of Agriculture and Water
Tabuk Agricultural Development Co. (TADCO)

Senegal

Institut sengalais de recherches agricoles (ISRA)

Sierra Leone

Egyptian Embassy, Agric. Div.
Functional Adult Literacy Program, CUSO
Rice Research Station, Rokupr

Singapore

Eastreco (Pte.) Ltd.
National University of Singapore

Solomon Islands

Chinese Agricultural Technical Mission

South Africa

Mayford Seeds (Pty.) Ltd.

Spain

Centro de Investigación y Desarrollo Agrario
Universidad Politécnica

Sri Lanka

Agricultural Research Station
Canadian High Commission
Department of Agriculture
Development Alternatives, Inc.
Gnanammah Integrated Research Farm
Israel Interests Section
Plant Genetic Resources Centre
Tropic Green Isle Seeds
University of Peradeniya
University of Ruhuna

Sudan

Agricultural Research Corporation
University of Khartum
University of Gezira

Suriname

Ministry of Agriculture, Animal Husbandry and Fishery

Swaziland

Agricultural Research Division
Malkerns Research Station
Ministry of Agriculture and Cooperatives

Switzerland

Station fedrale de recherches agronomiques de Changine

Taiwan, China

Academia Sinica
Evergrow Seed Company
Fengshan Tropical Horticultural Experiment Station
First Seed Company
Fu Jen University
Known You Seed Company
National Chiayi Institute of Agriculture
National Chung Hsing University
National Pingtung Institute of Agriculture

National Taiwan University
Taiwan Agricultural Research Institute (TARI)
Taiwan Seed Improvement and Propagation Station

Thailand

Agricultural Development Research Center in Northeast Thailand (ADRC)
APTA Phaya Thai Court
Biological Nitrogen Fixation Research Center
Chainat Field Crops Research Center
Chia Tai Co., Ltd.
Chiang Mai Field Crop Research Center
Department of Agriculture
Hsin Seed Co., Ltd.
IBSRAM
Kasetsart University
Maejo Institute of Agricultural Technology
Pacific Seeds (Thai), Limited
Thai Potato Seed Co., Ltd.
TOP/AVRDC

Tonga

Department of Agriculture
M.A.F.F.

Trinidad and Tobago

University of the West Indies

United Kingdom

University of Birmingham
University of London
University of Reading

USA

Asgrow Seed Company
Campbell Inst. for Research and Technology
Dairyland Seed Co., Inc.
Funk Seeds International
Harris Moran Seed Company
Honolulu Community Gardens
Land O'Lakes, Inc.
Mississippi Agricultural and Forestry Experiment Station
Northrup King Company
Northwest Area, Grain Legume Genetics and Physiology Research
Peto Seed Co., Inc.
Seedcraft, Inc.
Sundance Farms, Inc.
Sungene Technologies Corporation
Texas A & M University
The Land EPCOT Center
University of Arizona
University of California
University of Hawaii at Manoa
University of Idaho
University of Illinois
University of Minnesota
University of Nevada-Reno
University of New Hampshire
USDA Plant Germplasm Quarantine Center
USDA Regional Plant Introduction Station
Virginia State University
Winrock International
Yuma Mesa Agricultural Center

Uruguay

Estación Experimental Granjera "Las Brujas"

Vanuatu

Torqil Centre

Vietnam

University of Cantho

Virgin Islands

University of the Virgin Islands
Water Isle Botanical Garden

Western Caroline Islands

Division of Agriculture and Forestry

Yemen Arab Rep.

Agricultural Research and Extension Project

Rural Development Project, al Mahwit Province
Seyun Research Center

Yugoslavia

University of Zagreb

Zaire

Institut national pour l'étude et la recherche agronomiques (INERA)

Zambia

University of Zambia

Zimbabwe

University of Zimbabwe

OFFICE OF INFORMATION SERVICES

During 1988 OIS undertook, among others, the following activities:

Publication Activities

- Published 16,385 copies of 15 formal publications and prepared 2,370 pages to the camera-ready stage;
- Edited 10 major documents, 2 periodicals, 30 symposium presentations and 15 informal documents; and compiled the *1987 Progress Report Summaries*;
- Printed 870,000 pages required by 287 internal print requests;
- Arranged for distribution of the French edition of AVRDC's *Sweet Potato Proceedings* which was copublished with CTA and ACCT; and monitored progress on *Beanflies of Food Legumes in the Tropics* which is being copublished with Wiley Eastern, Ltd. of New Delhi; and
- Aided AVRDC scientists to obtain publication of 14 journal papers and prepare 4 papers for future publication.

