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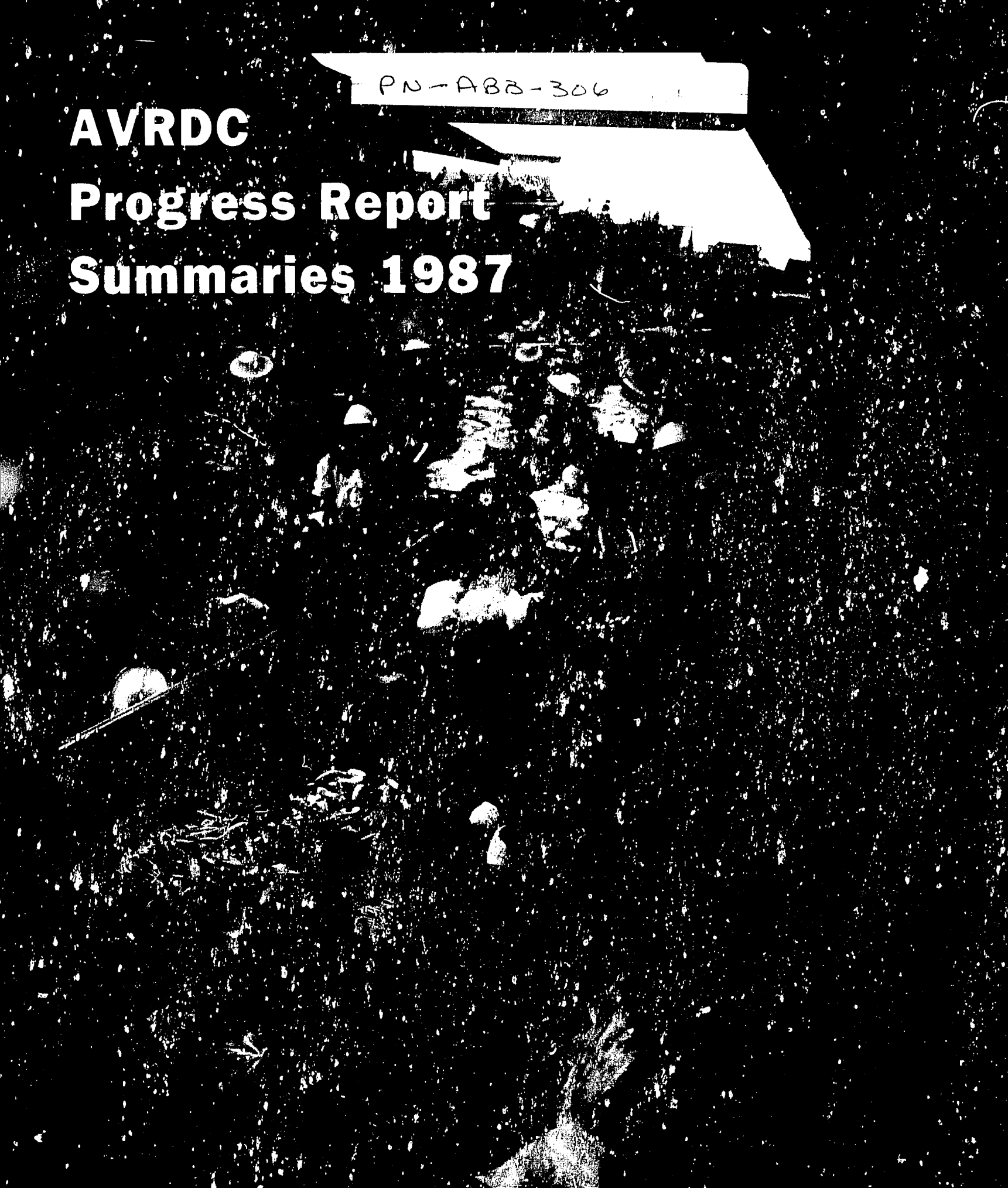
AVRDC Progress Report Summaries 1987



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; varietal 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 360 persons from a dozen countries. The Center's budget, which totaled US$6.47 million in 1987, is provided by the governments of the Republic of China, the United States of America, Japan, the Kingdom of Thailand, the Republic of Korea, the Federal Republic of Germany, the Republic of the Philippines and the French Republic. Special project funds are provided by a variety of international donors including the Asian Development Bank, the Swiss Development Corporation, the International Development Research Centre of Canada, the Agency for International Development, the Sasakawa Peace Foundation and the International Board for Plant Genetic Resources.

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

about the cover: Thai vegetable market photographed by Chen Ming-che

AVRDC
Progress Report
Summaries
1987

About this Report

This report provides an overview of AVRDC research in 1987. 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

Every few years, flag words emerge, representing ideas which may be new in concept, or merely old ideas with new names. The flag words, at the height of their popularity, are often called buzz words, because they resemble the sound of activity made by man's noble ally, the bee.

A few of the 'buzz words' in modern agriculture which are being overworked at the moment are constraints, networking and sustainbility. All are very good words, all have useful meanings. The word of caution is that a new name does not always indicate a new idea or new activity.

The word constraint has been part of agricultural research effort for more than two hundred years. The various meanings of the word include: to confine; to check; to hold back; and to restrict. A thief caught and held with shackles around his arms and legs may not be able to spell the word but he is definitely experiencing a constraint.

Many of the early fertilizer studies helped to break the bonds of low yields. Plant breeders have helped to cut the cords restricting production associated with diseases, high temperature and photoperiod. We are now entering an era in which biotechnology may take us to new levels of achievement that we may not have thought possible.

The AVRDC is committed to reducing constraints, and has been since its dedication in 1973. As a center for germplasm, information and training, all efforts are related to activities of assistance for that purpose. The problem is matching resources with demand. It is very much like the mosquito entering a dormitory of sleeping soldiers, 'I know what I want to do, but where should I start?'

Vegetable production in the tropics has many levels of constraints. The small farmer may be confined by too much rain, too little money or poor roads to the market. The extension worker may be ineffective due to the lack of a vehicle, poor resource materials or inadequate training. The vegetable researcher may operate at reduced efficiency because of limited access to research literature, insufficient funds or lack of trained manpower. At the policy level, government officials may unintentionally restrict the development of a vigorous vegetable industry by poor pricing policies, poor support for research and extension, or failure to help develop better roads and market facilities.

It is not possible for a research institution such as the AVRDC to address all levels of constraint. Our task is to assist national programs improve their research and extension efforts. We must constantly assess which constraints are most important; how much, when and how we can be of most help; and how best to match our resources to national program needs.

Fortunately, many helpful forces of increasing significance are developing. The national programs are becoming better trained and equipped. The private seed and allied support companies are providing more and more assistance to the small vegetable farmer in the tropics. The consuming public is becoming more aware of food quality, food safety and nutrition. The small farmer is learning more about marketing, postharvest losses and causes of low profit and will soon be asking for more and more answers and solutions from their national programs.

All of these forces are associated with a developing vegetable program. Perhaps a new buzz word will be coined for these developments; in the meantime, we might wish to call it by a simple term, commercialization.

George A. Marlowe

George A. Marlowe
Director General

Abbreviations and Acronyms

-AARD - Agency for Agricultural Research and Development (Indonesia)
-ABA - abscisic acid
-ACB - Asiatic cornborer
-ACC - 1-aminocyclopropane-1-carboxylic acid
-ACCT - Agency for Cultural and Technical Cooperation (France)
-a.i. - active ingredient
-AID - Agency for International Development (USA)
-AMV - alfalfa mosaic virus
-ARTT - advanced soybean rust tolerance trial
-ASET - AVRDC Soybean Evaluation Trials
-AVRDC - Asian Vegetable Research and Development Center (IARC)
-AYT - advanced yield trials
-AzMV - Adzukibean mosaic virus

-BARI - Bangladesh Agricultural Research Institute
-BC - backcross
-BCMV - bean common mosaic virus
-BICMV - blackeye cowpea mosaic virus
-BORIF - Bogor Research Institute for Food Crops (Indonesia)
-BW - bacterial wilt
-BYMV - bean yellow mosaic virus
-BS - bacterial spot

-CAAS - Chinese Academy of Agricultural Sciences
-CARDI - Caribbean Agricultural Research and Development Institute
-CATIE - Tropical Agricultural Research and Training Center
-CENARGEN - Centro Nacional de Recursos Genéticos (Brazil)
-CIAT - Centro Internacional de Agricultura Tropical (CGIAR)
-CIRAD - Centre de coopération internationale en recherche agronomique pour le développement (France)
-CLS - Cercospora leaf spot
-CMS - cytoplasmic male sterility
-CMV - cucumber mosaic virus
-CSIRO - Commonweath Scientific and Industrial Research Organization (Australia)
-CV - coefficient of variance
-CVMV - chili veinal mottle virus
-CTA - Technical Center for Agricultural and Rural Cooperation (EC)
-DAIS - District Agricultural Improvement Station (Taiwan)
-DAS - days after sowing
-DAT - days after transplanting
-diam - diameter
-DBM - diamondback moth

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

-FAO - Food and Agriculture Organization of the United Nations
-FMV - feathery mottle virus

-GRSU - Genetic Resources and Seed Unit (AVRDC)
-GYT - general yield trial

-HES - Horticultural Experimental Station (Rep. of Korea)
-HI - heat injury
-HS - heat sensitive
-HT - heat tolerant

-IAA - indoleacetic acid
-IARC - international agricultural research center
-IARI - Indian Agricultural Research Institute
-IITA - International Institute for Tropical Agriculture (CGIAR)
-IMN - International Mungbean Nursery (AVRDC)

-INRA - Institut nacional de la recherche agronomique (France)
-IPM - integrated pest management
-IRRI - International Rice Research Institute (CGIAR)
-ISNAR - international Service for National Agricultural Research (CGIAR)
-IYT - intermediate yield trial

-JICA - Japan International Cooperation Agency

-LEHRI Lembang Horticulture Research Institute (Indonesia)

-MARDI - Malaysian Agricultural Research and Development Institute
-MLO - mycoplasma-like organism

-NBPGR - National Bureau of Plant Genetic Resources (India)

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

-PC - principal component (analysis)
-PeMV - pepper mottle virus
-pm - powdery mildew
-POP - Philippines Outreach Program (AVRDC)
-PStV - peanut stripe virus
-PVC - polyvinyl chloride
-PVMV - pepper veinal mottle virus
-PVY - potato virus Y
-PYT - preliminary yield trial

-RCBD - randomized complete block design
-RYT - regional yield trial

-SPLV - sweet potato latent virus
-SPUB - sweet potato virus B
-SPV II - sweet potato virus II
-SPVB - sweetpotato vine borer
-SPYDV - sweet potato yellow dwarf virus

-t - metric ton
-TA - technology adaptation
-TBRV - tobaco ringspot virus
-TEV - tobacco etch virus
-TLCV - tomato leaf curl virus
-TMV - tobacco mosaic virus
-ToMV - tomato mosaic virus
-TOP - Thailand Outreach Program (AVRDC)
-TRSV - tomato ringspot virus
-TSWV - tomato spotted wilt virus

-USDA - United States Department of Agriculture

-WAT - weeks after transplanting

CROP IMPROVEMENT PROGRAM

CHINESE CABBAGE

INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 1,085 packets of seed was distributed to 93 cooperators in 39 countries.

Crop Releases

China - The Vegetable Research Institute, Jiangsu Academy of Agriculture officially released AVRDC Hybrids 58 and 62 as 'Summer Pearl' and 'Summer Abundance', respectively, and provided farmers with the recommended cultural practices in the Jiang Su Agriculture Science Journal.

International Trials

Indonesia - The Indonesia-AVRDC Bilateral Program conducted initial trials at its Lembang Horticultural Research Institute which identified several AVRDC hybrids for future lowland and highland trials.

Japan - AVRDC Hybrids 82-46 and 83-20 and OP variety 77 M(3)-27 produced larger heads and proved more promising for midsummer sowing than local varieties in trials at the Fukuoka Prefecture Horticultural Research Center.

Liberia - AVRDC OP 77M(2/3)-46 was the highest yielder in a trial conducted by Lowland-N.C.R.D.P. Soft rot and/or downy mildew were serious in Hybrid 59, 77 M(3)-27 and 77 M(3)-35.

Malaysia - AVRDC Chinese cabbage 82-156, 82-157, 77 M(3)-27 and 77 M(2/3)-46 obtained yields from 33.3 to 36.5 t/ha in trials by MARDI at its Jalan Kebun Station.

Nepal - AVRDC Hybrid 62 received the highest rating for its early maturity, compact head, bolting tolerance and highest yield per unit time and area in trials conducted by HMG/FAO Vegetable Production Project.

Nigeria - In a trial conducted by IITA, AVRDC Hybrid 58 showed heat tolerance with no internal rot and the highest yield.

Philippines - AVRDC-POP, in cooperation with the East-West Seed Co., conducted a feasibility study on production of Hybrid 62 in the Baguio highland area.

Turkey - AVRDC Hybrid 83-20 showed a perfect harvest rate, early maturity and high yield in two summer trials by the Dept. of Horticulture, Cumhuriyet University.

BREEDING

Combining Ability Trial

Inbred lines previously developed from the Hakuran backcross program were crossed with old heat-tolerant inbreds and the resulting combinations were tested in a summer trial. The eight best entries were selected for their early maturity, perfect heading rate, high harvest rate and promising preference traits to be further evaluated in the following year.

Advanced Yield Trials

Nine F_1 hybrid combinations selected from the 1986 combining ability trials were further evaluated in six advanced yield trials over the summer season. Two combinations, 86181 and 86187, were comparable in maturity and stability, and were slightly superior in yield to the standard check, Hybrid 62.

Cytosterility Backcross Program

To develop a simpler and more stable alternative to the self-incompatibility system in F_1 hybrid seed production, two different sources of cytoplasmic male sterility (CMS), radish and *Brassica juncea* had been backcrossed to tropical Chinese cabbage. Radish-originated CMS lines in the BC_5-BC_6 generation were evaluated for their combining ability during the summer season. They performed much poorer than the corresponding male-fertile lines as both parents and F_1 hybrids. Backcrosses in BC_4-BC_5 of *B. juncea* origin showed less undesirable traits than in the previous generation. Twenty-four elite plants were selected from this group of CMS backcross materials to be used in further backcrosses.

The backcross lines (left and right rows) appear similar to the recipient line (middle row) after five backcrosses using mustard ex male-sterile source. The potential of this source of male sterility is still under study.

F_1 hybrid (left) using both male fertile parents and F_1 hybrid using radish ex male-sterile maternal parent (right). This source of male sterility is of no practical use.

Temporary Breakdown of Self-incompatibility

In search of economic methods to multiply self-incompatible inbred lines of Chinese cabbage and related crops, CO_2 gas treatment and salt (NaCl) spray effects were studied with bee pollination. The CO_2 treatment did not significantly increase pod and seed set. A daily spray of salt (1%-2%), however, successfully broke self-incompatibility and produced as high seed yields as bud poilination. Observation of pollen germination on the stigma and pollen tube count in the style corresponded with the seed yield data.

ENTOMOLOGY

Biological Control of DBM in Luchu Township

Attempts were made to control diamondback moth (DBM) (*Plutella xylostella*) on a commercial crucifer planting of 115 ha owned by 130 farmers in Luchu Township in Kaohsiung County. A total of 110,050 cocoons of two larval parasites, *Diadegma eucerophaga* and *Apanteles plutellae*, were released at intervais throughout the season. Total parasitism ranged from 10.2% to 24.0%. This level of parasitism, coupled with use of *Bacillus thuringiensis*, gave adequate control of DBM. Despite advice to the contrary, most farmers used chemical insecticides which caused parasite mortality and reduced parasitism. An effective extension program is a necessity for the success of any biological control program with DBM.

Biological Control of DBM in Yuangminshan

Attempts were made to control DBM by release of two larval parasites, *Diadegma eucerophaga* and *Apanteles plutellae*, on farmers' fields in a 10-ha isolated area near Taipei. A total of 97,300 parasites

Diamondback moth damage on cabbage.

were released during the season. The parasitism ranged from 20% to 80% and the DBM population was reduced from over 10 larvae per plant to 0.3 per plant. Secondary pests were kept under check by sex pheromone and occasional sprays of *Bacillus thuringiensis*. *Spodoptera litura* still caused some damage.

DBM Parasitism

Certain biological studies were conducted with two larval parasites of DBM, *Diadegma eucerophaga* and *Apanteles plutellae*, to understand the nature of parasitism in order to enable us to exploit them for the control of diamondback moth (DBM). *Diadegma* prefers lower temperatures (15°-25°C) than *Apanteles* (20°-35°C). The second and third instar larvae are preferred over the first and fourth instar for oviposition by *Diadegma* with no parasitism at all of the fourth instar diamondback moth larvae. *Apanteles* parasitized all instars of its hosts. Second instar larvae were slightly preferred over other instars. Both parasites were able to parasitize equally the larvae of insecticide-resistant and susceptible strains of DBM. Among the insecticides, all formulations of *Bacillus thuringiensis*, and insect growth regulator, CME-134, and a selective aphid pirimiphos were not toxic to either parasite. A synthetic pyrathroid, deltamethrin, was highly toxic.

Effect of Neem Extract on DBM

Neem (*Azadirachta indica*) seed and chinaberry (*Melia azedarach*) seed and bark extracts sprayed on cabbage leaves caused considerable mortality in diamondback moth larvae. These treatments also adversely affected emergence of diamondback moth adults from treated pupae. Both plant materials showed a similar effect to the commercially used insect growth regulators.

Testing of *Bacillus thuringiensis* Formulations

Certain newly developed insect growth regulators and formulations of *Bacillus thuringiensis* were tested for control of DBM and imported cabbageworm (*Pieris rapae*) in two field tests. Insect growth regulators BAS 166801 at 60 g a.i., PH70-23 at 75 g a.i., WL115110 at 50 g a.i., IKI7899 at 50 g a.i. and CME134 at 37.5 g a.i./ha gave good control of both pests. Among *Bacillus thuringiensis* formulations, Thuricide gave superior control of both pests and greater yield compared to four other formulations.

MUNGBEAN

INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 4,371 seed packets was distributed to 97 cooperators in 41 countries.

Crop Releases

Australia - 'Satin', which had AVRDC's V 2013 as a parent, was registered by CSIRO Division of Tropical Crops and Pasture because of its high yield, resistance to lodging and to CLS.

Somalia - The Legumes and Oil Crops Section of the Bonka Research Station released 'Filsan' (AVRDC cultivar VC 1168B) because of its early maturity and nonshattering quality.

Thailand - The Chai Nat Field Crops Research Center released 'Chai Nat 60' (AVRDC cultivar VC 1178) for its early and uniform maturity, high yield and suitability for rice-based cropping systems.

International Trials

IMN

In the 14th International Mungbean Nursery (IMN) trials, it was found that location contributed to 76% of the total variation. Eight lines, V 3426, VC 2750A, VC 2754A, VC 2768A, VC 2802A, VC 3004A, VC 3012B and VC 3061A, were considered moderately stable. Three accessions (V 2010, V 2984 and V 3726) and two AVRDC lines (VC 1628A and VC 3012A) were highly sensitive to environmental changes and, therefore, less stable cultivars.

Bahamas - The Department of Agriculture reported that AVRDC breeding lines, VC 1628A, VC 2768A and VC 2768B produced high yields (>1.5 t/ha) during the fall season.

Cameroon - The Comité Diocesdin de Dévelopment reported that three AVRDC breeding lines, VC 1628A, VC 2755A and VC 2764A, produced high yields of about 1.5 t/ha in acidic soils.

China - The Institute of Crop Germplasm Resources, CAAS reported that the area under mungbean production increased by 60,000 ha to 530,000 ha in 1987. AVRDC mungbean lines such as VC 1973A, VC 2778A and V 1381 were well received.

Laos - Of the more than 100 AVRDC lines evaluated at the Haddokkeo Research Station, three lines, VC 1168B, VC 2750A and VC 1560D, have been selected because of their high-yielding and resistance to PM characteristics.