Public Awareness Activities

- Issued two press releases and met with journalists from five countries;
- Organized a press visit which led to the publication of four articles in major German newspapers and three radio broadcasts; and
- Represented AVRDC at the first meeting of the "Public Awareness Association for International Agricultural Research".

Data Bases

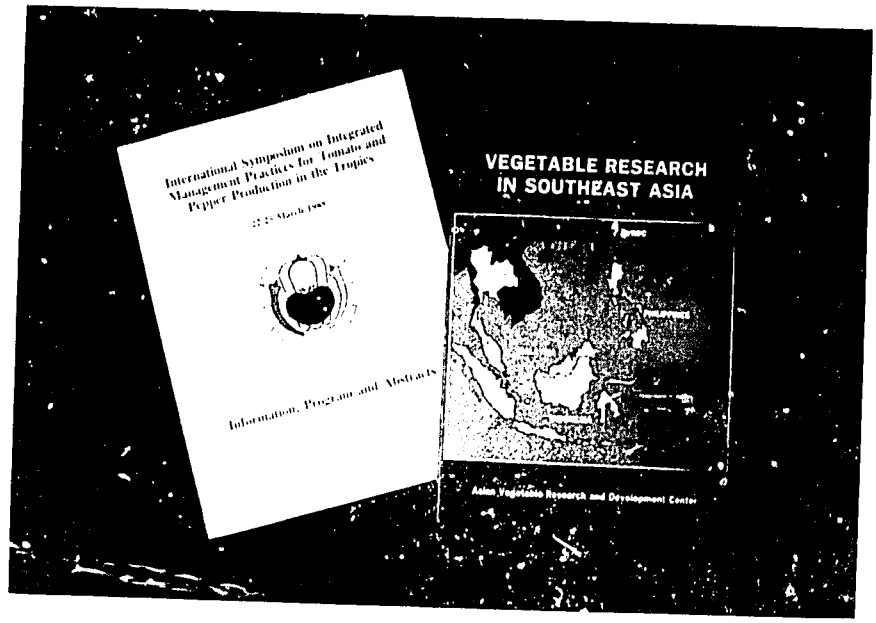
- Completed a survey of library addresses, updated these addresses and included a new library data base in the mailing list.

Photographic and Art Services

- Made 19,300 photographic records of the scientific work in progress during 1988 in over 750 separate photographing sessions in the fields, laboratories and studio; and
- The art unit drew nearly 500 figures, tables, posters, book covers, etc. from 127 requests.

Symposium/Workshop Support Services

- Prepared the printed materials necessary for the Tomato and Pepper Symposium, organized a publication display/sales and issued a news release; and
- Prepared the printed materials required for the Vegetable Research in Southeast Asia Workshop, distributed 165 publications to participants, edited the 23 presentations and published the proceedings.



Distribution Activities

- Continued implementation of the activities outlined in the 1986 proposal "Towards a Cost-effective Publication Policy";
- The cost of automatic complimentary distribution has been subsidized through a contribution to the "Publication Distribution Fund";
- Evaluated the functioning of AVRDC's complimentary library distribution scheme, reduced the number of recipients and instituted selective dissemination of publications (SDP) to the libraries based on their needs;
- Continued to fully utilize postal tariffs through publication design techniques to reduce weight and consolidate mailings; and
- Increased sales by 25% over 1987 by further extending the commercial distribution network and continued promotional activities, including prepublication offers, discounts to selected groups, systematic requests for book reviews and sales/displays at scientific meetings.

Publications Available

How to Order

All of the publications listed below can be ordered from the Office of Information Services (OIS), AVRDC, P.O. Box 205, Taipei 10099. The following list of distributors in the highly developed countries (HDC) and less developed countries (LDC) have many of these publications available for sale in local currency.

The prices quoted below include surface postage. If airmail delivery is required the additional postal charges will be added to the invoice. All charges should be paid with a US dollar check (**payable by a bank in the USA**) made out to AVRDC, or with Unesco coupons.

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Republic of Singapore

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2nd Floor, Newfield Building
42-3 Ontsuka 3-chome
Bunkyo-ku, Tokyo 112
Japan

TRIOPS. Tropical Scientific Books
Toeche-Mittler Distribution
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Sydney, N.S.W. 2001
Australia
(Orders for Oceania)

Agribookstore
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Arlington, VA 22209
USA (Orders for North America)

LDC Distributors

World Universities Press
B-5/132, Safdarjung Enclave
New Delhi - 110 029, India

Publications Section
CGPRT Centre
Jalan Merdeka 99
Bogor 16111, Indonesia

Africa Book Services, Ltd.
Quran House
Mfangano Street
P.O. Box. 45245
Nairobi, Kenya

University of Malaya Co-Operative Bookshop, Ltd.
P.O. Box 1127
Jalan Pantai Baru, 59.700
Kuala Lumpur, Malaysia

National Book Store, Inc.
Library Services Center
701 Rizal Ave.
Manila, Philippines

INDEX, Book Promotion & Service, Ltd.
Ploenchit Road, Pathumwan
Bangkok 10500, Thailand

Annual Progress Reports

1983 Progress Report. 444 p.
1984 Progress Report. 480 p.
1985 Progress Report. 471 p.
1986 Progress Report. 541 p.
(All issues of Progress Reports cost HDC $20.00; LDC $15.00)

Progress Report Summaries

1985 Progress Report Summaries. 96 p.
1986 Progress Report Summaries. 94 p.
1987 Progress Report Summaries. 98 p.
1988 Progress Report Summaries. 100 p.
(All issues of Progress Report Summaries cost HDC $7.50; LDC $4.00)

Symposium Proceedings

AVRDC. 1977. Vegetable Technology in Asia. Proceedings of the Workshop on Pre- and Post-harvest. 156 p. (HDC $12.00; LDC $8.00)

Cowell, Robert (ed.). 1978. Tropical tomato: Proceedings of the First International Symposium. 290 p. (HDC $18.00; LDC $10.00)

Talekar, N. S. and T. D. Griggs (eds.). 1981. Chinese cabbage: Proceedings of the First International Symposium. 489 p. (HDC $25.00; LDC $15.00)

Villareal, R. L. and T. D. Griggs (eds.). 1982. Sweet potato: Proceedings of the First International Symposium. 481 p. (HDC $28.00; LDC $15.00)

Shanmugasundaram, S., Edward Sulzberger and Bruce T. McLean (eds.). 1986. Soybean in Tropical and Subtropical Cropping Systems, Revised ed. 485 p. (HDC $25.00; LDC $18.00)

Talekar, N. S. and T. D. Griggs (eds.). 1986. Diamondback Moth Management: Proceedings. 483 p. (HDC $25.00; LDC $18.00)

Shanmugasundaram, S., P. Lastimosa and N. Llemit (eds.). 1987. Soybean Varietal Improvement: Proceedings of the International Workshop. 93 p. (HDC $7.50; LDC $4.00)

Lastimosa, Pura J. and Norma V. Llemit (eds.). 1987. Gardening Nutritious Vegetables; Proceedings of the Vegetable Improvement Gardening Workshop. 136 p. (HDC $10.00; LDC $6.00).

Sapin and Grange (trans.). 1988. La Patate Douce: Actes du premier symposium international. CTA, ACCT and AVRDC, Belgium. p. 483. (From the original Sweet Potato: Proceedings of the First International Symposium. R.L. Villareal and T.D. Griggs (eds.) AVRDC, 451 p. (HDC $28.00; LDC $15.00).