Vietnam - The Faculty of Agriculture, University of Cantho, reported that 60% of the area under mungbean cultivation in the Mekong Delta is occupied by three AVRDC varieties 'DX91' (VC 1560D), 'DX102A' (VC 2768A) and 'DX113' (VC 2763A) which are recommended in Alluvial soils.

BREEDING

Hybridization Program

To combine high yield, early and uniform maturity and disease resistance, single plants were selected from the segregating population derived from the 1986 factorial design hybridization and were intercrossed to further generate recombinations and breaking of linkage blocks. In the fall season, the single plants selected from the first segregating generations were advanced by selfing, and crossed with four elite mungbean lines, VC 3890A, VC 2755A, VC 2768A and V 3726 to introduce more favorable alleles in the gene pool. The performance of each population will be evaluated in the advanced generation for desirable traits.

Genotype × Environmental Interactions

Because yield trials conducted over years and seasons require considerable expenditure of resources, estimation of genotype × environmental components will be useful to obtain information on the optimum number and allocation of replicates, seasons and year. Data from two years (1984 and 1986) and three seasons (spring, summer and fall) involving 10 elite mungbean lines were used in this analysis to estimate genotype × environmental components. Based on the results, it was concluded that yield trials conducted over three years, three seasons and three replicates would be the most cost effective and realistic for the evaluation of mungbean yield trials at AVRDC.

CLS Resistance

The high-yielding, early and synchronously maturing mungbean lines V 3726, VC 1628A and VC 1973A are susceptible or moderately susceptible to CLS. The level of CLS resistance in 13 newly developed, early maturing mungbean lines was evaluated under fungicide-protected and nonprotected conditions along with both resistant and susceptible checks. New lines with high levels of synchronous maturity, large seed and high yield with moderate levels of resistance to CLS such as VC 3737A, VC 3890A and VC 4050A were identified. Four other lines, VC 2991A, VC 3664A, VC 3853A and VC 3766-3B-2-B were very high yielding and showed high levels of CLS resistance. However, maturity was only moderately synchronous.

New AVRDC Elite Breeding Lines

A multivariate technique known as principal component (PC) analysis was used as a means of assessing the progress towards achieving the multiple breeding targets in the mungbean breeding program. A hypothetical ideal mungbean cultivar with desirable characteristics was included in the PC analysis along with the new elite lines and check cultivars. The first two principal components accounted for 53% of the information on the desirable traits. The position of the new breeding

lines, compared to the check cultivars on the two-dimensional plane, indicated the amount of progress achieved towards meeting the ideal cultivar. Potential mungbean lines which could serve as better parents for future hybridization were also identified.

Mungbean Cultivar Blends

Two mungbean cultivar blends, each comprised of three mungbean cultivars in equal proportions and their component lines, were tested in the summer and fall season at AVRDC to improve the yield stability of mungbean lines under low input, unfavorable environments. The pure line, VC 2768A, produced the highest yield in both seasons. However, the yield differences between the two cultivar blends and/or among the other four component lines were not significant. The results of the sequential yield component analysis revealed that the seed yield was greatly influenced by the pods/peduncle and the proportion of flowering nodes. These two cultivar blends will be further evaluated for yield stability, especially under poor environments, in IMN trials.

Covariance Analysis

Mungbeans are very sensitive to microsoil variation in the experimental sites within the same location and season. A large fertility gradient or microsoil variation in the experimental sites is an impediment to reliable estimation of cultivar effects. Therefore, the effectiveness of moving mean (computed from 2-5 adjacent plots) covariance analysis compared with randomized complete block design for error control in mungbean yield trials was investigated. The results clearly indicated that covariance adjustment using moving means computed from five adjacent plots gave superior control of the experimental error and is, therefore, recommended in a situation where a large number of lines are evaluated in a site with a large fertility gradient.

CLS-resistant line VC 3890A.

Beanfly damage in stem.

ENTOMOLOGY

Beanfly Resistance

Three agromyzid species, *Ophiomyia phaseoli*, *O. centrosematis* and *Melanagromyza sojae* are important pests of mungbeans from tropical to subtropical Asia, Africa and the Pacific. In 1979 AVRDC identified a mungbean accession, V 4281, which had a moderate level of beanfly resistance. This accession, which has poor agronomic characters and is susceptible to diseases, is being utilized at AVRDC for breeding agronomic breeding lines with beanfly resistance. In 1987 two progenies were screened which were bulked through seven generations and selected in the F_8 on a single-plant basis for high-yield potential. In the screening of the first set of progeny, comprised of 144 entries, 17 entries had low beanfly infestation, similar to the resistant check, over two observations. In the second set, comprised of 50 progeny, 8 entries had low beanfly infestation similar to the resistant check. These 25 entries already carry disease resistance and high yield potential. Their actual yields under high beanfly population pressure will be evaluated in 1988 before making these lines available to the national programs.

Insect Growth Regulators for Beanfly Control

Among the three selective insect growth regulators tested for the control of beanflies on mungbeans, cyromazine, at rates between 75 and 150 g a.i./ha gave control comparable to omethoate, a broad spectrum organophosphorus insecticide.

Asiatic Cornborer Resistance

Studies were conducted to understand the characteristics of the Asiatic cornborer (ACB) (*Ostrinia furnacalis*) damage to mungbeans in order to breed mungbean cultivars resistant to this pest and develop alternate control measures if resistant cultivars could not be developed. There was a significant positive correlation between plant stem diameter and insect infestation. Similarly, accessions with short internodes were significantly less damaged than those with long internodes. Trichome density on the stem had no bearing on ACB damage. *Vigna sublobata* was generally less damaged than mungbean and among 100 *V. sublobata* accessions, 25 were free of ACB damage. The thin stems of *V. sublobata* could be responsible for less ACB damage to this species. In a corn and mungbean intercrop, ACB overwhelmingly preferred corn initially but eventually moved to mungbean after most corn plants had been damaged.

Bruchid Resistance Breeding

Practically throughout the world, a bruchid (*Callosobruchus chinensis*) causes considerable damage to stored mungbeans. AVRDC identified one black gram accession, VM 2164, which is highly resistant to the pest and initiated a breeding program to develop agronomic mungbeans with bruchid resistance. In 1987 two backcross populations (BC_1F_5 and BC_1F_6) were screened for resistance to bruchids in storage. Certain BC_1F_5 populations that showed less bruchid damage were as susceptible in the next generation (BC_1F_6) as the susceptible mungbean check. It was found that although the hybrids of mungbean and VM 2164 are resistant, advanced progeny that carry more mungbean traits are susceptible to bruchid infestation.

New Sources of Bruchid Resistance

In a search for new sources of resistance to the bruchid within mungbean or cross-compatible *Vigna* species, all 100 *V. sublobata* accessions studied were resistant to this bruchid. The insects laid eggs on some accessions but larvae failed to bore into the seeds. Rough and hard seed coats appeared to be responsible for this effect. One beanfly-resistant *V. glabrescens* accession, V 1160, also showed a high level of resistance to *C. chinensis*. Among additional recently screened mungbean germplasm, one mungbean accession showed a high level of resistance. The mechanism of bruchid resistance in this accession will be studied in 1988.

PEPPER

BREEDING

Pepper Improvement Program

Based on information from the literature, a questionnaire survey and AVRDC's own observations, problem areas which deserve high priority in the pepper varietal improvement program are resistance to: (1) viruses (TMV, CMV, PVY and CVMV), Phytophthora rot and bacterial leaf spot for both hot and sweet peppers; (2) bacterial wilt (sweet pepper); and (3) anthracnose (hot pepper). Sunscald tolerance (sweet pepper) and increased pungency (hot pepper) also require attention. Early maturity is essential to make the crop more easily adaptable to various farming systems. More basic studies are needed on fruit development under heat- and virus-stress conditions and on root reaction to excessive soil moisture. Green-colored bell-type sweet peppers of about 100 g fruit weight have been found to be the most widely acceptable, while hot peppers showed a great diversity in consumers' preference.

For the tropicalization of sweet pepper, parallel backcross programs for each of one or two traits, followed by a pyramidization process in one genotype are proposed. In hot pepper, identification and distribution of the row and enhanced breeding materials to help national programs tackle area-specific problems will be the major activity of AVRDC. The desired breeding nature of improved genotypes and desirable type of cooperation with national programs, as well as subject areas which need urgent attention from other disciplines, are discussed.

Germplasm Evaluation Trials

To find useful genetic materials for the pepper improvement program, a total of 318 entries were evaluated through two observational, two preliminary and one advanced germplasm evaluation trials. Promising genotypes were sought for early maturity, yield, fruit characters and disease resistance. Eighty-eight different crosses were made among the selected entries for various objectives.

ENTOMOLOGY

Literature Survey of Insect Pests

A detailed survey of the literature on insect and mite pests of pepper was conducted to determine the focus for AVRDC research. A total of 293 insect and mite species infest pepper plants in the field and some attack pepper fruit in storage. Foliage harbors the largest number of species (111) followed by fruits (71), stems (38), flowers (31) and roots (8). Fourteen species damage pepper fruits in storage and four species attack young seedlings. Some species such as aphids, thrips and mites attack more than one plant part. *Myzus persicae* (Sulzer), an aphid species which is an important virus vector, is the most widespread insect

***Heliothis armigera* on pepper.**

infesting pepper in 37 countries including several tropical countries. Two other well-known virus vectors, an aphid (*Aphis gossyppi* Glover) and a whitefly (*Trialeurodes vaporariorum* Westwood), occur in 13 and 10 countries, respectively. While *A. gossyppi* occurs in the tropics as well as temperate areas, *T. vaporariorum* occurs mainly in temperate areas. Two mite species, (*Hemitarsonemus latus* and *Tetranychus urticae* Koch) are also widespread and found in the tropics. At least five species of fruitflies attack pepper and all of them are present in the tropics.

PATHOLOGY

Pepper Diseases

Viruses, Phytophthora blight, bacterial leaf spot, powdery mildew and anthracnose were the most important diseases of peppers in Taiwan in 1987. Three hot pepper cultivars, MC4, MC5 and Szuchuan were found resistant to tomato bacterial wilt in the field nursery. In field surveys two different anthracnose species were found. *Colletotrichum gloeosporioides* caused slightly sunken dark yellow spots on the red, ripe fruit. Its conidia showed a dull or round shape at the ends. *Colletotrichum capsici* caused a darker infected area and its conidia were tapered at both ends, resulting in a sharp pointed shape. The symptom caused by *C. gloeosporioides* was more frequently found than that of *C. capsici* in the disease nursery. Some lines highly resistant to anthracnose were found. The pathogenicity of the isolates of *Phytophthora capsici* showed significant difference either in hot pepper or in the early stage after inoculation in sweet pepper. Seven very highly resistant lines were obtained from the resistance screening trial.

Shock reactions of CMV on pepper.

Monitoring for Viruses

Ten successive plantings of five *Capsicum* cultivars, selected for breeding materials, were monitored at 25- to 35-day intervals for the presence of viruses in AVRDC fields. Four viruses, CVMV, CMV, PVY and TMV were found. Viruses were first detected about 29 days after transplanting. CMV and CVMV generally appeared first, followed by PVY. TMV incidence was generally low and occurred at later times (55-60 DAT).

Virus Isolation and Straintyping

A survey for pepper viruses was conducted in Taiwan and Thailand. A total of 1,037 leaf samples were collected and tested by ELISA for presence of 11 viruses (CMV, PVY, PeMV, PVMV, CVMV, TEV, TMV, PVY, TSWV, AMV, TBRV and TRSV). Only four viruses, CVMV, CMV, PVY and TMV (in order of importance) were detected. Pure isolates of each virus have been recovered. Preliminary straintyping indicated that PVY-0 is the most prevalent strain of PVY in Taiwan.

PHYSIOLOGY

Water Uptake, Growth and Fruit-set of Peppers

Preliminary studies on hot and sweet peppers under greenhouse conditions reveal that both peppers consumed more than 770 liters of water throughout a 120-day growing period, and carried certain levels of heat tolerance in terms of fruit-setting. A larger proportion of dry matter was diverted to the stems of hot peppers, which had high dry matter production and high nitrogen content in the leaf and stem.

SOYBEAN

INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 19 packets of AVRDC Soybean Evaluation Trials (ASET), 407 elite breeding lines, 58 pedigrees/populations and 108 germplasm accessions was sent to cooperators in 33 countries.

Crop Releases

Indonesia - Upon the recommendation of BORIF, the Ministry of Agriculture released 'Tidar' (AVRDC's G 2120-M). 'Tidar' was from 8% to 182% higher yielding than the existing varieties and, because of its earlier maturity, it will fit into rice-based cropping systems.

Taiwan, China - The Kaohsiung DAIS released AVRDC vegetable soybean cultivar AGS 292 as 'Kaohsiung No. 1' because of its high yield, resistance to downy mildew and suitability for mechanical harvesting.

International Trials

ASET - Thirteen ASET results were received from scientists from 12 countries. The results revealed that AGS 124, AGS 129, AGS 217, AGS 299 and AGS 162 outyielded the local checks in one or more countries.

Mali - After a number of trials the Soybean Association of Mali would like to purchase 7,000 kg of seeds of either AGS 200 or AGS 215.

Sri Lanka - The Canadian organization, Plenty, reported that AGS 186, AGS 188, AGS 190 and AGS 191 vegetable soybeans performed very well, were readily accepted by the consumers and had less beany flavor.

Vietnam - Among the entries received from AVRDC, G 2261 has been reported to be performing well.

BREEDING

Hybridization

To develop productive good quality vegetable soybeans modified backcrossing was used. Specific crosses were made to combine narrow leaflet, high yield and resistance to soybean rust, downy mildew, stink bug and defoliators. Crosses were also made to enhance the seed size and seed quality of improved AVRDC selections. Selections will be made for the desirable combination of traits from the inbred generations of the crosses. Hybridization was also utilized to understand the inheritance of a few specific characters.

Evaluation of introductions

New soybean introductions may have useful genes for the breeding program. Therefore, new germplasm and improved varieties are introduced and evaluated. Of the 175 new accessions from five countries, there was sufficient seed available for 110 introductions which were evaluated in three different trials. None of the entries were superior in yield compared to the AVRDC checks. Seven entries were selected for their superior seed quality and soybean rust resistance/tolerance which need to be confirmed in further trials.

Yield Trials

Selected pedigrees are evaluated at various stages for their superior yield potential combined with disease resistance, seed quality, maturity duration and other desirable agronomic characteristics. Genotypes such as GC 82341-7-2, CG 81038-18-3, GC 81075-36, PI 379618, GC 81075-16, GC 8108C-13 and 269 had either similar or higher yield potential in the spring and/or summer seasons and a better level of bacterial pustule and downy mildew resistance than AGS 129 (check). Although season-specific and multiple-season adapted genotypes were selected from the yield trials, since the genotype × environment interaction is predominant, it is desirable to have multilocational yield trials to identify wide adaptability.

Soybean Rust Tolerance

Soybean rust is an important yield-limiting constraint for soybean production in the tropics and subtropics in Asia. Significant genotype × fungicide interaction was observed in the yield trials. Genotypes AGS 302, SRE-D-14A and GC 00138-29 had higher yield potential with lower rust tolerance level. SRE-C-56A and SRE-D-14B had a high level of rust tolerance but they had relatively low yield potential. Crosses between the former and the latter groups are proposed to combine high yield and a high level of rust tolerance. The correlation between percent rust infection and yield was highly significant. In the two yield trials 52% and 69% of the yield loss is attributed to reduction in 100-seed weight.

The importance of evaluating and incorporating good seed quality along with high yield potential and rust resistance is emphasized.

Bacterial Pustule Resistance

During the rainy season, bacterial pustule can cause yield reduction in soybean. A higher level of bacterial pustule resistance reported in AGS 129 and G 8190 relative to the known resistant cv. CNS needs to be better understood. Results showed that bacterial pustule disease, initiated at the R4 to R5 growth stage, can cause more than 60% yield reduction in susceptible cv. Shih Shih compared to 12% in AGS 129, 1% in G 8190 and no yield loss in CNS. Such results suggested that the resistance in CNS is as good as or better than AGS 129 and G 8190. The inheritance studies indicated that resistance to bacterial pustule is probably governed by a recessive gene as reported earlier. However, the major dominant gene governing the susceptibility to bacterial pustule is modified by other susceptible genes. Selected resistant F_2 pedigrees will be progeny-tested in the F_3 to confirm their resistance. From 2.7% to 3.0% of the F_2s were selected as being resistant to bacterial pustule and containing other desirable agronomic characters.

Breeding Vegetable Soybeans

Soybean as a vegetable has excellent potential in enriching the diet of people in the developing tropical and subtropical countries. From crosses made in 1983, GC 83011-35 and GC 83008-16 yielded 12.8 and 11.7 t/ha marketable pods against 8.5 t/ha for the check Ryokkoh in the spring season. In the summer, in spite of a typhoon, AGS 292 and GC 83006-7 were able to give 13.1 and 10.3 t/ha compared to 8.1 t/ha for the check Tzurunoku. In order to increase the percentage of two- and three-seeded pods the narrow leaflet gene, Inln, is being introduced into the vegetable soybeans through backcrossing.

AVRDC vegetable soybean released as Kaohsiung No. 1 in Taiwan.

ENTOMOLOGY

Tolerance to Beanflies

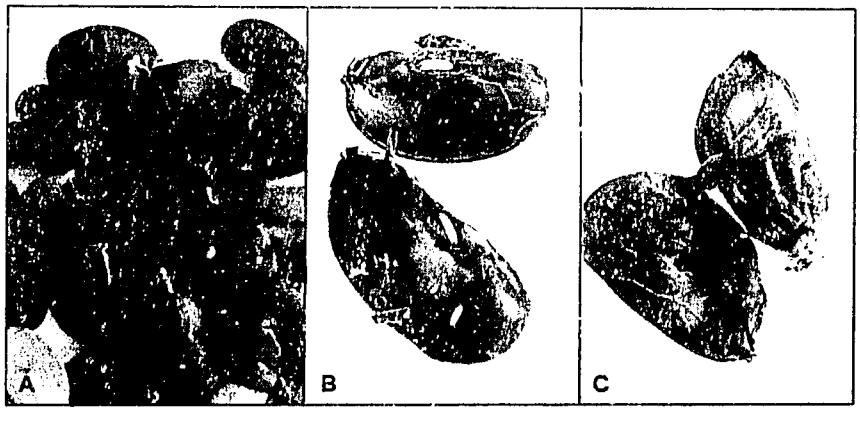
Tolerance of soybean germplasm to a beanfly species, *Melanagromyza sojae* (Zehntner) damage was studied in three tests. Soybean accession G 8586 showed consistently less yield loss due to beanfly infestation for three consecutive years. PI 171444, PI 229358, and G 794 also showed tolerance to beanfly damage.

Beanfly Resistance

Four plant introductions, PI 171444, PI 171451, PI 227687 and PI 229358, were tested at the cotyledon stage for beanfly, *Ophiomyia phaseoli*, resistance in a greenhouse. The number of pupae per plant was significantly less in PI 227687 than in the susceptible check and the three other PI accessions. Plant mortality was significantly less in PI 171444 and PI 227687. PI 227687 appears to be resistant and PI 171444 tolerant to *O. phaseoli*.

Mass-rearing of Beanflies

A simple and inexpensive procedure that utilizes freshly emerged soybean cotyledons, was developed for mass-rearing of beanfly, *Ophiomyia phaseoli*. Beanfly adults lay eggs in the soybean cotyledons and the larvae feed and pupate in that plant part. Larvae and pupae can be taken out and used for studies at any stage of development or the pupae can be maintained until adult emergence. The insect raised in this manner retains its ability to infest soybean. Up to 2,000 flies per day have been raised by this method with the input of one laborer.



Mass rearing of *Ophiomyia phaseoli*: (A) beanfly in feeding tunnels; (B) larvae; and (C) pupae in soybean cotyledons.

Biology of *Ophiomyia centrosematis*

The biology of an agromyzid pest, *Ophiomyia centrosematis* (De Meijere), was studied under laboratory conditions utilizing soybean as a host plant. The insect laid eggs just underneath the epidermis in the hypocotyl of young seedlings. Oviposition started on the third day and lasted until the 18th day after adult emergence. Most of the eggs were laid between 1100 and 1700 hours. On the average a single female laid 63.25 ± 13.68 eggs in her lifetime. Larvae which fed on cortex tissue had three instars during 10.88 ± 1.89 days of the larval period at 28°C. Despite numerous eggs being laid, a maximum of only two pupae were found per plant. Adults emerged between 1100 and 1300 hours at room temperatures from 18° to 20°C and between 0700 and 0900 hours from 28° to 32°C. Most of the matings took place between 0500 and 0800 hours. The longevity of male adults was 15.36 ± 5.36 days while that of the female was 12.45 ± 4.06 days. Within the range of 20° to 35°C, the higher the temperature the shorter were the developmental stages. Under laboratory conditions, *O. centrosematis* infested 15 common legume crops. On soybean, mungbean, snap bean, adzuki bean, cowpea, pigeonpea, horse gram and alfalfa the insect completed all growth stages successfully. On black gram, rice bean and faba bean the larvae mined into the stem but failed to become pupae and on moth bean, chickpea, lentil and cluster bean the insect oviposited but eggs failed to hatch. Oviposition in soybean increased with increasing plant age between three and seven days after germination. It declined thereafter.

Sex Pheromone Activity in Beanfly

Laboratory experiments were conducted to determine whether classical sex pheromone activity exists in the beanfly, *Ophiomyia phaseoli*. Mating activity occurred mainly between 24 and 48 h after adult emergence. Repeated sex pheromone bioassay utilizing Y tube and one- to two-day-old virgin females and unmated males indicated that the classical sex pheromone activity common in insects belonging to Lepidoptera does not exist in either females or males of *O. phaseoli*.

Insecticide Screening for Beanfly

Among nine organophosphorus, synthetic pyrethroid, and insect growth regulators tested, cyromazine, an insect growth regulator, gave control of beanflies (*Melanagromyza sojae*) comparable to the standard organophosphorus chemical, omethoate.

Biology of Stink Bug

The biology of the stink bug (*Riptortus clavatus* Thunberg) was studied in the laboratory utilizing potted soybean plants. The egg stage lasted from 4.15 days at 35°C to 12.64 days at 20°C with egg mortality increasing from 5% at 20°C to 19% at 35°C. Very high nymphal mortality was observed at 20°C. There are five nymphal instars with the total nymphal period lasting from 13.9 days at 35°C to 22.8 days at 25°C. There was a highly significant positive correlation between the progression of nymphal instars and the lengths of the body and

antennae. Adults survived for 22.8 days. Eggs were laid singly mostly on the foliage. Oviposition lasted from three days to 24 days after adult emergence. A total of 129 eggs were laid by a single female.

Resistance to Limabean Podborer

In a preliminary screening of 1,000 soybean accessions, planted once each in September and October 1986, for resistance to limabean podborer (*Etiella zinckenella* Trietsche), eight entries, G 3515, G 3543, G 3574, G 3638, G 3681, G 3755, AGS 99 and AGS 169, were relatively less damaged than the rest in both plantings. In a second screening of selected accessions that were least damaged in 1985, accessions G 3469 and G 3472 were the least damaged in four monthly plantings between July and October 1986. These accessions have distinctly smaller pod and seed sizes compared to the susceptible check. Among the four defoliator plant introductions, PI 227687 and PI 229358 were significantly less damaged than the susceptible check. Resistance of these accessions will be confirmed during the 1987-88 season.

Trichome Density

In a survey of pod morphology of 1,667 soybean accessions, the trichome density on green pods (R3-R4) ranged from 101 to 663 trichomes per 4 mm^2 of pod surface. The pod size ranged from a diameter of 1.93 to 8.28 mm. There was no statistically significant correlation between the trichome density and the pod size. This data will be used for selecting soybean germplasm in screening for *E. zinckenella* resistance.

PATHOLOGY

Advanced Soybean Rust Tolerance Trials (ARTTs)

Three advanced trials (ARTT-I, ARTT-II and ARTT-III) were conducted in both fall 1986 and spring 1987. A total of 42 lines was tested in the fall season and 36 in the spring season. Five of the cultivars (AGS 302, SRE-B-15C, SRE-C-56A, SRE-D-14A and SRE-D-14B) far surpassed the original selection criteria. They had superior performance with respect to yield and rust tolerance over 5-6 environments and demonstrate that high levels of rust tolerance and stable, high yield can be combined in advanced lines. The yield stability of SRE-D-14B is close to the ideal of 1.0, and yield, either with or without fungicide protection, was superior to all check cultivars. In ARTT-II the two best cultivars across both seasons, SRE-D-14-0-Bkl-6e-1-3-Bk-2-2 and SRE-D-14-0-Bkl-6e-1-3-Bk-1- 2, had yields similar to AGS 129, the highest-yielding check,

when protected with fungicide and yielded 1.24 and 1.09 t/ha more than the best-yielding check, AGS 181, when the plants were not protected by fungicide. Nine cultivars from ARTT-II were selected and will be further evaluated.

Screening for Rust Resistance

Soybean rust is one of the most serious diseases of soybean in Southeast Asia. No highly-resistant or highly-tolerant soybean cultivar has been identified yet. Therefore, a total of 212 *Glycine* accessions were screened by artificial inoculation to identify additional sources of resistance. Fifty accessions were selected as highly resistant based on at least three test evaluations. Because of their high levels of rust resistance, these accessions will be excellent materials for interspecific soybean hybridization programs.

Germination of Soybean Seeds

The effect of seed size, genetic potential and storage condition (cold room vs room temperature and containers, nylon net bag vs closed plastic jar) on the germination of soybean seeds was studed. Soybean seeds from three different cultivars that varied in seed size from large seed (23.6 g/100-seed weight) to small (12.4 g/100-seed weight) were utilized in a 12-month storage study. The germinability of all three cultivars remained uniformly high and unchanged after a one-year storage period in the cold room in plastic jars sealed with screw-top lids. The large-seeded cultivar, PI 459025, had distinctly better longevity and germinability than the other two cultivars. Therefore, the genetic potential for seed longevity can be high in large-seeded cultivars. Apparently, seed longevity is strongly influenced by a complex interaction between genetic potential, storage temperature and seed moisture. It appears that exposure to high humidity alone may not be sufficient to cause an increase in seed moisture content. It also appears that high temperature adversely affects the actual germination process and may confound future studies on seed longevity.

Inheritance of Resistance to PStV

Inheritance of resistance to a soybean isolate of peanut stripe virus (PStV-strain PN) was studied in three soybean varieties, AGS 129, Ankur and PI 230971. Genetic analysis was based on necrotic, mosaic and symptomless reactions in inoculated soybeans. A single incompletely dominant gene in AGS 129 was found to confer the resistance to PStV and was tentatively designated as *Pst*. The homozygous parent AGS 129, possessing the genotype *Pst Pst* was immune, while Ankur and PI 230971, with a genotype of *pst pst*, were susceptible, showing mosaic symptoms. The heterozygous genotype *Pst pst* resulting from the cross of either Ankur or PI 230971 with AGS 129 reacted with necrosis, distinctly different from the reactions of either of the homozygous genotypes. This genotypic effect was confirmed through the phenotypic segregation in BC, F_2 and F_3.

Virus Survey in Indonesia

In a survey of soybean, mungbean and peanut in East Java, the following viruses were found: AzMV, BCMV, BICMV, BYMV, PStV, CMV and an unknown poty virus. Peanut mottle virus, cowpea mosaic virus S, cowpea mosaic virus Y, cowpea mottle virus, peanut stunt virus, southern bean mosaic virus, blackgram mottle virus, and alfalfa mosaic virus were not detected. Bean yellow mosaic virus accounted for 85% of the soybean samples with various types of yellowing symptoms. This virus is considered responsible for the yellow mosaic epidemics on soybean, reported previously in this area.

Virus survey in Indonesia.

SWEET POTATO

INTERNATIONAL COOPERATION

Safe Germplasm Exchange

To minimize the risk of possibly distributing virus-infected vegetatively propagated sweet potato germplasm, AVRDC developed a virus elimination scheme which utilizes thermotherapy and meristem tip culture followed by indexing for absence of viruses by serology and two cycles of graft-indexing on susceptible indicator plants. The following 22 improved sweet potto varieties are now available:

- I57 (Tainung 57)
- I 981 (Tainung 66)
- I 423 (Tainan 17)
- CN 1028-15
- CN 1038-16
- CN 1058-10
- CN 1108-13
- CN 1216-10
- CN 1219-1
- CN 1232-9
- CN 1280-3
- CN 1345-8
- CN 1367-2
- CN 1421-56
- CN 1421-68
- CN 1448-49
- CN 1448-59
- CN 1489-43
- CN 1489-89
- CN 1510-25
- CN 1517-139
- CN 1525-11

International Trials

China - Eleven AVRDC sweet potato lines were included in yield trials conducted by cooperative research institutions. These institutions were the Chinese Sweet Potato Research Laboratory in Xuzhou; the Sweet Potato Laboratory of the Jiangsu Academy of Agricultural Science in Nanjing; the Crop Research Institute of the Sichuan Academy of Agricultural Science in Chengdu; and the Upland Crop Research Institute of the Guangdong Academy of Agricultural Science in Guangzhou.

AVRDC sweet potato CN 1108-13 performed well in these preliminary yield trials. In Xuzhou the clone outyielded the best check variety, Xushu 18 (the newly released, award-winning Chinese national sweet potato variety), in total leaves, root yield and chip production. CN 1108-13 was selected to be further tested for adaption to broader growing areas in China.

BREEDING

Hybridization Program

Three open crosses and a series of hand crosses were conducted. The main objectives of the crosses were to: (1) obtain higher dry matter yield for staple/feed type; (2) raise dry matter content of orange-fleshed type; (3) obtain higher level of scab resistance; and (4) backcross sweet potatoes to interspecific hybrids

Seedling Screening and OYTs

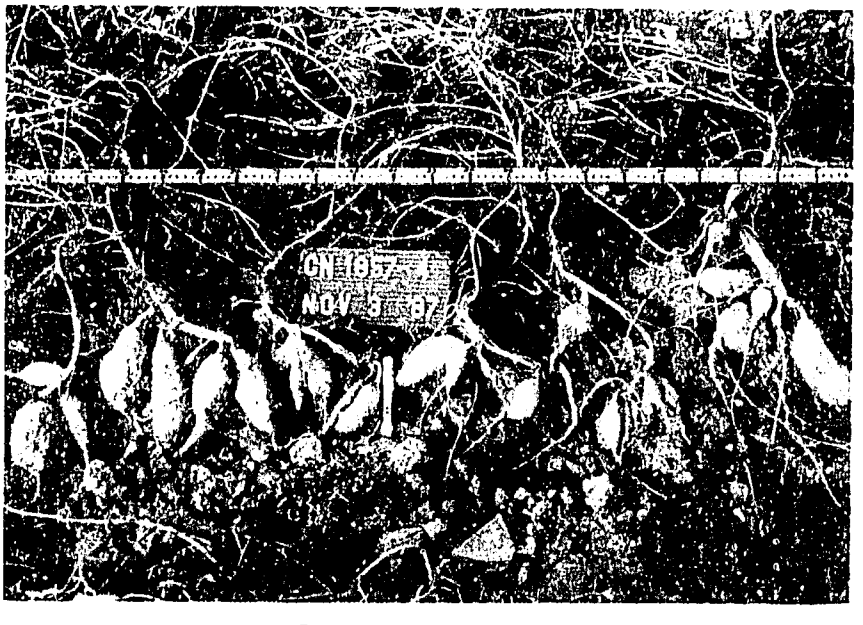
A total of 65,435 seeds were sown in the 1987 seedling screening trials from which 2,196 clones were entered into observational yield trials (OYTs). In the OYTs selection was made mainly based on flesh color, dry chip weight and root performance.

Preliminary and Advanced Yield Trials

In order to select clones which adapt well to humid tropical conditions, preliminary yield trials (PYTs) and advanced yield trials (AYTs) were conducted in two different seasons (spring and summer) in the hot-wet season in Taiwan Out of 21 entries in the AYT, three breeding lines with high dry matter yield (CN 1510-25, CN 1489-89 and CN 1688-116) showed relatively good tolerance to the hot-wet conditions.

Utilization of Interspecific Hybrids in Breeding

In order to utilize wild relatives in breeding, 4 × hybrids (obtained from the crosses between sweet potato cultivars and 4 × *Ipomoea*



Promising BC_1 hybrid.

trifida) were evaluated in 1986 and some of them showed weevil resistance or high dry matter content. Backcrossings were conducted and the BC_1 progenies were evaluated in OYT trials to monitor whether the desirable traits of the 5× hybrids could be transfered into the backcross progenies and to recover the yielding ability. There are clear differences by crossing directions between sweet potatoes and the 5× hybrids for capsule set, seed germination and root performance. Weevil resistance will be evaluated in 1988.

Preliminary Germplasm Evaluation for Less Sweetness

Sweetness of sweet potatoes depends on the concentrations of both nonreducing and reducing sugar. The development of nonsweet sweet potatoes is one of the possibilities to promote the utilization of this crop as a staple or a supplemental staple. A total of 70 germplasm was analyzed for nonreducing sugar content and the activity of beta amylase which converts starch into reducing sugar during cooking. Thirteen clones showed low beta-amylase activity and also low sugar content and were identified as promising breeding materials.

ENTOMOLOGY

Sweetpotato Weevil Resistance

Three sets of trials were conducted to screen sweet potato germplasm for resistance to sweetpotato weevil, *Cylas formicarius formicarius*. Certain accessions showed significantly less infestation than the standard susceptible checks. Since wide variation in weevil infestation of any particular sweet potato accession from season to season and location to location is common, the least-damaged accessions will be screened next year to confirm their resistance.

Interspecific Cross Progeny Screening

Forty-nine progenies of a cross between *Ipomoea batatas* and *I. trifida*, that were least damaged in the 1985-86 season, were screened for resistance to sweetpotato weevil. There was wide variation among the replicates of each entry and among the entries which missed selection of the least damaged clones based on statistical test. Nonetheless 13 entries were free of weevil infestation and five entries had less than 1 weevil/kg roots. These entries will be screened next year to confirm the stability of resistance.

Root Characters and Weevil Infestation

In a three-year (1984-86) study of correlation between easily quantifiable sweet potato root characters and sweetpotato weevil (*Cylas formicarius*) infestation, no significant and consistent correlation was observed between root characters such as dry matter, sugar, beta carotene, and protein content and weevil infestation.

Irrigation and Weevil Infestation

The influence of irrigation on sweetpotato weevil was investigated once each in the 1985-86 and 1986-87 autumn seasons. Increasing the frequency of irrigation during the season tended to reduce weevil infestation but also reduced root yields. A proper balance between the frequency of irrigation to reduce soil cracking, thereby denying the weevil access to roots, and at the same time preventing the excess soil moisture from adversely affecting the root yield; should be established for each soil type and crop cultivar.

Weevil Sex Pheromone

Studies were conducted in the utilization of synthetic sex pheromone of the sweetpotato weevil in the field. A dose of 0.1 μg was more effective than five virgin females in attracting weevil males. Within a range of 0.001 to 1 mg, a proportionately greater number of males were captured in traps baited with increasing concentrations of the sex pheromone. Among five different traps tested, a water trough trap with an opening near the top in all directions was more effective, easy to use and relatively less expensive than other traps. The capture of weevil males decreased with traps placed at increasing distance from 5 to 100 m from the pheromone source. Within a distance of 10 m, over 90% of the males were captured in the pheromone-baited trap. Preliminary studies indicated the possibility of utilization of sex pheromone for communication disruption in which the insect will not mate thereby reducing their population.

Weevil Integrated Control

Attempts were made to introduce integrated pest management (IPM) technology to control sweetpotato weevil in farmers' fields on Penghu Island, Taiwan. IPM was based on the use of weevil-free cuttings for planting, removing *Ipomoea* sp. plants from the surroundings and the use of a sex pheromone to trap male weevils. A total of 69,315

Sweetpotato weevil damage (below).

male weevils were captured in sex pheromone traps in 62 fields. The number of weevils per kg of roots at harvest ranged from 0 to 98 with a mean of 14.5. The percentage of weevil-damaged roots ranged from 0 to 58% with a mean of 11.6%. In the majority of the cases, the root damage was less than 10% and in nine fields there was no weevil infestation. If every farmer in a community rigorously follows the IPM measures, this method has the potential to eradicate the weevil over a period of time.

Resistance to Vine Borer

Progeny of crosses between sweetpotato vine borer (SPVB), *Omphisa anastomosalis* (Gueneé), resistant accessions and agronomic cultivars were screened for SPVB resistance on Penghu Island, Taiwan. The average damage among 122 breeding materials was 33.2% plants damaged. The damage was 34.4% for a susceptible check and 7.1% for three resistant checks. In some progeny, despite heavy SPVB damage, the root yield was high. This raises the possibility of developing SPVB-tolerant sweet potato cultivars. Eight entries with less than 20% damaged plants were selected for further improvement.

Vine Borer Resistance Characterization

Studies were conducted on plant morphology, oviposition preference and larval feeding of SPVB in order to understand the mechanism of SPVB resistance in three sweet potato accessions: I 55, I 92 and I 789. No clear-cut difference was found in plant morphology and oviposition but feeding of larvae in intact plants indicated that certain active principles in stems reduce larval feeding and cause significantly greater larval mortality in resistant, than in susceptible, sweet potato accessions. This finding will be confirmed in 1988.

Vine Borer Sex Pheromone Activity

Laboratory and field studies were conducted to characterize sex pheromone activity in SPVB. In female moths there was a distinct calling behavior which initiates at the beginning of the evening dark period; mating starts 6.5 hours after the initiation of darkness. Peak matings occurred between 7 and 7.5 hours after the onset of darkness. Most adults emerged from pupae one hour after initiation of darkness and few mated later during the same night but most mated the following night. Three- to four-day-old virgin females attracted a greater number of males than the younger or older ones. Virgin females of six days and older failed to attract males. These data will be utilized for isolating the SPVB sex pheromone in future studies.

PATHOLOGY

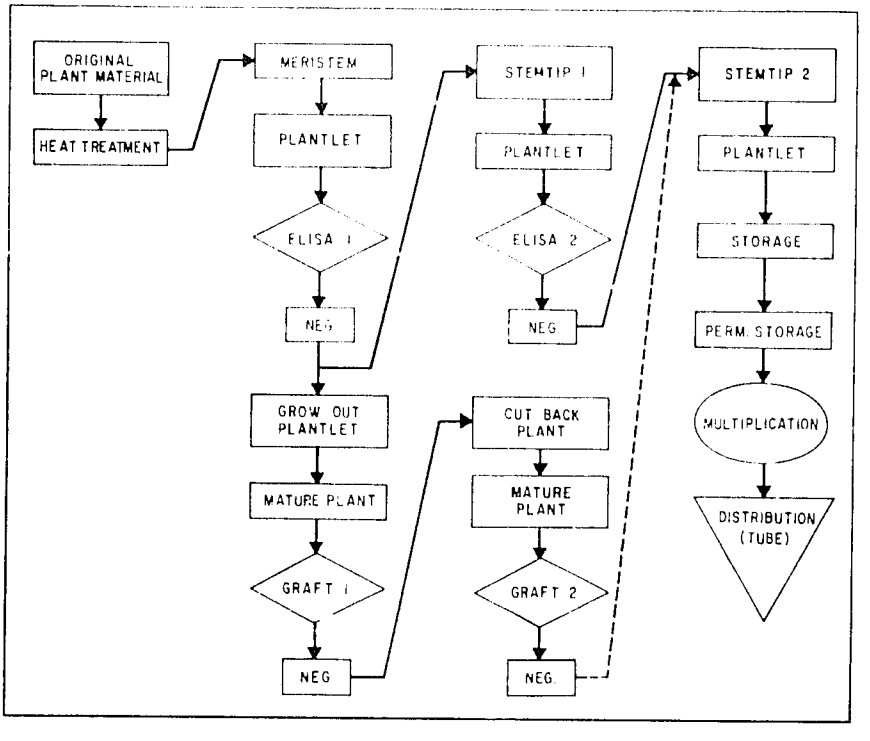
Sweet Potato Scab

Sweet potato scab is very serious in the wet, humid tropics. Resistance screening was compared at two locations, Hualien where

scab is endemic, and Tainan where scab is normally not endemic. The feasibility of a seedling screening method and the comparison of scab evaluation methodologies were also investigated. A scab epidemic could be induced by artificial inoculation and overhead irrigation at Tainan (AVRDC) during the summer rainy season. It was found that cultivars rated highly resistant to scab at Hualien were rated similarly under Tainan conditions. A seedling screening test is not feasible at this time. For greenhouse screening tests, the selected scab rating system evaluates the percentage of diseased stems and petioles. Under field conditions, the preferred rating system is a 0-5 scale, where a value of 1 indicates a level of disease similar to or less than the highly-resistant standard check cultivar, V2-30, and a value of 4 indicates a level of disease similar to the highly susceptible standard check cultivar, TN New 31.