Bruce T. McLean (ed.). 1988. Vegetable Research in Southeast Asia. 242 p. (HDC $17.50; LDC $10.00)

S. Shanmugasundaram and Bruce T. McLean (eds.). 1988. Mungbean: Proceedings of the Second International Symposium. 750 p. (HDC $40.00; LDC $25.00)

Technical Bulletins

TB 1 Menegay, M. R. 1975. Taiwan's specialized vegetable production areas: An integrated approach. 17 p. (HDC $4.00; LDC $3.00)

TB 2 Menegay, M. R. 1976. Farm management research on cropping systems. 19 p. (HDC $4.00; LDC $3.00)

TB 3 Calkins, P. H. 1976. Four approaches to risk and uncertainty for use in farm management extension. 18 p. (HDC $4.00; LDC $3.00)

TB 4 Calkins, P. H. 1977. Farmers' viewpoint of sweet potato production in Taiwan. 44 p. (HDC $5.00; LDC $3.50)

TB 5 Calkins, P. H. 1978. Vegetable consumption in five cities of Taiwan. 24 p. (HDC $4.00; LDC $3.00)

TB 6 Huang, S. Y. and P. H. Calkins. 1978. Summer tomato production in Taiwan. 29 p. (HDC $5.00; LDC $3.50)

TB 7 Huang, K. R. and P. H. Calkins. 1978. Vegetable production in Taiwan; A survey of 300 farmers. 36 p. (HDC $5.00; LDC $3.50)

TB 8 Calkins, P. H. 1978. Why farmers plant what they do: A study of vegetable production technology in Taiwan. 92 p. (HDC $7.50; LDC $4.00)

TB 9 Calkins, P. H. and H. M. Wang. 1978. Improving the marketing of perishable commodities: A case study of selected vegetables in Taiwan. 65 p. (HDC $6.00; LDC $3.50)

TB 10 Calkins, P. H. and S. H. Tu. 1978. White potato production in Taiwan: A farm survey. 29 p. (HDC $4.00; LDC $3.00)

TB 11 Calkins, P. H. 1978. Soybean production in Taiwan: A farm survey. 28 p. (HDC $4.00; LDC $3.00)

TB 12 Riley, James J. 1978. Evaluation of environmental parameters in the humid tropics for crop scheduling purposes. 31 p. (HDC $4.00, LDC $3.00)

TB 13 Shanmugasundaram, S. 1979. Varietal development and germplasm utilization in soybeans. 36 p. (HDC $5.00; LDC $3.50)

TB 14 Caldwell, John S. and Donald W. Newsom. 1984. Vegetable consumption and production in two municipalities in Ilocos Norte, Philippines. 24 p. (HDC $4.00; LDC $3.00)

TB 15 Green, S. K. 1984. Guidelines for diagnostic work in plant virology. 43 p. (HDC $5.00; LDC $3.50)

TB 16 Caldwell, John S. 1987. Assessing rainy season vegetable production alternatives: A case study in 'upstream' farming systems research. 50 p. (HDC $5.00; LDC $3.50)

TB 17 Opeña, R.T., C.G. Kuo and J.Y. Yoon. 1988. Breeding and seed production of Chinese cabbage in the tropics and subtropics. 92 p. (HDC $7.50; LDC $4.00)

Bibliographies

Talekar, N. S., H. C. Yang, S. T. Lee, B. S. Chen and L. Y. Sun (comps.). 1985. Annotated Bibliography of Diamondback Moth. 469 p. (Gratis, limited stock distributed selectively.)

Hwang, P. L., F. C. Chen and C. C. Wei (comps.), Saadaoui, M., A. T. Tschanz and J. W. Soderlund (eds.). 1987. Soybean Rust Bibliography. 103 p. (HDC $7.50; LDC $5.00)

AVRDC. 1988. Disease and Insect Pests of Mungbean and Black Gram: A Bibliography. 254 p. (HDC $17.50; LDC $10.00)

Directories

Yoon, Jin-Young. 1988. Directory of Chinese Cabbage Researchers. 62 p. (HDC $6.00; LDC $3.50)

Shanmugasundaram, S. 1989. Directory of Mungbean and Soybean Researchers. 140 p. (HDC $12.00; LDC $8.00)

Monographs

Bressani, Ricardo. 1982. World needs for nutrition and the role of vegetables and legumes. 22 p. (HDC $4.00; LDC $3.00)

Chandler, Robert F. 1983. The potential for breeding heat tolerant vegetables for the tropics. 10 p. (HDC $3.00; LDC $2.00)

Choudury, B. 1984. Vegetables and the quality of life in the year 2000. 7 p. (HDC $3.00; LDC $2.00)