Virus Elimination and Indexing

Virus elimination and virus indexing has been accomplished for the first set of AVRDC promising breeding lines. Twenty-one months were required to complete the procedure from sprouting to distribution. Another 134 lines (comprising AVRDC breeding lines Set II, part of the Thailand germplasm collection and some AVRDC accessions) are ready for graft indexing. These lines have not been heat-treated. Several other batches comprising 47 lines from China, Puerto Rico, Papua New Guinea, Peru and Nigeria have been heat-treated and meristemed and are now ready for/or are undergoing virus-indexing using serological tests and grafting to susceptible indicator plants. All antisera (FMV, SPYDV, SPLV and SPV II) used for virus indexing have been produced at AVRDC.



Sweet potato virus indexing at AVRDC.

Meristem-derived Sweet Potatoes

Stem cuttings of meristem derived and nonmeristem derived plants were grown in a nonreplicated field trial to obtain an indication of the vigor of the meristem-derived plants and of possible mutation of morphological characters. The meristem-derived plants did not differ in overall morphology from nonmeristem-derived plants. Yields were generally comparable.

Medium for Meristem Culture

A new standard medium (medium L) has been proposed by IBPGR for sweet potato tissue culture. On medium L, 41% of the meristems developed into viable plantlets, compared to 53% for medium K, the AVRDC standard medium. However, when explants are first placed on medium L and then transferred to medium K, approximately 61% of the meristems produced viable plantlets. The combination of these two media has now become standard use at AVRDC.

Medium for Rapid Propagation

In order to produce the large number of aseptically propagated plants of AVRDC elite breeding lines required for distribution, a rapid *in vitro* propagation medium was sought. Three different cytokinin-containing liquid media were tested on excised stem pieces, each contained one axillary bud. One of the media tested released the axillary bud from apical dominance and promoted the development of numerous buds, which developed into viable shoots and later plantlets.

Heat Treatment and Meristem Excision Against SPYDV

Meristem tip culture and thermotherapy have been widely used to eliminate viruses from infected tissues of a number of different crops. The effectiveness of both virus elimination methods was studied in SPYDV-infected sweet potato tissue. It was found that meristems were free of the virus, whereas some of the stem sections immediately below the meristems still contained the virus. A heat treatment of 37°C for one or two months was apparently sufficient to eliminate virus in the tip of the stems up to 2.5 cm below the meristem.

Elimination of MLO

Only limited information is available on the elimination of mycoplasma-like organisms (MLOs), which cause sweet potato witches' broom, by meristem tip culture, thermotherapy or antibiotic treatment. In studies using severely infected witches' broom plant materials, it was shown that MLOs were eliminated by meristem tip culture but not by culture of 1 cm stem tips excised immediately below the meristem. However a one-month treatment of stem cuttings with heat (37°C) and a three-day treatment with tetracycline prior to excision of stem tips, resulted in a high percentage of healthy plantlets.

PHYSIOLOGY

Photosynthesis and Respiration of Leaf Cuttings

Net photosynthetic rates and gas conductance in the leaves of self and reciprocally grafted leaf cuttings were measured. High-yielding CN 1028-15 scions had the highest net photosynthetic rate, but this was reduced by the low-yielding stock, CN 1367-2. High-yielding stock increased leaf gas conductance of low-yielding scions, and thus increased photosynthetic potential. Results clearly indicated that the developing storage root had a regulatory effect on photosynthesis in the leaf. Furthermore, grafted leaf cuttings with the low-yielding stock had high specific leaf weights. Specific leaf weight may be used as an indication of source potential and sink strength.

Anatomical Observations of Leaf Cuttings

Anatomical observations were carried out on self and reciprocally grafted leaf cuttings of CN 1028-15 and CN 1367-2. A large amount of starch granules were deposited in leaf blades and petioles when CN 1367-2 (weak sink strength) was used as the stock. The developing storage roots of CN 1028-15 had greater anomalous cambium number and more large parenchyma cells which, as indications of strong sink strength, could accommodate more assimilates from the leaf.

Potassium Content of Leaf Cuttings

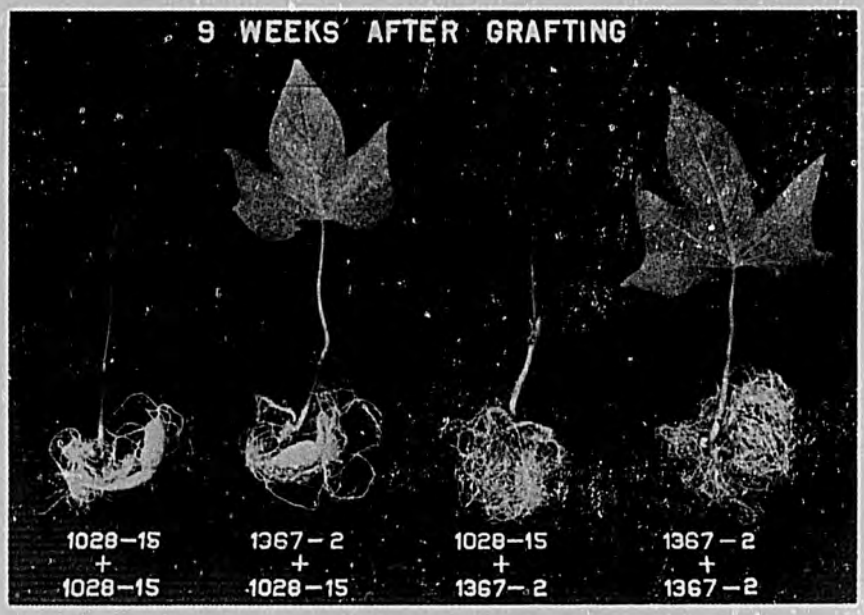
Potassium contents were determined in different parts of self and reciprocally grafted leaf cuttings of CN 1028-15 and CN 1367-2. High K contents in nonstorage organs of grafted leaf cuttings with the high-yielding CN 1028-15 stock may be related to the ready translocation of assimilates to the developing storage roots; and in storage roots be related to starch formation.

Cytokinins and Auxins during Storage Root Development

Fibrous and storage roots of self and reciprocally grafted leaf cuttings of CN 1028-15 and CN 1367-2 were examined for endogenous hormonal contents during the initiation of storage root development. Both zeatin riboside and indoleacetic acid (IAA) increased with advancing storage root development, and storage roots of high-yielding grafted leaf cuttings of CN 1028/CN 1028 contained high amounts of both zeatin riboside and IAA. Both zeatin riboside and IAA probably are needed for the bulking of storage roots.

Starch Synthesis of Leaf Cutting

Self and reciprocally grafted leaf cuttings of CN 1028-15 and CN 1367-2 were determined for enzyme activities of starch synthesis. Starch synthesis in the developing storage roots is probably controlled by the availability of carbohydrates rather than enzymatic activities of starch synthesis.



Reciprocal grafting of sweet potato leaf cuttings.

Source Potential and Sink Strength

Thirty-five sweet potato clones without prior selections for any agronomic characteristic were assessed for source potential and sink strength, i.e. total and storage root dry matter productions, by grafting of rooted leaf cuttings with themselves or low-yielding CN 1367-2 or high-yielding CN 1028-15 as scions. None of 35 clones outyielded the high-yielding CN 1028/CN 1028 in storage root dry matter; however, the results clearly indicate the rooted leaf cutting could be used as an easy method for assessing source potential or sink strength in sweet potatoes.

Varietal Difference in Amylase, Total Soluble Sugar and Starch

Eight sweet potato clones were examined for amylase activity, soluble sugar and starch content in leaves and/or storage roots from *in vitro* plantlets or callus, rooted leaf cuttings and field-grown plants, in order to establish some screening parameters for nonsweetness in sweet potatoes. Soluble sugar contents and amylase activities varied greatly with environmental and plant factors, and the characteristics of these need to be further studied before an easy screening method can be established.

Temperature Effect on Rooted Leaf Cuttings

Rooted leaf cuttings were planted in January and May to investigate the clonal differences in growth and yield under different temperature conditions. Both I 423 and CN 1517-139 produced high total dry matter and storage root under high temperature conditions. However, there was a trend of reduction in starch content under high temperature conditions.

TOMATO

INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 2,136 seed packets was distributed to 95 cooperators in 59 countries.

Crop Releases

Philippines - The Philippine Seedboard officially released AVRDC processing tomato CL 2784-1-1-4 as 'BPI-Tm P-1' or 'Mapula' because it outyielded Roma VF (check) by 16% and possess better processing traits, bigger fruit, more intense red color, and a soluble solids content of 6.3%.

Trinidad and Tobago - The Ministry of Food Production officially released AVRDC lines CL 1131-0-0-43-4-12 and CL 143-0-10-3-1-10 as 'CES No. 1' and 'CES No. 2', respectively, because of their heat tolerance; suitability to high density planting; extreme tolerance to bacterial wilt; resistance to fruit cracking; marketable yields as high as 90 t/ha; and firm fruits with good solids content and excellent red color.

International Trials

Italy - Sementi Nunhems S.R.L. found that AVRDC lines PT 1656-2 and CLN 496 possessed good quality and resistance to common leaf diseases.

Indonesia - The NTT Integrated Area Development Project noted decidedly better yields with AVRDC lines, with CL 5915-206-2-5-0 obtaining the highest yield.

Nigeria - Shell Petroleum Development Corp, Nigeria Ltd. found AVRDC lines CL 5915-93-1-0, CL 5915-93-1-0-C-1 and CL 5915-223-2-1-0 to have commercial potential.

Senegal - A FAO/Senegal Institute for Agricultural Research trial selected four AVRDC lines for advanced trials. Of these CLN 229 BC1F2-4-1-4-1-1 and CLN 236 BC1F2-26-3-3-15 are from AVRDC's first batch of nematode-resistant tropical lines.

Yemen, PDR - The Elkod Research Center conducted a heat tolerance trial in temperatures ranging from 29° to 34°C in which CL 9-0-0-1-3-0 outyielded the check by 300%.

BREEDING

Crosses and Populations

Progenies from crosses to develop nematode-resistant tropical lines have been undergoing selection for important characters required for tropical adaptation. New tropical lines coming out of the program carry nematode resistance. Screening and selections have been made from segregating populations with resistance to bacterial leaf spot and potato virus Y (PVY).

In 1987, 14 special crosses were made to incorporate fruit firmness into the tropical genetic background. In the processing type, 12 crosses were made to develop new inbred lines which combine heat tolerance, disease resistance, fruit firmness, good vine cover and compact growth habit.

An additional 30 crossses were made to breed cherry-type tomato lines which are adapted to hot, humid conditions. A total of 24 crosses were also made to incorporate resistance to tomato yellow leaf curl virus into AVRDC's tropical fresh-market and processing lines.

Heat Tolerance in New Introductions

Fifteen new introductions were evaluated for fruit-setting ability during the 1987 hot, humid summer. None compared favorably with the heat-tolerant (HT) line, CL 5915-153-3-3-0. However, the new materials produced firmer fruits than AVRDC's HT checks and carried usable levels of heat tolerance, especially when compared with heat-sensitive (HS) check, TK-70, and HT check, CL 5915-93-1-0-C-1. Some of these HT lines have already been used as sources of firmness and heat tolerance in the AVRDC tropical tomato program. The other materials will be valuable additions to the heat-tolerant parental stocks.

Bacterial Wilt Resistance

Eight sets of genetic materials were screened for bacterial wilt (BW) resistance using the field screening method developed in 1986. Regression analyses of two trials indicated that the distributions of inoculum in the BW nurseries were homogeneous. The coefficient of variation (CV), which was generally below 25%, provided further proof of the adequacy of the tests.

Bacterial wilt-resistant genetic materials, comparable in level to L 285 and CLN 65-349, possibly the two most resistant stocks in the AVRDC program, were found in all eight trial sets. The most advanced materials already have multiple resistance to BW, tomato mosaic virus (ToMV) and nematode; moreover, they have been selected for other important traits such as good fruit-set under hot conditions, crack resistance, improved fruit size and relative fruit firmness.

In tests of large-fruited F_1 hybrids, the proportion of the hybrids with good BW resistance was generally higher when both parents possessed BW resistance, even in varying degrees, than when one of the parents was susceptible. However, resistant F_1s could still be found

in the latter crosses although the frequency of those that compared favorably with the resistant checks, L 285 and CLN 65 349, was lower than in crosses among resistant parents.

Analysis of Segregation for Heat Tolerance

Genetic analysis of the cross CL 5915-153-3-3-0/BL 267 did not readily show the characteristic bimodality of distribution that was evident in the 1986 genetic materials. Given the unexpected heterozygosity of the heat sensitive parent, BL 267, this was not surprising. There were still compelling indications that the number of heat tolerance genes differentiating the parents in the present cross may also be as few as had been concluded in the 1986 study.

In the current materials, a single backcross to the recurrent tropical parent did not show any decisive advantage over selfing in terms of increasing the frequency of selectable individuals. The advantage, if any, would not be enough to offset the tedium of manual pollinations required to produce the backcross progenies.

Variation in Quality Between Tropical Lines

Two near-isogenic lines differing in growth habit were compared for various fruit quality attributes. The indeterminate isoline proved to be superior in major quality parameters, such as soluble solids, total solids, color and sugar-acid ratio, to its determinate counterpart. Moreover, vitamin C was also significantly higher in the indeterminate isoline. Regulating the fruit load by maintaining a fixed number of developing clusters per plant also improved the vitamin A and C contents, resulted in higher sugar-acid ratio and produced slightly less acidic fruits. Based on these preliminary results, selection of indeterminate tropical lines should lead to new genotypes with better quality than could be obtained with determinate tomatoes. The use of indeterminate varieties may also be combined with the traditional pruning system to obtain further improvements in quality.

Yield Trials of Tropical Breeding Lines

Three batches of tropical lines were evaluated in the 1987 summer season. Of the few nematode-resistant tropical lines tested, none proved to be superior in yield and heat tolerance to the heat-tolerant checks. The lines that showed advantage in fruit firmness will be further tested in 1988. Among the bacterial wilt- and ToMV-resistant lines, one entry (CLN 294B1F2(G)-28-17-1) outyielded the heat-tolerant check, CL 5915-153-3-3-0, and produced firmer, less cracked fruits without blotchy ripening symptoms. This line will be included in our international distribution list.

Processing Tomato Yield Trials

Four preliminary and six advanced trials of new processing hybrids were conducted in the 1986 winter and 1987 spring seasons, respectively. Outstanding hybrids selected from the 1986 PYTs showed the following desirable characteristics: high yield, good soluble solids content, fruit firmness and, in a few cases, better concentrated harvest

Processing tomato field day.

than the check cultivars. The best selections from these trials were entered in the advanced trials conducted in the 1987 spring season.

The best performing hybrids in the AYTs also showed the same desirable characteristics as in the PYTs, except that the soluble solids content in these trials generally tended to be lower, presumably because of the high soil moisture and high temperature conditions during the harvest period. The soluble solids content of the selected hybrids were always comparable, however, with that of the check, TK 70. Four hybrids performed consistently well in both winter and spring seasons.

Mulching with black plastic invariably improved the productivity of tomatoes in the advanced trials without undue effects on processing quality. However, mulching encouraged excessive vegetative growth and greater incidence of foliage diseases.

ENTOMOLOGY

Fruitworm Resistance

In a continuation of our tomato fruitworm (*Heliothis armigera* Hübner) resistance breeding program, 26 BC_1F_3 families were evaluated for fruitworm resistance and desirable horticultural characters. There was a significant negative correlation between the fruit number per plant and the fruitworm damage. Nineteen resistant plants belonging to 10 families were selected for further improvement of horticultural characters.

Trichome Density and Foliage Characters

An F_2 population of a cross between tomato fruitworm-resistant *Lycopersicon hirsutum* f *glabratum* and susceptible *L. esculentum* was

surveyed for the presence of high density of glandular trichomes which contain 2-tridecanone, a chemical responsible for imparting the fruitworm resistance in certain *L. hirsutum* accessions. In certain entries foliage showing *L. esculentum* characters possessed high trichome density but the larval mortality in these entries was not always related to the trichome density. It seems that quantitative measurement of 2-tridecanone in foliage or bioassay with *H. armigera* is necessary to judge the inheritance of the fruitworm resistance rather than comparison of the trichome density.

Pheromonal Control of Fruitworm

Based on the preliminary studies during 1985-86 which showed potential for achieving communication disruption by the use of a commercial, slow-release formulation of tomato fruitworm sex pheromone, studies were conducted between October 1986 and February 1987 to achieve this in the field. The tomato crop was grown by two methods: staking as is done for fresh-market production and nonstaking as is commonly done for processing tomato production. Biclure, a commercial slow-release pheromone dispensor, was placed 1 m above the soil surface at 5 m grid throughout the treatment field. Observations on the fruit damage were monitored at intervals starting with the appearance of a substantial number of ripe fruits.

The percent fruit damage in the pheromone treatment processing-type tomato field was 19.34%, 11.09% and 19.03% as against 5.70%, 5.29% and 5.36% in the control field. The fruit damage was uniform throughout the field. In the stake field, the fruit damage was 10.15% and 12.78% in the treated and 7.33% and 7.80% in the control field. There was no significant difference in percent fruits damaged in the border area (11.45%) and center (14.16%) of the treatment field as well as check fields; 8.22% and 7.38%, respectively. Virgin female-baited traps caught significantly less males in the treated than in the check field (4/trap in treated, 16/trap in control). There was no

Pheromone traps in tomato fruitworm-control field showing small size of field and neighboring corn field.

significant difference in marketable yield in treated and check fields. The cause of greater fruitworm damage in the pheromone-use area appeared to be due to the migration of mated females from a neighboring corn field, which was near the pheromone-use area but not in the vicinity of the control field. Partial failure of communication disruption due possibly to reduced concentration of pheromone cannot be ruled out. In view of the potential for mated female migration, a larger field size seems to be essential for successful control of fruitworm by communication disruption.