Innes, N. L. 1983. Breeding field vegetables. 34 p. (HDC $5.00; LDC 3.50)

Liu, M. S. and Paul C. Ma. 1983. Postharvest problems of vegetables and fruits in the tropics and subtropics. 14 p. (HDC $3.00; LDC 2.00)

Wittwer, Sylvan H. 1983. Frontiers for science and technology in vegetable production. 19 p. (HDC $4.00; LDC $3.00)

Miscellaneous

Van der Goot, P. 1930 [translated 1984]. Agromyzid Flies of Some Native Legume Crops in Java. 102 p. (HDC $7.50; LDC $4.50)

Franssen, C. J. H. 1934 [translated 1987]. Insect Pests of Sweet Potato Crop in Java. 24 p. (HDC $4.00; LDC $3.00)

Shanmugasundaram, S., T. S. Toung and L. F. Chen. 1985. AVRDC Soybean Evaluation Trial (ASET) 1980 & 1981. 62 p. (Gratis, limited stock distributed selectively.)

Ahn, Chang-Soon, Jin-Hu Chen and Hao-koan Chen. 1985. International Mungbean Nursery (IMN) 1981 & 1983. 86 p. (Gratis limited stock distributed selectively.)

Shanmugasundaram, S. 1988. A Catalog of Mungbean Cultivars Released Around the World. 20 p. (HDC $4.00; LDC $3.00)

International Guide Sheets

78-63 Park, H.G. 1978. Suggested cultural practices for mungbean. 2 p. (Gratis)

78-64 Park, H.G. 1978. Procedures for mungbean evaluation trials. 4 p. (Gratis)

78-65 Villareal, Ruben L. and S.H. Lai. 1978. Pollen Collector. 2 p. (Gratis)

78-66 Riley, James J. 1978. AVRDC crop environment. 2 p. (Gratis)

78-101 Villareal, Ruben L. and S.H. Lai. 1978. Procedures for tomato evaluation trials. 4 p. (Gratis)

79-112 Shanmugasundaram, S. 1979. Suggested cultural practices for soybean. 2 p. (Gratis)

79-121 Hubbell, John N. and M. Y. Chiang. 1979. Suggested cultural practices for sweet potato experiments. 2 p. (Gratis)

79-125 Shanmugasundaram, S. 1979. Evaluating AVRDC soybeans. 4 p. (Gratis)

79-127 Kuo, C.G. and S.H. Lai. 1979. Suggested cultural practices for tomato. 3 p. (Gratis)

80-134 Villareal, Ruben L. and H.F. Lo. 1980. Procedures for sweet potato evaluation trials. 4 p. (Gratis)

80-144 Opeña, Romeo T. and S. H. Lo. 1980. Procedures for Chinese cabbage evaluation trials. 6 p. (Gratis)

85-234 Kuo, George C. 1985. Handling of sweet potato germplasm. 2 p. (Gratis)

85-238 Kuo, George C., Steve Lin and Sylvia Green. 1985. Sweet potato germplasm for international cooperators. 3 p. (Gratis)

87-272 Yoon, Jin-Young, Romeo T. Opeña and Lien-chung Chang. 1987. Cultural practices for Chinese cabbage at AVRDC. 6 p. (Gratis)

88-292 Talekar, N.S. 1988. How to Control Sweetpotato Weevil: A practical IPM approach. 6 p. (Gratis) — Chinese edition also available.

Newsletters

Centerpoint — This newsletter of AVRDC provides up-to date information on research, training, publications, etc. (Gratis)

TVIS News — This journal was prepared by the Tropical Vegetable Information Service (TVIS) through AVRDC. It provided a platform of exchange of information for scientists working with mungbean, soybean and Chinese cabbage. (HDC $4.00/issue; LDC $2.00/issue)

Vol 1., Nos. 1, 2; Vol. 2, No. 1; Vol. 3, Nos. 1, 2

Soybean rust newsletter — This annual newsletter is published by the International Working Group on Soybean Rust through AVRDC. (HDC US$5.00/issue; LDC US$2.00/issue)

Journal Paper Reprints

JP 1 Mackenzie, D. R., L. Ho, T. D. Liu, Henry B. F. Wu and E. B. Oyer. 1975. Photoperiodism of mungbean and four related species. HortScience 10(5):486-487.