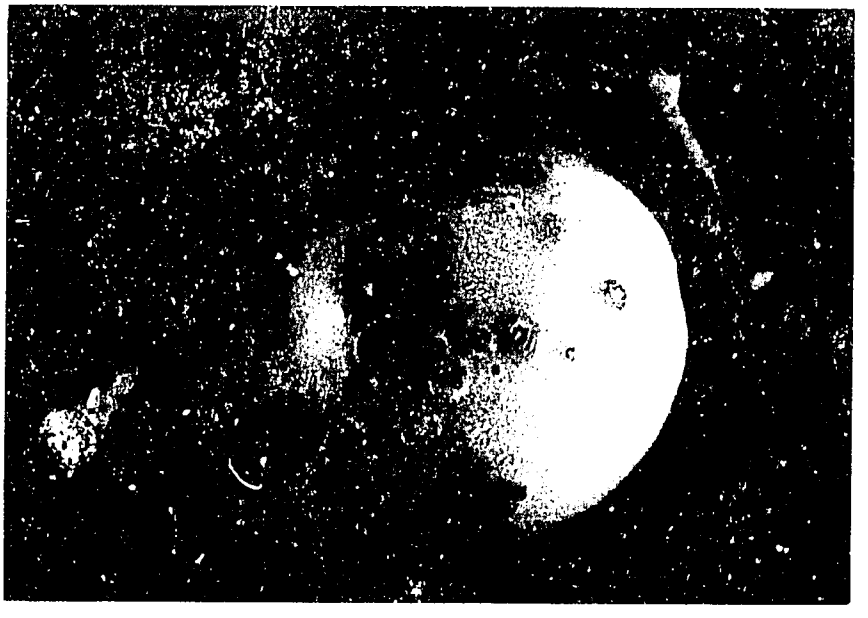
PATHOLOGY

Virus Resistance Screening

Both CMV and TLCV are important viruses of tomato in the tropics and subtropics, causing considerable yield losses. Commercial cultivars with resistance are not available. Materials with reported resistance to TLCV were tested both in Thailand and at AVRDC, and were found to be susceptible. Resistance to CMV is present in wild *Lycopersicon* sp. The resistance of L 533 was confirmed, although the line was found to contain some susceptible plants (23%).

Bacterial Spot — Development of Resistance Screening Methodology

Greenhouse studies. Bacterial spot (BS) caused by *Xanthomonas campestris* pv. *vesicatoria* is a serious foliar disease of tomato in the tropics. AVRDC recently selected BS and its causal organism for intensive research. The effect of plant age, inoculum density and pressure of inoculum application was investigated, using Flora-Dade, a susceptible



Bacterial spot on tomato.

cultivar and Hawaii 7998, a resistant cultivar. Hawaii 7998 was more resistant to BS on leaf, petiole, stem, and peduncle than Flora-Dade, but not on fruit. The 35- to 44-day-old plants of both varieties had the highest percentage of diseased leaf area. Across different inoculum densities,the percentage of diseased leaf area, the lesion number and lesion size were significantly higher on the susceptible variety. Optimum inoculum concentration for mass-screening trials was determined to be 108 cfu/ml. Increasing inoculation pressure did not consistently affect the disease parameters measured. The data indicate that lesion size is the most stable single disease parameter to measure resistance.

Disease development in the field. A commercially acceptable tomato cultivar, resistant to bacterial spot, has not yet been developed. Therefore, research was undertaken to identify a suitable field screening method for BS resistance. Six lines were tested including a resistant and a susceptible check. Artificial inoculation, after transplanting and heavy rainfall, appears to be necessary for disease development. Sprinkler irrigation, even as often as four times per day, did not have the same effect as heavy rainfall. CLN 5915-153D4-3-3-0 and CLN 191B1F2-1-7-0 were highly susceptible. Flora-Dade and CLN 5915-206D4-2-2-32-15 were moderately susceptible, CLN 363B1F2-167-1-0 was moderately resistant, and Hawaii 7998 was highly resistant to BS. Throughout the course of this epidemic, average lesion size was very stable and therefore appears to be a useful parameter for estimating the level of resistance in preliminary mass screening tests.

Screening for Resistance to CLS

Cercospora leaf spot (CLS) (*Cercospora fuligena*) is a serious foliar disease of tomato in tropical countries. The best media for rapid mycelial growth was found to be dextrose agar with either rice, oat or corn meal added and that the optimum temperature for growth was between 24° and 28°C. However, conidia were not produced in any of the culture conditions used in these experiments and therefore mycelial fragments were used as inoculum. Nearly the entire tomato germplasm collection was screened under greenhouse conditions to determine the levels of resistance/susceptibility to *C. fuligena*. Thirty-nine accessions were classified as highly resistant, 546 as moderately resistant and the remaining 4,446 accessions were classified as either moderately or highly susceptible.

'Resistance-breaking' Biotypes of *Meloidogyne incognita*

Only one gene for resistance to root-knot nematode is known to exist in tomato. Reports in the literature indicate that 'resistance-breaking' races of *M. incognita* can be developed in the greenhouse after repeated life cycles on the resistant cultivars. Four root-knot nematode isolates were successively cultured through three cycles on four root-knot nematode-resistant tomato cultivars. The number of galls and egg masses produced per root system at the end of the second cycle increased more than threefold. This large increase during the 2nd and 3rd cycles indicates that 'resistance- breaking' biotypes of the root-knot nematode had developed or were selected for during the first cycle when the nematode was cultured on the resistant plants. Additional studies are necessary to determine the occurrence and population

dynamics of 'resistance-breaking' biotypes in the field and to assess their potential damage to the tomato crop.

PHYSIOLOGY

Tomato Fruit Size

Five tomato genotypes of different fruit sizes were grown under cool-season conditions to investigate for the relationship of cell number and size, carbohydrate level and fruit size. Fruit size was demonstrated to be the most important yield component in determining the final fruit yield level in this cool-season experiment; it was strongly related to the initial ovary size before or near anthesis. Developing ovary size from six days before anthesis to three days after anthesis was predestined by cell number rather than cell size and, hence, cellular layer in the pericarp. Varietal difference in fruit size was also expressed in the ovary cultured under *in vitro* conditions for 30-40 days. *In vitro* culture of developing ovaries at 32°C tended to reduce fruit size of large-fruited entries.

High soluble sugar contents in the sepal, pedicel, ovary and leaf from three days before anthesis to seven days after anthesis were positively related with high fruit set but negatively related with ovary development of large-fruited entries. High starch contents in sepal, pedicel and leaf opposite to the cluster, on the other hand, were related to large fruit development. Although the fruit size is predetermined genetically, its final expression may be influenced by the competition of assimilates due to the number of fruits set, position of fruit or clusters, or temperature conditions. The analysis of carbohydrates in the sepal and leaf before anthesis may serve as cues for fruit-size potential.

Hormonal Control and Carbohydrate Changes in Pedicel Abscission

Abscission of tomato floral pedicels was examined under *in vitro* conditions and carbohydrate contents in the reproductive organs, leaves and stems were determined. Floral pedicels of heat-tolerant CL 5915-153 and L 123 abscised much slower than other entries. Basipetal applications of IAA at 2 ng/pedicel prevented abscission of all pedicels; acropetal and basipetal applications of ABA and ACC, on the other hand, enhanced abscission of pedicels of CL 5915-153 and L 123. High fruit-setting potential of CL 5915-153 and L 123, under either cool or hot conditions, was likely related to the ready availability of soluble sugars in the reproductive organs. The implication for plant breeding is that some initial screening of tomatoes for heat tolerance, based on *in vitro* pedicel abscission or analysis of carbohydrates with a limited number of entries, may be possible under cool season conditions.

Tomato Fruit Set

Both brassinolide and BAS 112 00 W were tested on tomato for possible improvements of fruit set and yield under high temperature conditions. No effect was observed with brassinolide; however, BAS 112 00 W increased fruit set of the heat-sensitive L 387, and fruit yield of both heat-tolerant FMTT 14 and heat-sensitive L 387. BAS 112 00 W was more potent than a commonly used growth regulartor, CPA; however, it has a similar effect as CPA to cause parthenocarpic fruit set.

PRODUCTION SYSTEMS PROGRAM

.49

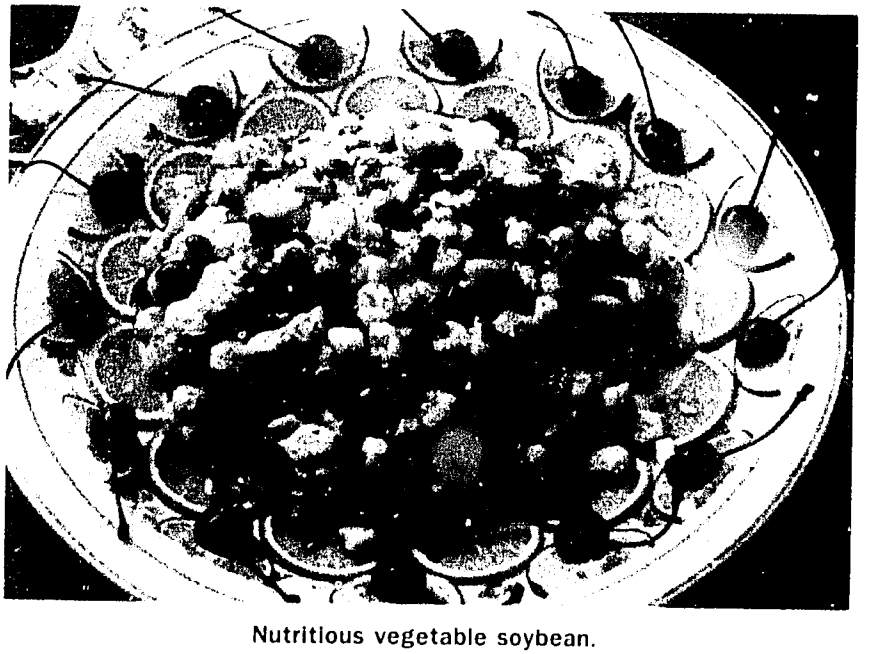
CHEMISTRY

Vegetable Soybean

The nutritional quality of the vegetable soybean was evaluated and compared to the green pea. Vegetable soybean was found to be more nutritious than green pea based on the dietary pattern of Taiwan. It is an excellent source of thiamin and a good source of protein, iron, riboflavin and phosphorous based on the nutritional quality index expressed as a nutrient density ratio. The postharvest properties of three vegetable soybean cultivars, Taishoshiroge (AGS 292), Tzu Zu No Ko (AGS 205), and Ryokkoh (AGS 305), were evaluated. The pod color of cultivar AGS 292 degraded faster than the other two cultivars. Frequent spraying of tap water was found to be effective for preventing color degradation of this cultivar. AGS 292 is also lower in protein content. A compositional analysis revealed that carbohydrates, sugar and starch are major constituents lost after harvest.

Bioavailability of Provitamin A

The effects of dietary compositions, such as protein source, starch source and edible fibers, as well as the contents of provitamin A, nonprovitamin A carotenoids and chlorophylls, on bioavailability of provitamin A were studied with experiments by rats. The bioavailability of beta-carotene was found to be a reciprocal function of beta-carotene concentration. Nonprovitamin A carotene, lycopene, inhibits the bioavailability of alpha- and beta-carotene but not beta-cryptoxanthine. Protein quality affects the bioavailability of beta-carotene of a sweet potato starch-based diet but this effect is not significant on a corn starch-based diet. Studies on protein and starch source combinations suggested that the casein-rice starch diet was the best combination tested. High edible fibers in the diet reduces the bioavailability of



Nutritious vegetable soybean.

provitamin A. Lignin was found to be a stronger inhibitor than pectin, hemicellulose and cellulose.

CROP MANAGEMENT

Density and Spacing of Vegetable Soybeans

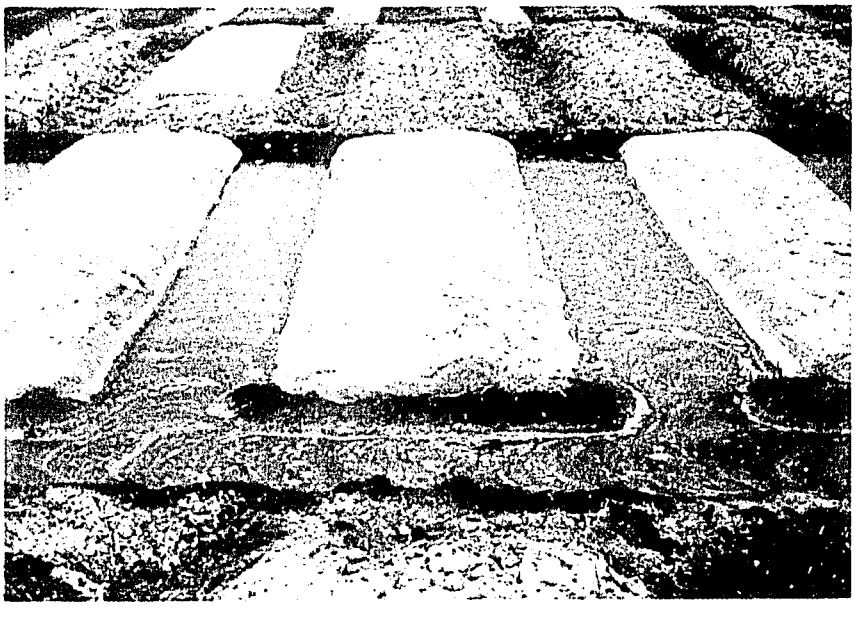
The yield of vegetable soybeans and their attributes were significantly affected by spacing and the number of plants/hill. Wider spacing and less plants/hill gave more pods and branches per plant but with more empty pods. Conversely, yields from narrow spacing and a high number of plants/hill were higher than those of wide spacing and low number of plants/hill, due to higher population density.

Spacing Effects of Sweet Peppers

A field study was conducted to evaluate the effect of spacing on growth and yield of bell peppers. The results indicated that when spacing was decreased, yield of the crop was increased. A 50-cm spacing gave the highest yield among the interrow spacings, whereas, a 40-cm spacing yielded the highest among the intrarow spacings. The yield difference was due to the difference in number of fruits/plant and number of plants/stand. The relative importance of the plant stand contribution toward the difference in yield was 2.3 times that of the number of fruits/plant.

Solarization Against Soft Rot in Chinese Cabbage

Soft rot is one of the most destructive diseases in Chinese cabbage. It infects the crop extensively in the hot-wet summer season. At present



Solarization against softrot in Chinese cabbage.

there is no reliable chemical control measure for this disease and not a single crop variety is resistant. By using a solarization technique, whereby the Chinese cabbage beds were covered and solarized by clear plastic sheets for 12 days, the soft rot incidence was dramatically reduced from 45% to 5%. About 71% of the marketable yield was recovered by this technique.

Irrigation Schedule for Tomatoes

To use limited irrigation water most efficiently, a study was carried out to evaluate the effect of a furrow irrigation schedule on tomato yield. The study revealed that with a proper irrigation schedule, tomatoes irrigated three times yielded as high as those irrigated four or five times. The most efficient and best treatment was to irrigate the crop three times at 0, 30, and 45 DAT. This irrigation schedule significantly enhanced fruit-setting of the crop as indicated by a higher number of fruits/plant at harvest

Drip Irrigation

Drip irrigation is the most efficient and effective system in supplying water for plant growth. At present, many types of drip irrigation systems are commercially available. Unfortunately, most of them are very expensive, highly sophisticated and delicate, and they require high pressure. These systems are obviously far beyond the reach of small-holding farmers who constitute the major proportion of the farming community in the tropics. Therefore, we developed a low-pressure drip irrigation system, specifically to meet the needs of small farmers. The system does not require high pressure or filtration, is very inexpensive, simple, and can be constructed by farmers themselves. It consists of PVC pipes which serve as laterals, holes (5.0 mm diam) on the laterals, sponges (2.0 cm long, 1.0 cm wide, and 0.7 cm thick) which served as drippers, and a water tank of 200 liter capacity. Results of a trial on Chinese cabbage indicated that the system performed satisfactory and the system uses 65.8% to 77.2% less water than furrow irrigation.

CROPPING SYSTEMS

New Vegetables

The purpose of this study is to gather more information on tropical vegetables for AVRDC's nutrition garden project and bilateral programs, and for the Center's cooperators. The second set of 15 new vegetables was selected in 1986. A total of 566 varieties of these crops had been collected through December 1987. Observational and advanced trials of some of these crops were conducted during 1987. Results showed that three entries of malabar spinach, four of yard-long bean, and two of kangkong outperformed other entries. These entries will be included in advanced yield trials for further confirmation and nutritional studies.

New Vegetable Crops: Onion

Following the recommendation of the last External Review (in 1984) to include new principal vegetable crops for a major research thrust

at AVRDC, many vegetables were evaluated based on a number of criteria such as popularity in the tropics, nutritional level, level of adaptability in the hot-wet tropics, potential to increase farmers' income, adaptability into existing cropping patterns, and practicality of including in the existing research environment of AVRDC.

Onion was considered as one of the priority crops proposed for research at AVRDC and the constraints in tropical onion production, the positive and negative aspects of including onions as an AVRDC crop, and the possible research thrusts for onions at AVRDC are summarized in this report.

Garden Program

Now that the production of vegetables on a garden basis has been clearly demonstrated, garden research during 1987 focused on the information on individual crops, and the possible interactions between crops. The characteristics which might be used in the garden design from 43 varieties of 16 vegetables have been recorded from the school and home gardens and placed in the Tropical Vegetable Data File (TVDF). The AVRDC noncirculating hydroponic system was adopted for urban home gardens, and seven out of eight leafy vegetables were found to be suitable for this system. Deep plowing and compost application were found to be suitable management techniques for the garden.

High Population Density of Mungbeans

Early and uniform maturity are needed for mungbeans to easily fit into various cropping systems and to reduce the labor requirement for harvesting. It was attempted to use management techniques, i.e. high population densities and harvest once-over, to achieve both objectives. Mungbean lines, VC 3738A and VC 2764A, were sown in three spacings at a rate of 400,000 and 800,000 plants/ha, respectively, during three seasons to compare their first harvest and total yields. It was concluded

that it is feasible with AVRDC-improved lines to harvest mungbeans once-over in order to reduce growth duration and to save labor cost. However, a high population density of more than 400,000 plants/ha should be maintained.

Intercropping Sweet Potato and Soybean

Intercropping has been shown to give a higher combined yield than sole cropping because of the better use of growth resources. It may be the only viable multiple-cropping scheme to increase crop productivity in rainfed areas. Sweet potato-soybean intercropping could be a good combination to increase total productivity as well as better balanced nutrition.

This study examined the effects of genotype, spatial arrangement, and relative planting of sweet potatoes and soybeans on competition of these two crops in intercropping, in order to minimize this competition and to increase intercrop productivity. It was found that sweet potato NT 67 and soybean AGS 66 were more suitable genotypes for intercropping than other entries. Two rows of soybeans per bed were a better arrangement than one row for this particular combination. Soybeans seemed to dominate in this intercropping system in the summer season planting.

Previous Crops and 'SH' Mixture

One of the main production constraints in intensive vegetable production systems is the continuous cropping hazards. This study examined the effects of rotating Chinese cabbage with rice and application of an 'SH' soil improvement mixture to alleviate the continuous cropping hazards. Chinese cabbage Hybrid 62 was grown after rice and after other vegetables with and without 'SH' treatment, and their yields were compared. Results implied that rotation with paddy rice could be an effective method to mitigate continuous cropping hazards caused by intensive vegetable production. 'SH' could reduce some of the hazard but was not as effective as the rotation with rice on land with high pH values.

CROSS-COMMODITY PHYSIOLOGY

Heat Tolerance in Vegetables

Different vegetable species were examined for heat tolerance by measuring electrolyte leakage of leaf tissue with a conductivity meter. Twenty vegetables were assessed for the optimum incubation temperature for leaf tissue heat injury (HI). An incubation at 50°C for 59 vegetables grown under three distinct seasons in the year showed that species of Monocotyledoneae and Convolvulaceae were heat tolerant, and that Cruciferae and Umbelliferae species were heat sensitive.

A regression analysis of stability showed that low leaf tissue HIs tended to be less fluctuated by environmental factors (high temperature) under different growing seasons; the hardening process probably was

not required in heat-tolerant vegetables. High leaf tissue HIs, on the other hand, tended to be less stable under different growing seasons; the hardening process might take place among some of these vegetables to ameliorate stress effects under high temperature conditions.

ON-STATION TESTING

Regional Yield Trials

Promising AVRDC lines and the selected varieties of new vegetables (including sweet and hot peppers, cauliflower, Chinese radishes, mustard, and snap beans) were tested under different environments in Taiwan through regional yield trials (RYT). After successful testing, vegetable soybean variety AGS 292 was released in 1987 because of its outstanding performance during these trials. Entries which outperformed the check entries in the RYT during 1986 and 1987 are: soybeans - AGS 208 and AGS 215; vegetable soybeans - AGS 190 and AGS 292; mungbeans - VC 3738A and VC 3890A; fresh-market tomato - FMTT 22; Chinese cabbages - AVRDC 85-216 and AVRDC 82-156; sweet potato - CN 1345-8; sweet pepper - Gypsy; hot pepper - Passion; Chinese radishes - Chui Pei Kan Zuyi and Tung Shih Kan Zu; mustard- tender green and Chinh singly; and snap bean - Witsa.

Vegetable Soybean Seed and Pod Size Relationships

Large pod size is one of the important criteria determining vegetable soybean quality. It was noticed that the pod size of one of the most popular vegetable soybean cultivars, 205 (Tzu Zu No Ko), was getting smaller each year. This project, in cooperation with the Kaohsiung DAIS, investigated the possible reasons responsible for this phenomenon and sought solutions to ensure the quality of vegetable soybeans. The first set of experiments studied the effects of the size of the seed sown on pod size, marketable and total pod yields, and seed size and seed yield. Results showed that the size of seed sown might not be a major factor responsible for the decreasing pod size. On the other hand, the cultivation management might have been related to this phenomenon. This warrants further investigation.

SOIL SCIENCE

Improved Cropping Systems

This study utilizes a crop rotation system to evaluate different cropping patterns and the effects of mulch and compost on yields of six crops. Results show that:

1) Soybean and rice in a sequence cropping are both adequate crop rotations with no continuous cropping hazards, while maintaining relatively high yields.
2) In the spring the cropping of soybean, rice and tomato are recommended.

3) In the summer the cropping of mungbean is highly recommended; rice is also recommended.
4) In the autumn the cropping of Chinese cabbage and corn are highly recommended, as well as tomato and soybean.
5) Application of compost with mulching increased yield and suppressed disease in Chinese cabbage.

Soybean Continuous Cropping

Since the autumn of 1983, soybean has been cultivated twice or thrice a year, in spring, summer and autumn, on the same land. The yield increased gradually each year and reached 4.6 t/ha in the spring cropping of 1987. No continuous cropping hazard had been observed.

DEVELOPMENT PROGRAM

55

Training

In 1987, 40 trainees from nine countries were enrolled in nine different disciplines at AVRDC. AVRDC provided a total of 93 man-months or 7.7 man-years of training. About one-third of the time was provided by plant breeding and two-thirds was shared by eight other disciplines. Only two of the 40 trainees came from the bilateral programs (one each from Indonesia and the Rep. of Korea). The rest came from national/other programs. Tomato ranked first among the crops chosen by participants as the subject of their studies followed by soybean, Chinese cabbage, sweet potato, mungbean and peppers. Sixty-three percent of the scholarship funds was provided by eight sponsors and 37% by AVRDC.

TVIS

The Tropical Vegetable Information Service (TVIS) is a multidiscipline, multicomponent activity in which the role of the Development Program is one of coordination. The main activity of TVIS is the administration and coordination of the IDRC-funded TVIS project. The project focuses on three principal AVRDC crops: Chinese cabbage, mungbean and soybean. During 1987 the single most significant activity of TVIS was to support the 2nd International Mungbean Symposium, held in Bangkok, Thailand. The TVIS-related literature data bases for these crops contain over 7,393 processed records and will continue to be expanded. A series of scientific information is being published in the form of bibliographics, directories, technical bulletins and extension documents for each crop. A total of 16 publications have been completed by the end of 1987 and 11 additional publications are expected to be published by the end of the first phase of the project.

AVRDC-INDONESIA VEGETABLE RESEARCH PROGRAM

Chinese Cabbage Variety Trials

Five trials were conducted by LEHRI and one by Universitas Islam Malang. In the first trial at Lembang, the early growth of the seedlings in the field looked normal but later the plants showed very slow growth: the plants grew vigorously in the morning but wilted during the day due to clubroot infection. No entry showed resistance to this disease.

Hybrid 82-46 performed well in head quality, uniformity and yield in the lowlands but this hybrid and OP 77 M(2/3)-43 showed a susceptibility to bolting in the highlands. Hybrid 62 performed best among the entries: it was early, uniform and high yielding in the lowlands as well as in the highlands. Other hybrids which showed better performance than the control varieties were Hybrids 82-157, 83-2 and 82-156.

Higher yields were obtained at Lawang (medium elevation) compared to the highlands and lowlands. This could be caused by the higher rate of fertilizer application, i.e. 200-80-150 kg/ha vs 100-100-100 kg/ha N, P_2O_5 and K_2O, respectively.

It is interesting to note that varieties tested in Delta Upang (a swampy area with pH 4.8), which were watered with saline water during the growing period were still able to produce good yields.

Tomato Variety Trials

Four trials were carried out at Lembang and Subang in the dry and wet seasons. Results of the dry season trials identified six high-yielding lines in the highlands, i.e. LG 154-1208, LSU-36-3-0, LSU-34-6-0, Berlu-6, LG-153-553 and Berlu-6. (LG selections are the result of SSD selection by crosses Gondol × Intan and Gondol × Ratna made by Dr.

Traditional watering method.

R.T. Opeña of AVRDC at Lembang; LSU selections were chosen from segregating populations of crossings made at Lousiana State University (USA); and Berlu selections came from Berlian). All of the entries were infected by late blight (ranging from 26.6% to 32.4%), while the bacterial wilt infections were low (ranging from 4.3% to 7.6%).

In the lowland trials only four entries gave yields of more than 10 t/ha, i.e. LSU-37-7-0, Berlu-1, LG-153-553 and LG 154-858. Six entries did not survive the heat, although straw mulch had been applied.

In the wet season trials nine AVRDC lines (8 FM TT lines and one CL 5915 line) gave better yields than the check, Ratna. Only three FM TT lines (-19, -18, -16) gave total yields of more than 10 t/ha and only two (FM TT-19 and -18) gave marketable fruit yields of more than 10 t/ha. Late blight infections ranged from 0% to 35% and bacterial wilt from 5% to 15%.

Lowland Crop Management of Chinese Cabbage

An experiment to study the effects of mulch application and planting distance on growth and yield of Chinese cabbage in the lowland area of Subang (elevation 100 m) in the dry season showed that mulching and planting distance significantly influenced the growth and yield of Chinese cabbage, but these effects varied depending on the variables observed. The MID4 treatment gave a high response to plant growth, especially to the enlargement of leaf canopy. MID2 and MoD4 treatments produced high head yields, but with no significant differences between them. The longest head size was reached by the MoD2 treatment.

Lowland Fertilizer Effects on Chinese Cabbage

In experiments carried out in Subang (elevation 100 m) in the dry season, the plant height at 4 WAT and canopy diameter at 2 WAT were

significantly increased by lime application. Although liming increased total yield by 22.5% and head yield by 14.6%, the results did not significantly differ from that of no liming. In general, N-P treatments caused significant differences in the plant growth and head yield of Chinese cabbage. Under this experimental condition, the highest head yield of Chinese cabbage was reached by an N_2P_2 treatment (90-90 kg N-P_2O_5/ha).

Lowland Mulching and Plant Spacing Experiments on Tomato

In an experiment conducted at lowland Subang (elevation 100 m) in a farmer's field from September to December 1986, mulching did not significantly affect the growth components of cv. Berlian. However, an increase in total yield (9.65%) and marketable yield (9.7%) was noted. The best plant spacing under this experimental condition was single row at 60 x 50 cm with a mulch application.

Lowland Fertilizer Effects on Tomato

An experiment conducted at Subang to study the effects of liming vs eight combinations of N and P in the dry season showed there was no significant difference in yield with the liming treatment but that there was a decrease in growth parameters. The N and P treatments gave a significant increase in both growth parameters and yield. An N-P combination of 90-45 (kg/ha) gave the best results (17.7 t/ha vs 9.6 t/ha for control). In the wet-season trial, liming had no significant effect on growth parameters but showed a marked increase in both total and marketable yields. N and P treatments showed variations in plant height (39.98 to 49.51 cm), and branch number (2.07 to 6.28). N and P treatments also caused variations in marketable and total yield ranging

Transplanting Chinese cabbage.

from 7.10 to 14.72 t/ha and 28.15 to 48.58 t/ha, respectively. The best results were obtained with the N and P combination of 90-45.

F_1 Seed Production

Two parent lines of Hybrid 62 received from AVRDC were observed in two seed production trials. Parent 1 was more productive in both trials. F_1 seed will be tested in January 1988 for comparison with Hybrid 62 and the parents.

Chinese Cabbage and Tomato Trials

Five Chinese cabbage hybrids (62, 82-46, 82-157, 83-2 and 58) and one OP variety (B-40), along with tomato entries GH-5, Berlu-6, 4210, LG 154-858, LG 153-553, CL 5915-93D$_2$-1-0, CL 1131-0-0-43 8-1, 1131-0-0-7-20-1 1 and CLN, were tested at three lowland and two medium elevations in Java in the wet and dry seasons.

AVRDC-KOREA BILATERAL PROGRAM

Disease Resistance and Sowing Time in Chinese Cabbage

In an experiment to compare sowing time with disease resistance, it was found that the earlier the time of sowing, the higher the infection rate for soft rot. Virus infection was the lowest at the first sowing and highest at the second sowing. Two selected crosses (SSD139-3 × SSD31-2 and SSD139-3 × B 18) were tolerant to both soft rot and viruses at the second sowing. Harvest ratios of the third and fourth sowings were higher than those of the other sowings in all crosses.

Cytoplasmic Male Sterility

One backcross was carried out during 1987 for two *Raphanus*-originated cytoplasmic male sterile (CMS) lines, Cheongbang and 60 Days, to achieve isogenic similarity with the recurrent parents. Seed-setting rates for both cultivars were lower than the parents. The germination rate for 60 days was similar to the recurrent parent and higher than that of Cheongbang. Although neither CMS line equaled the parents in plant weight and number of leaves, they did in leaf length. More backcrosses are necessary to develop seed-setting ability and other characteristic for CMS lines.

In *Brassica juncea*-originated CMS plants, a BC_4F_1 generation was made to three lines in 1987. The seed-setting rate was very low compared to last year's performance, as well as compared to the recurrent parents. Advance generation will be made next year.

To clarify the genetic background of the CMS plants originating from the Korean native turnip found in 1986, two CMS plants, originating from different lines, were crossed with eight male fertile lines. All offsprings of the two CMS lines crossed with three lines in which CMS plants were found in 1986, segregated into male sterile and male fertile at the same rate, but when crossed with other lines proved to be male-fertile plants. With these results the two CMS lines are assumed

to be GMS or CGMS. After precise clarification of the genetic background, the male-sterile lines will be used to breed male-sterile Chinese cabbage.

In an experiment to determine an efficient culture method for yield improvement, varieties TM 103 (AVRDC) and Jinhong (HES) were used. Results pointed to net prop and staking culture without pinching as being promising for their effectiveness in reducing the amount of defective fruit. Superior fruit-set ability in nonstaking of TM 103 with high ridge compensated sufficiently for low planting density and a relatively high rate of defective fruit.

AVRDC-MARDI VEGETABLE RESEARCH PROGRAM

Development of Improved Planting Materials

Hot pepper. Research conducted on hot pepper included screening of varieties for high yields, hybridization to develop lines with desirable agronomic traits and incorporation of disease resistance into these lines, as well as fertilizer and disease management studies.

From the various genotypes screened earlier, bird pepper (*Capsicum annuum* var. *aviculare* (Dierv.) D'Arcy & Esbb.) has been identified as the most resistant to anthracnose in pepper, followed by Serrano Tampiqueno, a Mexican cultivar. Crosses made to incorporate the resistant factor or factors from bird pepper to susceptible cultivars are being purified (F_7) and evaluated for their agronommic performance.

From other studies, the five viruses most prevalent in Malaysia have been identified as VMV, TSWV, CMV, TMV and TLCV. The incidence of CVMV is most common while the other viruses often occur in mixed infection with CVMV. A resistance gene against CVMV from *C. annuum* var. *aviculare* has been successfully incorporated into a susceptible cultivar and the advanced material is now at the F_9 generation. Emphasis

Anthracnose on pepper.

is currently placed on breeding for multiple resistance to viruses. Meanwhile progenies that are resistant to both CVMV and CMV have been isolated from crosses between resistant Mexican varieties and susceptible cultivars.

Chinese cabbage. A replicated yield trial on 25 Chinese cabbage varieties, 13 of which were from AVRDC, was conducted at Jalan Kebun Station. Autumn Queen (43.3 t/ha) yielded significantly higher than both MARDI and AVRDC control checks (Saladeer and Hybrid 62, respectively). Promising AVRDC varieties (82-156, 82-157, 77 M(3)-40, and 77 M(2/3-46) that outyielded the local check by at least 16% will be evaluated in further yield trials with varieties from other sources.

Mungbean. Results from an IYT conducted on 14 mungbean varieties from AVRDC indicated that there were no significant differences between the yields of all varieties tested. The top four performers were VC 2768A, VC 2523A, VC 1628 and VC 2778A with yields above 1,000 kg/ha. These varieties will be used in subsequent yield trials together with material from other sources.

Another yield trial was conducted with eight mungbean varieties in late 1987. None of the AVRDC varieties outyielded the local check VC 1163-2-2-6-2B. The three varieties, viz. VC 1502A, VC 2770C and VC 3664A, with yields exceeding 1,000 kg/ha, have been selected for further evaluation.

Soybean. A replicated yield trial was conducted with four AVRDC varieties and a local check at Serdang. Three varieties produced significantly higher yields than that of the local check, Palmetto. Two of these (AGS 190 and G 81083-63) are vegetable types with a seed size of more than 20 g/100 seeds.

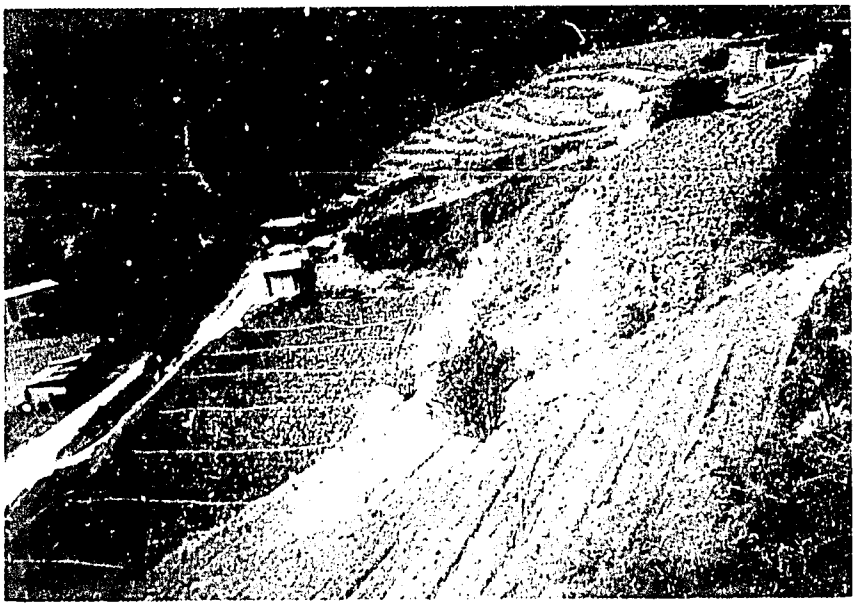
Sweet Potato. A replicated yield trial was conducted at Serdang in which 27 superior varieties from AVRDC were tested against 3 high-yielding MARDI varieties and one local variety. The highest fresh tuber yields were from CN 1219-1 (20.9 t/ha) and I 423 (18.4 t/ha). The highest dry tuber yields were obtained from CN 1219-1 (5.13 t/ha) and PC 1-177 (4.97 t/ha).

Tomato. Thirty-four AVRDC tomato lines, 10 of which were processing types, were evaluated against two local checks, MT1 and MT11, on peat soil. The results indicated that none of the AVRDC lines produced significantly larger fruits or higher yields than MT1.

Other Vegetable Research

Evaluation of commercial varieties and hybrids from local and foreign seed companies was also conducted on cauliflower, garlic, lettuce, white potato, asparagus, long bean, French bean and cucumber. Promising varieties were identified among the following species; cauliflower (4), garlic (1), cabbage (2), white potato (five for lower and six for higher altitudes in the Cameron Highlands) and lettuce (4).

Cauliflower. Twenty commercial varieties from Japan, Taiwan, the Netherlands, the United States, and Thailand were evaluated on peat



Vegetable production in the Cameron Highlands, Malaysia.

soil at Jalan Kebun. The four best-yielding varieties were Snow Top, Snow Queen, Fengshan Extra Early and Chai Tai No. 1. These varieties yielded higher (by 53% to 70%) and produced significantly heavier heads than the check, Superball.

Garlic. A trial was conducted at the Cameron Highlands station to evaluate the performance of four garlic varieties (Fu-Wei, Ho Mei, Shi-Lo and Shi-Kong) from Taiwan. No significant difference in yield was observed. The yields obtained were low, ranging from 2.27 t/ha (Shi-Kong) to 2.93 t/ha (Fu-Wei). Shi-Lo, however, produced heavier bulbs with the least weight reduction during storage. It will be further evaluated before introduction to farmers.

Management of Pests and Diseases

Studies on pest and disease management include chemical control of diamondback moth, *Plutella xylostella* (L.); cabbage webworm, *Hellula undalis* (F.); virus vectors of chili and leaf miner of sugar peas, *Chromatomyia horticola*. Several screening trials were conducted to determine the efficacy of various fungicides against anthracnose of chili, bacterial diseases of cabbage and tomato, late blight of tomato and rust disease of long bean. Several interim integrated packages were also tested to determine their effectiveness in the control of virus diseases of chili.

AVRDC-PHILIPPINES OUTREACH PROGRAM (POP)

Chinese Cabbage Yield Trial

Fifteen entries composed of F_1 hybrids and OP lines were evaluated and compared to the check, Reyna Elena (Hybrid 62), during the

Irrigation pond, the Philippines.

wet and dry seasons. There were significant differences between entries but none significantly outyielded the check which produced 16.92 t/ha marketable head yield during the dry season and 19.88 t/ha during the wet season. Hybrid 82-156 was highly resistant to soft rot (2% infection) while lines 77 M(2/3)-43 (18.3%), Hybrid 57 (16.7%), and 82-46 (14.7%) were rated susceptible.

Chinese Cabbage GYT

A wet season general yield trial (GYT) was conducted on four promising selections to reconfirm their yield potentials over the check under the prevailing hot-humid conditions of the lowland tropics. The check, Reyna Elena (Hybrid 62), obtained the highest yield of 18 t/ha and was followed closely by entry 82-46 with 17.5 t/ha. The grand mean yield for the five entries was 15.9 t/ha. The percentage of soft rot infection was low for all the entries except for Hybrid 58 which had 1% infection.

Seed Production of Hybrid 62

In order to undertake Chinese cabbage hybrid seed production in Baguio City during the cool season, the parental lines of Reyna Elena (Hybrid 62), E-7 and B-18 need a vernalization period of 21, and 14 days, respectively, at 9°C. The optimal fertilizer rate is 150-90-90 NPK kg/ha. Both under- and over-vernalization have a negative effect on flower and seed production.

Mungbean PYT

Eighty-nine mungbean lines were evaluated in three sets of PYTs to identify lines with high yield potential, desirable agronomic characters, and disease resistance, particularly Cercospora leaf spot (CLS) and

powdery mildew (PM). In Set I, 16 entries completed the third season of PYT evaluation. No test lines outyielded the check BPI-Mg5 in either the dry or wet season of 1987. Of the 23 entries evaluated in Set II, 7 entries had yields ranging from 1,485 to 1,644 kg/ha which significantly outyielded the check, BPI-Mg5 (1,205 kg/ha). In Set III, out of 50 entries, only line VC 4060-2B-2-B-1-B, with a mean yield of 1,447.0 kg/ha, significantly outyielded the check, BPI-Mg5 (1,104 kg/ha). Of the 89 entries evaluated, 8 showed high resistance to CLS.