JP 3 Wu, Henry B.F., T.T. Yu and T.D. Liou. 1974. Physiological and biochemical comparisons of sweet potato varieties sensitive (Tai-Lung 57) and insensitive (Red-Tuber-Tail) to chilling temperatures. Bull. 12, Roy. Soc. of New Zealand, p. 483-486.

JP 5 Mew, I-pin C., T.C. Wang and T.W. Mew. 1975. Inoculum production and evaluation of mungbean varieties for resistance to *Cercospora canescens*. Plant Dis. Reptr. 59:397-401.

JP 6 Mew, T.W. and W.C. Ho. 1976. Varietal resistance to bacterial wilt in tomato. Plant Dis. Reptr. 60:264-268.

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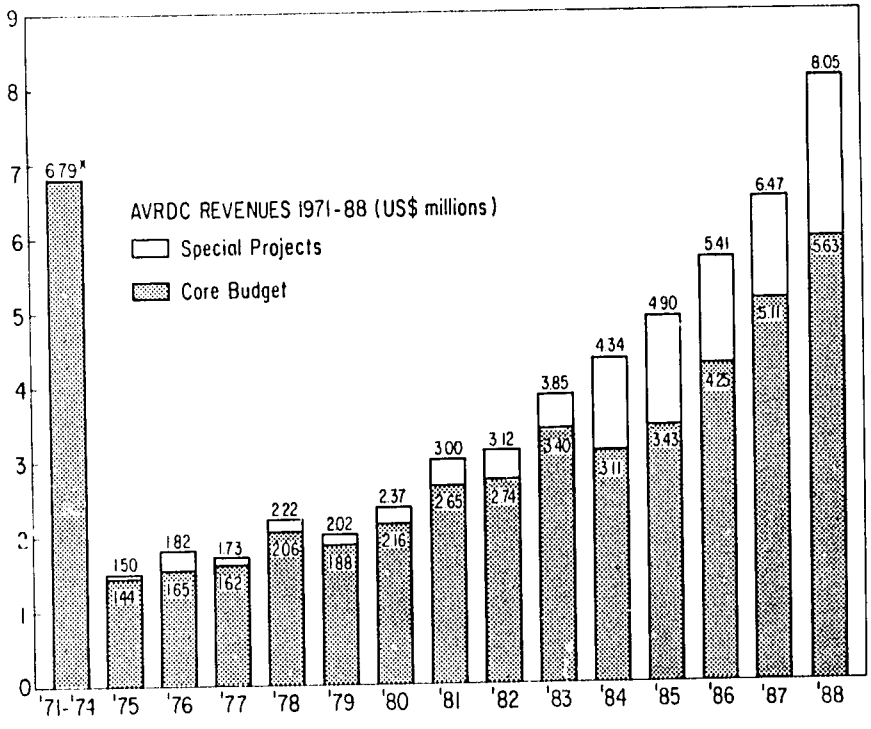

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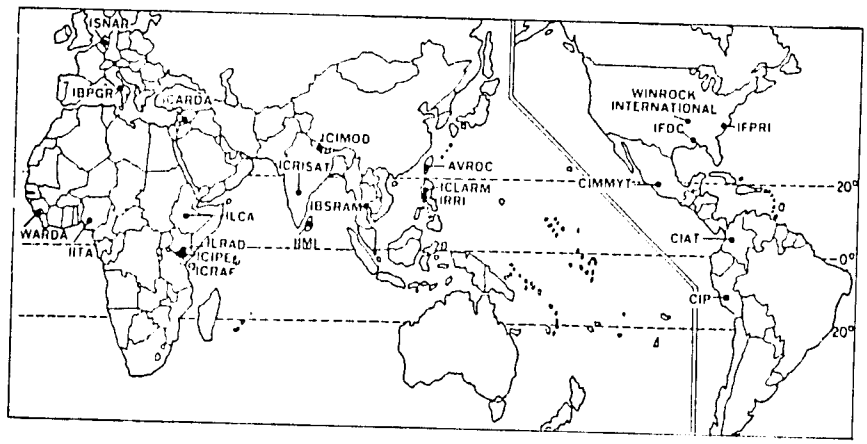

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