Mungbean GYT

Three sets of entries were evaluated under the GYT for 1986-87. Of the 18 entries in Set I, none significantly outyielded the highest yielding check, BPI-Mg5 (1,616 kg/ha). In Set II only VC 3821-B-1-1-1-B with 1,708 kg/ha outyielded the check, BPI-Mg5 (1,629 kg/ha). Of the 11 entries in Set III, six promising lines with mean yields ranging from 1,286 to 1,496 kg/ha outyielded BPI-Mg5 (1,231 kg/ha). These lines were also rated moderately resistant to CLS and mungbean virus.

Mungbean RYT

RYT is a cooperative endeavor between research institutions and agencies involved in varietal improvement. For the crop year 1986-87, line EGM 1973 (VC 1973) performed exceptionally well in all RYT sites with 1,164 and 1,177 kg/ha in the dry and wet seasons, respectively. It ranked first among the 12 entries in five locations during the wet season and in two locations during the dry season. The four other AVRDC entries in the RYT were all rated moderately to highly resistant to CLS, PM, rust and virus diseases. They also exhibited high tolerance to lodging.

IMN

Of the 20 International Mungbean Nursery (IMN) entries evaluated during the wet season, no lines significantly outyielded the check, Pagasa 1 (V 3476) (1,317 kg/ha). The grand mean yield for the 20 entries was 1,120 kg/ha. Cercospora leaf spot infection for all entries was moderate, with a mean rating of 2.97.

Soybean PYT

Twenty-two promising lines/accessions from AVRDC and other sources were evaluated in the PYT during the dry and wet seasons of 1986-87. The study was conducted to identify and evaluate soybean lines with high bean-yield potential, resistance to common pests and diseases and other desirable attributes. During the dry season, 4 entries significantly outyielded the highest-yielding check, BPI-Sy 4. During the wet season, no entry significantly outperformed the check.

Soybean GYT

Low yield was obtained in the dry-season trial due to drought and severe infestation of mites at R-2. Only GC 50095-7-0-9 gave a highly significant yield difference over the highest-yielding check. None of the

entries during the wet season significantly outyielded the higher-yielding check UPL-Sy2 (2.63 t/ha). Until now entry GC 50095-7-0-9 has given consistently high bean yields during the dry and wet season trials.

Soybean RYT

Promising soybean lines from the GYT were evaluated in the regional yield (RYT) against two standard checks. The study was designed to verify the performance of the promising strains/varieties under the different regions of the Philippines in terms of yield potential and reaction to major pests and diseases. After a six-crop-season trial, EGSY-19 (AGS-19) was recommended for technology adaptation (TA) testing in different regions. The results from the two-season TA/TV testing form the basis for the future regional recommendations of varieties.

Sweet Potato Germplasm Collection

A total of 110 sweet potato lines/accessions from local and foreign sources (mostly AVRDC) are maintained at the station.The collection serves as a source of research materials for POP and other research organizatons.

Sweet Potato PYT

A total of 25 AVRDC sweet potato lines were evaluated under the PYT for the second year against the check BNAS to determine their marketable tuber yield and other agronomic characters. For the 1986 crop year, two sets of plantings were made; the first set during the wet and the second set during the dry season.

In the wet-season trial, 10 test entries with marketable tuber yield, ranging from 21.9 to 34.0 t/ha, significantly outyielded the check (9.8 t/ha). The three highest yielding entries, CN 1219-1, CN 942-47 and CN 1232-9, also produced high yields during the 1985-86 dry season trial. The dry season set did not produce credible data due to severe drought.

Sweet Potato GYT

The promising lines/accessions from the PYT are elevated to the GYT to confirm further their marketable root yield, reaction to major pests and diseases, and other agronomic characters. Sixteen promising lines/accessions were evaluated against the check BPI-Sp2 during the wet and dry seasons of 1986-87. Results of the wet-season trial showed that none of the test entries outyielded the check (20.1 t/ha). However, six lines (LS 27-12, CI 551-3, CI 949-1, CI 916-46, CI 951-6 and CI 916-66 with yields of 10.6 to 18.8 t/ha) may be considered promising. In the dry-season trial, entries CI 946-30, CI 913-6 and CI 946-25, with yields of 9.98, 10.56 and 10.88 t/ha, respectively, significantly outyielded the check (6.48 t/ha). The grand mean yield for the 17 entries was 6.11 t/ha.

Sweetpotato Weevil Resistance

The study was temporarily suspended for the 1987 crop year because of the lack of new lines to be evaluated for reactions to

sweetpotato weevil (*Cylas formicarius formicarius* F.). Until now all the lines/accessions evaluated have been found to be moderately susceptible to very susceptible.

Tomato Single-Seed Descent Trial

The single-seed descent trial conducted during the dry season 1986-87 was composed of three sets of plantings. These were: Set 1 with 10 AVRDC OP lines; set 2, with 7 AVRDC F_1 hybrids, four OP lines, and 5 East-West Seed Co. F_1 hybrids (all fresh-market lines) and; set 3 with 52 AVRDC processing tomato F_1 hybrids. Most of the OP fresh-market tomatoes that showed good yield performance were elevated to the PYT during the wet season 1987.

Tomato PYT

Of the 13 AVRDC OP fresh-market tomato lines evaluated in a PYT during the dry season (1986-87), only CL 5915-222 D6-0-5 obtained the same yield as the check (33.1 t/ha). Two sets of plantings were made in the wet season. In Set 1, the check variety, Marikit, outyielded all of the test entries. In Set 2, 6 of the 11 OP lines outyielded Marikit.

Tomato GYT

CL 143-0-1-3-3-1 and CL 551-6-0-18-1-1 have completed the four-season evaluation during the dry season 1986-87. These will be submitted for regional yield trial (RYT) when enough seeds have been produced. During the wet season 1987, four promising selections from the PYT were elevated to the GYT.

Tomato RYT

The regional yield trial (RYT) was conducted at 11 stations throughout the country. AVRDC line CL 1344-48 outyielded the check, Improved Pope, by 19.86%. AVRDC line CL 2784-1-1-4, an OP processing tomato, was approved by the Philippine Seedboard in May 1987 and released for cultivation; its local name is 'Mapula'.

AVRDC-THAILAND OUTREACH PROGRAM (TOP)

Tomato Trials

Of the 10 hybrids and one local check tested in three tomato yield trials for new breeding lines, FMTT-23 had the highest market fruit yield (37.7 t/ha) followed by FMTT-21 (35.5 t/ha). All 11 AVRDC F_1 hybrids tested outyielded the local check (P502) by as much as 147%. PT 4148 (54.0 t/ha) was the highest yielding line followed by PT 4030 (51.5 t/ha). The local check had heavier fruits than the new AVRDC lines. PT 4030, followed by PT 4045, were the most susceptible to early blight disease. All AVRDC F_1 hybrids were orange colored and not firm.

In tomato trials for heat tolerance, the new AVRDC OP lines set larger fruit during the hot-wet season than the former HT lines. Indeterminate type CL 5915-39D4-1-2-0 (26.6 t/ha) and determinate type CL 5915-93D_4-1-2-0 (28.3 t/ha) were the highest yielders among the eight lines tested.

Chinese Cabbage Evaluation

After seeds were distributed to farmers for evaluation, questionnaires were sent out to determine practices adapted and problems encountered. Farmer responses showed that Hybrid 62 had more rapid growth than any commercial cultivar and matured earlier (42.5 DAS). The trials showed that Hybrid 62 can be grown well in central and southern Thailand and that it is noted for good head formation, high yield in the summer season and low production cost (due to rapid growth and early maturity).

Sweet Potato Evaluation

In an evaluation of nine AVRDC cultivars with one local check, CN 1028-15 was considered best for its quality, weevil tolerance and good agronomic characters. Although previous reports classified this cultivar for animal feed, this study indicated it is fit for human consumption.

Soybean Trials

In soybean yield trials, AGS 270 and AGS 208 yielded higher than either check cultivars OCB or SJ5. Seed quality of the varieties, however, was rather poor, with AGS 324 (earliest maturing) and AGS 124 (latest maturing) having the worst quality.

Fifteen AVRDC lines were tested in the 1987 dry and rainy seasons. Results showed that AGS 270 (1.7 t/ha), AGS 208 (1.6 t/ha), AGS 129

Research at Kamphaengsaen Campus.

(1.3 t/ha) and AGS 217 (1.3 t/ha) were among the disease-susceptible lines. AGS 129, however, was highly resistant to both downy mildew and bacterial pustule.

Fifteen vegetable soybean cultivars, introduced from AVRDC, were evaluated against NW 1. Vesoy #4, Vesoy #1, 7016 and NW 1 all gave acceptable yields, however, the seeds were too small for the export market.

Mungbean Trials

Results of the 14th IMN showed that few lines were able to significantly outyield VC 1973A. VC 3012B yielded the highest (1.87 t/ha) but was among lines with the smallest seed size. VC 2755A and VC 2768A yielded comparably to VC 1973A.

The evaluation of selected sublines from VC 1973A and VC 2778A revealed that lines extracted from VC 1973A were rather uniform and showed no variation in any of the traits measured. Lines from VC 2778A displayed some variation in yielding abilities and other agronomic characters. No line displayed overall superiority compared to mass-selected Kamphaeng Saen 1 and 2.

In a fertilizer trial, application of HaO and honey as foliar fertilizers had no significant effect. Both HaO and honey, however, tended to increase seed weight of VC 2778A.

Preliminary results of the 15th IMN showed that no new entries outperformed VC 1973A for yield and seed size. Of the 10 mungbean lines reported as resistant to several insects at AVRDC, none displayed any superiority over Kamphaeng Saen 1 and 2 in Thailand.

Crop Release

The Thailand Department of Agriculture officially released the new mungbean variety Chainat 60 (VC 1168/Mg 50-10H/Y × ML-6). It is the earliest maturing among all varieties available in Thailand.

2nd International Mungbean Symposium

The efforts of the Thai Government, Kasetsart University, the Dept. of Agricultural Extension and the Dept. of Agriculture, combined with the AVRDC and TOP directorate and staff successfully conducted the Second International Mungbean Symposium in Bangkok. Over 200 scientists from 31 countries, reported the recent progress on mungbean research and development work.

Discussion during the Second International Mungbean Symposium.

Regional Programs

Thailand Regional Training and Research Program

Fourteen training scholars from China, Indonesia, the Philippines, Sri Lanka, Thailand and Vietnam completed the 5th Regional Training Course on Vegetable Production and Research, bringing to 64 the number of scholars who have completed the course. The 6th Regional Training Course, consisting of six Chinese, seven Vietnamese, three Sri Lankan, two Thais and one Filipino, began in October 1987.

Africa Vitamin A Gardening Project

The objective of this AID-funded project is to increase the production and consumption of vitamin A garden crops in the Sahelian region of West Africa. During the first year of operation the project's progress covered the following activities: site selection; setting up project administration; establishing collaborative contacts; hiring, orienting and placing of project staff; negotiating a Memorandum of Understanding; getting equipment and supplies ordered and in place in Taiwan and at the Africa project site; establishing a mechanism for an independent project evaluation; setting up a training center; initiating a needs assessment; and establishing reporting procedures. At the end of year one, land was prepared by the Africa project staff and observation trials were begun on 14 garden crops at the project's site near Niamey, Niger.

GENETIC RESOURCES AND INFORMATION SERVICES

GENETIC RESOURCES AND SEED UNIT

GRSU Goals

The goals of the GRSU are to promote the utilization of the collections through evaluation and comprehensive documentation; build up base and active collections of vegetable species popular in the tropics; strengthen AVRDC's cooperation within the international network of genebanks; and ensure that incoming and outgoing seed samples are free of pests and diseases.

Germplasm introduction

In 1987 the GRSU acquired a total of 5,954 accessions of 21 crop genera. The most important batches are the collections of 4,313 *Capsicum* from USDA, germplasm from the Central Institute for Genetics and Research on Cultivated Plants (German Dem. Rep.), CATIE, MARDI, the Rural Development Administration (Rep. of Korea), Bruinsma Selectiebedrijven Hybrid Seed Company (Netherlands), Research Center for Agrobotany (USA), and the 513 accessions of 12 crop genera collected in Nepal by Prof. M. Iizuka.

Germplasm Conservation

The GRSU maintains 27,599 accessions. Since commission of our long-term stores in mid-1985, we have transfered 5,186 accessions

Multiplying plants in the nethouse.

into base storage. Efforts are concentrated on the principal crops. Since pepper was made a principal crop in 1986, 4,313 accessions have been acquired including accessions from all the major collections in the USA, from CATIE, the Fed. Rep. of Germany, Thailand, Malaysia, etc. Batches of these accessions are being characterized and evaluated to support the utilization work. Accessions for base and active collections are multipled in nethouses.

Germplasm Characterization

A total of 1,250 accessions of tomatoes and 508 of *Capsicum* have been characterized.

Germplasm Documentation

The GRSU, with the assistance of the AVRDC Computer and Statistical Services, is developing an AVRDC genetic resources data base using the MINISIS software program. Presently, all passport data has been entered as well as the characterization data which has been obtained for mungbeans, sweet potatoes, non-USDA soybeans and OP Chinese cabbage.

Seed Distribution

A total of 12,183 seed samples (germplasm and breeding lines) were distributed to 305 cooperators in 95 countries and territories in 1987. Two big batches of germplasm were provided for our entomologist to screen against beanflies in soybean and our plant pathologist to screen against Cercospora leaf spot in tomato.

Germplasm Utilization and Evaluation

The utilization and evaluation of mungbeans, soybeans and sweet potatoes since 1972 are summarized. The important parents for the improvement of these crops at AVRDC are identified. The useful germplasm identified through years of screening and evaluation are listed. These summaries form a very useful set of reference information.

Evaluation in 1987

Tomato. A total of 5,071 entries from 5,031 accessions were screened for resistance to Cercospora leaf spot. Only 11% of the entries showed certain levels of resistance. The 37 accessions classified as resistant are listed.

Sweet potato. Tubers of 734 entries from the AVRDC sweet potato germplasm collection (1985/86 season) were analyzed for dry matter, fiber, protein, starch and sugar content with a Near-IR analyzer. Wide variation was found in all the tuber characters studied. Accession I 362 has starch content up to 78%; I 954 has dry matter content of about 42%; I 963 has protein content of 11.08%; I 122 has sugar content of 27.14%; and I 498 has low sugar content of only 8.78%.

Germplasm Recipients 1987

Anguilla (UK)

Corito Trading Co., Ltd.

Argentina

Agrotecnica Trebol Sur S.R.L.
Instituto Nacional de Tecnología Agropecuaria
Universidad Nac. de Tuc.

Australia

Gatton Redland Hort. Res. Station
Horticulture Research Station
Pacific Seeds
Redlands Horticultural Research Station

Bangladesh

BARI
MCC
Institute of Postgraduate Studies in Agriculture

Barbados

CARDI

Belize

CARDI

Bhutan

Centre for Agricultural Research and Development
Department of Agriculture

Brazil

EMBRAPA-CENARGEN
EMBRAPA-UAPNPBS-RIO de Janeiro
University Federal de Viçosa

Brunei

Ministry of Development

Burma

UNDP
IRRI/Burma Program

Cambodia

Church World Service

Canada

Agriculture Canada
Plant Gene Resources of Canada
University of Guelph

Cape Verde Islands

Instituto Nacional de Investigacao Agraria (INIA)

Chile

FAO

Colombia

Agrotrading Import & Export Corp. (ATRIMEXCO)
CIAT

Cook Islands

Totokoitu Research Station

Costa Rica

Centro de Asesoria e Investigación Biologica y Agricola
Coalicion Costarricense de Iniciativas de Desarrollo (CINDE)
Finca Selvamar
Mision Techica Agricola De Taiwan
San Joaquin de Flores Heredia

Cuba

Instituto Nacional de Ciencias Agricolas (INCA)

Dominica

Agricultural Technical Mission

Dominican Republic

Centro Sur de Desarrollo Agropecuario (CESDA)
Enda - Caribe

Egypt

Field Crops Research Institute
Minufiya University

El Salvador

Agricultural Technical Mission

Ethiopia

Bako Research Centre
JOCV/Ethiopia
Nazrek Agricultural Research Station

Fiji Islands

Legalega Research Station
Ministry of Primary Industries
Sigatoka Research Station
Vuda Garden Ltd.

France

Andre Blondeau Selectionneur-Obtenteur
Clause Seed Company
Ecole nationale superieure agronomique
INRA

Germany, Democratic Rep.

Zentralinstitut für Genetik und Kulturpflanzenforschung

Germany, Federal Rep.

Bayer AG
Biologische Bundesanstalt für Land und Forstwirtschaft
University of Bonn

Ghana

Agricultural Services Co-operative Society Ltd.
Nyankpala Agricultural Experiment Station
Tanyigbe Atidze Community Farms

Guadeloupe (France)

Centre de recherches agronomiques des Antilles et de la Guyana

Guam (USA)

University of Guam

Honduras

Oficina de la Mision Tecnica del Japon
La Escuela de Agricultura

India

Aligarh Muslim University
Ankur Agrl. Research Laboratory
Assam Agricultural University
AT & PO Bonand
Central Agricultural Research Institute
Central Experiment Station
Coromandel Indag Products India (P) Ltd.
Dept. of Genetics & Plant Breeding
Family Planning Association of India
Farm & Home Consultancy Service
Farm Seeds
Fredrick Institute of Plant Protection and Toxicology
Haryana Agricultural University
I/C, Scheme for Res. on Veg. Crops
IARI
Inst. of Advanced Studies, Merrut
ISNAR
Lakhnu Pura Rural Integrated Project
Nath Seeds Private Ltd.
NBPGR
National Pulses Research Centre
PAK-College of Agriculture
Punjab Agricultural University
Reg. Res. Station/TNAU

Rural Leprosy Trust
Sheetal Hybrid Seeds Company
Tagore Society for Rural Development
The University of Agricultural Sciences

Indonesia

AARD/ISNAR
Agricultural Technical Mission
Akademi Farming Semarang
Balittan Sukamandi (SURIF)
Centre for the Application of Isotopes and Radiation
Horticulture Research and Development Centre, Lembang
Indonesia/AVRDC Bilateral Project
Lembang Horticultural Research Institute (LEHRI)
Malang Research Inst. for Food Crops (MARIF)
Nutrition Research and Development Centre
Sub Balai Pasar Mining
Universitas Merdeka Madium
University of Merdeka

Iran

Seed and Plant Improvement Institute

Iraq

Agriculture and Water Resources Research Centre

Israel

NIRIT Co.

Jamaica

FAO
Irwin
University of the West Indies

Japan

Agricultural Research Center
Fukuoka Pref. Federation of Agrl. Cooperatives
Ibaraki-Ken Horticultural Experiment Station
Kagome Co., Ltd.
Kagoshima Agri. Exp. Station
Kochi University
Morioka Branch, Veg. & Ornamental Crops Res. Sta.
Nagano Chushin Agriculture Experiment Station
Nagasaki Agricultural Association
Ogasaware Sub Tropical Agricultural Center
Okinawa Sekiyu Seisei Co., Ltd.
Sakata Seed Corporation
Taiyo Consultants Co., Ltd.
Takarazuka Research Center
The University of Tokyo
Tokyo Agricultural University
Tsukuba International Agricultural Training Center, JICA

Jordan

Eastern Company

Kenya

National Dryland Farming Research Station

Kiribati

Engelhardt Training Centre

Korea, Rep. of

Cheju National University
Chon-Buk Rural Development Administration
Dongwon Nongsan Seed Co.
Gyeongsang National University
Horticultural Experiment Station, Rural Development Administration
Jeju Provincial Office of Rural Development
Provincial Rural Development Administration (PRDA)
The Chonnam Provincial Rural Development Administration

Lebanon

American University of Beirut

Liberia

AVSPP/NCRDP
Lowland - NCRDP
NCRDP - Saolepea

Madagascar

Madagascar - IRRI

Malawi

Bvumbwe Research Station

Malaysia

Agriculture Research Centre
MARDI
Universiti Pertanian Malaysia

Maldives

Kandhu Edhuruge

Marshall Islands

Agricultural Technician Mission in Marshall Island

Mauritius

Farming Society

Mexico

Centro de Investigaciones Agrícolas del Golfo Centro
SARH, Inst. Nacional de Investigaciones Agrícolas

Namibia

Ju/wa Bushman Development Foundation

Nepal

HMG/FAO Vegetable Seed Production Project
Institute of Agriculture and Animal Sciences
PADCO
Rural Development Centre
Secretariate of National Agricultural Research
The United States Mission to Nepal
Tribhuvan University
Vegetable Development Division

Netherlands

Bejo Zaden B.V.
Bruinsma Seeds B.V.
Deruiter Zonen B.V.
Glasshouse Crops Research & Experiment Station
Royal Sluis B.V.
Sluis & Groot Research, Zaadunie B.V.

Niger

Institut pratique de development rural (IPDR)

Nigeria

Ahmadu Bello University
Anambra State University of Technology
IITA
M.A.N.R.
Ministry of Agriculture and Natural Resources
Nosamag Farms (Nig.) Ltd.
Okapuala Cooperatives
Omorogbe Farms Ltd.
Shell Petrot-Dev. Corp. Nig. Ltd.
UNDP/FAO Project NIR/84/014

Niue Islands

Dept. of Agriculture & Fishery

Pakistan

Agricultural Research Institute
National Agricultural Research Centre
Nuclear Institute for Agriculture and Biology
STM International

Panama

Nestle Panama, S.A.

Papua New Guinea

Division of Primary Industry

Laloki Agrl. Research Station
Pacific Adventist College (PAC)

Peru

Estacion Experimental Agropecuaria
Estacion Experimental Baños del Inca

Philippines

Asian Farming Systems Network/IRRI
AVRDC/PCP
Benguet State University
Bohol Agricultural Promotional Center
Don Mariano Marcos Memorial State University
Institute of Plant Breeding
IRRI
Mariano Marcos State University
Mindanao State University
Ministry of Agriculture and Food
Negros Forest & Ecological Foundation Inc.
Nestle Philippines, Inc.
Northern Mindanao State Institute of Science & Technology
Panay State Polytechnic College
Pangasinan State University
Phil-nut Product & Food Industry
Rizal College of Agriculture & Technology
Second Laguna de Bay Irrigation Project, Veg. Component
University of Eastern Philippines
University of the Philippines at Los Baños
Visayas State College of Agriculture

Polynesia, French

CIRAD

Portugal

Universidade de Evora

Saipan

Northern Mariana College

Samoa, American

American Samoa Community College

Saudi Arabia

Community Development Consultants (UDC)
Tabuk Agricultural Development Co. (TADCO)

Senegal

Institut senegalais de recherches agricoles

Seychelles

Grand'Anse Experimental Centre

Singapore

Eastreco (Pte.) Ltd.
World Farm Col. Ltd.

South Africa

University of Stellen Bosch

Sri Lanka

Agricultural Research Station
Israel Interests Section
Department of Agriculture
Development Alternatives, Inc.
Tea Research Institute
Tropical Sunblest Fruit Company

St. Lucia

CARDI

Swaziland

Agricultural Technical Mission
Univ. of Swaziland

Switzerland

NESTEC - TAGR.

Tahiti (France)

CIRAD

Taiwan, China

Academia Sinica
Chiayi Agricultural College
Fu Jen University
Hwalien DAIS
Known You Seed Company
National Chiayi Institute of Agriculture
National Chung Hsing University
National Taiwan University
Taichung DAIS

Tanzania

Ilonga Agrl. Res. Institute
Kilombero Sugar Co. Ltd.

Thailand

Northern Regional Agriculture Development Centre
Chainat Field Crops Research Centre
Chia Tai Co., Ltd.
Chiangmai University
College of Agriculture
East-West Seed Company
Field Crops Research Institute
Kasetsart University
Maejo Institute of Agricultural Technology
Oxfam-Belgique
Prince of Songkhla University
Srisamrong Field Crop Experiment Station
Thailand Institute of Scientific and Technological Research
TOP/AVRDC

Togo

Ecole sup. d'agronomie

Trinidad

Caribbean Chemicals and Agencies Ltd.
The University of the West Indies

Turkey

Cumhuriyet University

United Kingdom

L.W. Lambourn & Co.

USA

AID - Wyoming Team
Asgrow Seed Company
Campbell Inst. for Research and Technology
Eagle Seed Co.
Ferry Morse Seed Co.
Harris Moran Seed Co.
Heinz USA
Hort. Science Institute, USDA
Land O'Lakes, Inc.
Mississippi Agr. & Forestry Expt. Station
Northrup King Company
Oklahoma State University
Oregon State University
Peto Seed Co., Inc.
Richfield Packing Co., Inc.
Seedcrast, Inc
University of California
University of Arizona, Tucson

Uganda

Luweero Rural Development Coop. Society Limited
Makerere University

Vanuatu

Matevulu College
Tagbe Agricultural School

Vietnam

University of Cantho

Yemen Arab Rep.

Ministry of Agriculture & Agrarian Reform

Yugoslavia

University E. Kardelj, Ljubljana

Zaire

Agriculture fruits et legumes, s.p.r.l.

Zambia

Mwapula Research Estates
National Irrigation Res. Sta.
Zambia Seed Co., Ltd.

Zimbabwe

Chiredzi Research Station

INFORMATION SERVICES

During 1987 OIS undertook, among others, the following activities:

Publication Activities

- Published 42,622 copies of 29 different publications which contained 2,062 camera-ready pages.
- Edited 16 major documents, 3 periodicals, 93 symposium presentations, 6 brochures and 40 informal papers; authored one issue of *Centerpoint* and compiled the 1986 *Progress Report Summaries*.
- Printed 3,176,924 pages required by 1,169 internal print requests;
- Initiated copublication of AVRDC Entomologist's monograph on *Beanflies of Food Legumes in the Tropics* by Wiley Eastern, Ltd. of Calcutta and assisted copublishers CTA and ACCT to ready the French edition of AVRDC's *Sweet Potato Proceedings* for press;
- Aided AVRDC scientists to: obtain publication of 13 journal papers, prepare 11 papers for future publication and prepare 24 symposium presentations.

Public Relations Activities

- Issued two press releases and met with journalists from four nations; and
- Arranged for AVRDC's input into the IARC Directors' new 'Public Awareness Committee'.

Data Bases

- Established a complimentary library mailing list data base and continued to keep the Center's mailing list data base up to date.

Photographic and Art Services

- Made over 16,000 photographic records of the scientific work in progress during 1987 in over 1,000 separate photographing sessions in the fields, laboratories or studio.
- The art unit drew 230 figures, tables, posters, book covers, etc. from 116 requests

Symposium Activities

- Edited the 83 papers and helped prepare and print all of the 2nd International Mungbean Symposium material, organized a publication display/sales at the Symposium, provided full photographic services and issued a press release.

Distribution Activities

- Began implementation of the activities outlined in the 1986 proposal 'Towards a Cost-effective Publication Policy':

AVRDC publication display
at Second International Mungbean Symposium.

- Carefully monitored postage expenditures for distribution of publications;
- Subsidized the cost of complimentary distribution by establishment of a 'Publication Distribution Fund' and obtained an initial pledge for 1988;
- To evaluate the effectiveness of the AVRDC complimentary library distribution scheme, OIS surveyed the 571 libraries to determine the value of AVRDC publications, availability, and use of deposited AVRDC publications, publication exchange and willingness and ability to purchase AVRDC publications in the future;
- Full utilization of postal tariffs through publication design techniques to reduce weight and consolidated mailings; and
- Quadrupled sales over 1986 by extending the commercial distribution network and more aggressive promotional activities including 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. 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.

HDC Distributors

Select Books Pte. Ltd.
19 Tanglin Rd.
Singapore 1024
Republic of Singapore

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

Agribookstore
1611 N. Kent Street, Suite 600
Arlington, VA 22209
USA
(Orders for North America)

INFO-LINE
GPO Box 506
Sydney, N.S.W. 2001
Australia
(Orders for Oceania)

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.
9th Floor, NBS Building
701 Rizal Ave.
Manila, Philippines

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

Annual Progress Reports

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

Progress Report Summaries

1985 Summaries. 96 p.
1986 Summaries. 94 p.
1987 Summaries. 98 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).

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)

Monographs

Ossani, 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

AVRDC. 1987. Accomplishments, Goals and Structure. 23 p. (Gratis)

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. 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. 1980. Procedures for sweet potato evaluation trials. 4 p. (Gratis)

80-144 Opena, 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., S. Lin and S. Green. 1985. Sweet potato germplasm for international cooperators. 3 p. (Gratis)

87-272 Yoon Jin Young, Romeo T. Opena 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 is prepared by the Tropical Vegetable Information Service (TVIS) through AVRDC and published twice a year. It provides a platform of exchange of information for scientists working with mungbean, soybean and Chinese cabbage. (HDC $4.00/issue, LDC $2.00/issue)

Soybean rust newsletter - This annual newsletter is published by the International Working Group on Soybean Rust through the TVIS project of 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 mung bean 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.

JP 7 Mew, T. W., W. C. Ho and L. Chu. 1976. Infectivity and survival of soft-rot bacteria in Chinese cabbage. Phytopathology 66:1325-1327.

JP 9 Mew, T.W. and W.C. Ho. 1977. Effect of soil temperature on resistance of tomato cultivars to bacterial wilt. Phytopathology 67:909-911.

JP 13 Opeña, R. T. and S. H. Lo. 1978. Derivation of matroclinal diploids in Chinese cabbage and evaluation of their significance in breeding. J. Amer. Soc. Hort. Sci. 103(6):820-823.

JP 15 Shanmugasundaram, S. and Samson C. S. Tsou. 1978. Photoperiod and critical duration for flower induction in soybean. Crop Sci. 18: 598-601.

JP 17 Kuo, C. G. and J. S. Tsay. 1977. Propagating Chinese cabbage by axillary bud culture. HortScience 12(5):456-457.

JP 20 Talekar, N. S., L. T. Sun, E. M. Lee, J. S. Chen, T. M. Lee and L. Lu. 1977. Residual behavior of several insecticides on Chinese cabbage. J. Econ. Entom. 70(6):689-692.

JP 27 Kuo, C. G., M. C. H. Jung and S. C. S. Tsou. 1978. Translocation of ^{14}C-photosynthate in mungbean during the reproductive period. HortScience 13:(5):580-581.

JP 29 Lim, W. L., S. H. Wang and O. C. Ng. 1978. Resistance in Chinese cabbage to turnip mosaic virus. Plant Dis. Reptr. 62:660-662.

JP 31 Villareal, R. L. 1979. Use of sweet potato (*Ipomoea batatas*) leaf tips as vegetables. Expl. Agric., 15(2):113-127.

JP 33 Villareal, R. L. Observations on multiple cropping in Taiwan. Philipp. J. Crop Sci. 1(3):129-136.

JP 34 Villareal, R. L. 1976. The philosophy in the tomato and sweet potato breeding programs of the Asian Vegetable Research and Development Center. Philipp. J. Crop Sci. Jan. - March 1976:32-35.

JP 36 Cowell, Robert C. 1976. Vegetable Research in Southeast Asia: The Asian Vegetable Research and Development Center. Entwicklung + Landlicher. Vols. 5 & 6.

JP 38 Ho, Leonard. 1976. Some aspects of seed production and distribution in Asia. Seed Technology in the Tropics. p. 179-205.

JP 39 Villareal R. L., S. K. Lin and S. H. Lai. 1979. Variations in the yielding ability of sweet potato under drought stress and minimum input conditions. HortScience 14(1):31-32.

JP 40 Villareal, R. L., S. C. Tsou, S. H. Lai and S. L. Chiu. 1979. Selection criteria for eating quality in steamed sweet potato roots. J. Amer. Soc. Hort. Sci. 104(1):31-33.

JP 41 Yang, C. Y. 1977. Past and present studies of soybean rust incited by *Phakopsora pachyrhizi* Syd. Bull. Inst. Trop. Agr. Kyushu Univ., Japan. 2:78-94.

JP 42 Cowell, R. L. and C. L. Luh. 1978. International research in agriculture. Span 21(3):104-106.

JP 45 Opeña, R. T. and S. H. Lo. 1979. Genetics of heat tolerance in heading Chinese cabbage. HortScience 14(1):33-34.

JP 46 Shanmugasundaram, S. 1979.Variation in the photoperiodic response of several characters in soybean, *Glycine max* (L.) Merrill. Euphytica 28:495-507.

JP 47 Talekar, N. S. 1980. Search for host plant resistance to major insect

pests in Chinese cabbage. In: Proceedings of the symposium on the production and insect control of cruciferous vegetable in Taiwan. April 17-18, 1980. Plt. Prot. Center, Taichung, Taiwan.

JP 48 Riley, James J. and Merle R. Menegay. 1978. Intensive agricultural practices in Asia. J. Food Proc. and Pres. 2:197-203.

JP 49 Villareal, R. L., S. K. Lin, L. S. Chang and S. H. Lai. 1979. Use of sweet potato (*Ipomoea batatas*) leaf tips as vegetables. Expl. Agric. 15:113-116.

JP 50 Hubbell, John N., Jr. 1980. The germplasm accession information system at the Asian Vegetable Research and Development Center (AVRDC). HortScience 15(1):17-21.

JP 51 Tschanz, A.T. and T.C. Wang. 1980. Soybean rust development and apparent infection rates at five locations in Taiwan. Prot. Ecol., 2:247-250.

JP 52 Shanmugasundaram, S. and M.S. Lee. 1980. Influences of night temperature on the flowering of the photoperiod sensitive and day-neutral soybeans. In: Proceedings of legume in the tropics. Faculty of Agriculture. Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia. p. 53-66.

JP 54 Kuo, C.G., J.S. Tsay, C.L. Tsai and R.J. Chen. 1981. Tipburn of Chinese cabbage in relation to calcium nutrition and distribution. Scientia Hortic. 14:131-138.

JP 55 Shanmugasundaram, S. and M.S. Lee. 1981. Flower-inducing potency of different kinds of leaves in soybean, *Glycine max* (L.) Merr. Bot. Gaz. 142(1):36-39.

JP 56 Chin, Michael. 1980. Administration of a research center under constraints - some ways of cutting costs. Entwicklung + Landlicher raum 5:5-9.

JP 57 Riley, J. J. and J. C. Moomaw. 1979. Vegetable production in tropical Asia. The Conference on Tropical Foods: Chemistry and Nutrition. Honolulu, Hawaii, March 28-30, 1979.

JP 58 Kuo, C.G., F.H. Hsu, J.S. Tsay and H.G. Park. 1980. Variation in specific leaf weight and RuDPCase activity in mungbean. Can. J. Plant Sci. 60:1059-1062.

JP 59 Chiang, H.S. and N.S. Talekar. 1980. Identification of sources of resistance to the beanfly and two other agromyzid flies in soybean and mungbean. J. Econ. Entom. 73(2):197-199.

JP 60 Kuo, C.G., J.S. Peng and J.S. Tsay. 1981. Effect of high temperature on pollen grain germination, pollen tube growth, and seed yield of Chinese cabbage. HortScience 16(1):67-68.

JP 61 Inouye J. and C.G. Kuo. 1981. Flower initiation of *Brassica* species under total darkness. HortScience 16(2):192-193.

JP 62 Villareal, R.L. and S.H. Lai. 1981. Cultivar responses of tomatoes to relay cropping. HortScience 16(4):552-553.

JP 63 Kuo, C.G., M.H. Chou and H.G. Park. 1981. Effect of Chinese cabbage residue on mungbean. Plt. and soil 61:473-477.

JP 64 Talekar, N.S. and Yuo Hwa Lin. 1981. Two sources with differing modes of resistance to *Calloso bruchusci chinensisci* in mungbean. J. Econ.

Entom. 74(5):639-642.

JP 65 Shanmugasundaram. S. 1981. Varietal differences and genetic behavior for the photoperiodic responses in soybeans. Bull. Inst. Trop. Agr. Kyushu Univ. 4:1-61.

JP 66 Kuo, C.G., J.S. Tsay, B.W. Chen and P.Y. Lin. 1982. Screening for flooding tolerance in the genus *Lycopersicon*. HortScience 17(1):76-78.

JP 67 Shanmugasundaram, S., C.R. Yen and T.S. Toung. 1982. Genotypic response to maximum and minimum input in soybean. In: Proc. of the plt. breeding symp., ROC Reg. Soc. of SABRAO and the Agric. Assoc. of China.

JP 68 Kuo, C.G. and R.S. Huang. 1982. Effect of vesicular-arbuscular mycorrhizae on the growth and yield of rice-stubble cultured soybeans. Plt. and Soil 64:325-330.

JP 69 Talekar, N.S. 1982. Effects of sweet potato weevil (Coleoptera: Curculionidae) infestation on sweet potato root yields. J. Econ. Entom. 75(6): 1042-1044.

JP 70 Talekar, N.S. 1983. Infestation of sweet potato weevil (Coleoptera: Curculionidae) as influenced by pest management techniques. J. Econ. Entom. 76(2):342-344.

JP 71 Tsay, J.S., W.L. Kuo and C.G. Kuo. 1983. Enzymes involved in starch synthesis in the developing mungbean seed. Phytochemistry 22(7): 1573-1576.

JP 72 Talekar, N.S., J.S. Chen and H.T. Kao. 1983. Long-term persistence of selected insecticides in subtropical soil: Their absorption by crop plants. J. Econ. Entom. 76:207-214.

JP 73 Talekar, N.S., J.S. Chen and H.T. Kao. 1983. Persistence of fenvalerate in subtropical soil after repeated biweekly applications over two years. J. Econ. Entom. 76:711-716.

JP 74 Talekar, N.S., H.T. Kao and J.S. Chen. 1983. Persistence of selected insecticides in subtropical soil after repeated biweekly applications over two years. J. Econ. Entom. 75:711-716.

JP 75 Sajjapongse, A. and Y.C. Roan. 1983. Effect of shading and leaf tying on summer Chinese cabbage. HortScience 18(4):464-465.

JP 76 Talekar, N.S. and B.S. Chen. 1983. Seasonality of insect pests of soybean and mungbean in Taiwan. J. Econ. Entom. 76:34-37.

JP 77 Talekar, N.S. and J.S. Chen. 1983. Identification of sources of resistance to limabean podborer (Lepidoptera:Pyralidae) in soybean. J. Econ. Entom. 76:38-39.

JP 78 Ruelo, J.S. 1983. Integrated control of *Meloidogyne incognita* on tomato using organic amendments, marigolds, and a nematicide. Plt. Dis. 67:671-673.

JP 80 Kuo, C.G. and C.T. Tsai. 1984. Alternation by high temperature of auxin and gibberellin concentrations in the floral buds, flowers, and young fruit of tomato. HortScience 19(6):870-872.

JP 82 Talekar, N.S., and Ko Wen Cheng. 1987. Nature of damage and sources of resistance to sweetpotato vine borer (Lepidoptera:Pyralidae) in sweet potato. Journal of Economic Entomology. 80:788-791.

JP 84 Green, S.K. 1985. Turnip mosaic virus strains in cruciferous hosts in Taiwan. Plt. Dis. 69(1):28-31.

JP 87 Kuo, C.G., H.M. Chen and L.H. Ma. 1985. Effect of high temperature on proline content in tomato floral buds and leaves. J. Amer. Soc. Hort. Sci. 111(5):746-750.

JP 88 Selleck, G.W. and R.T. Opena. 1985. National Programs: the need for increased emphasis on the development of vegetables and legumes. FFTC Book Series No. 30, p. 54-66.

JP 89 Talekar N.S. 1987. Host plant resistance to insects attacking soybean and mungbean in the tropics. Insect Science and its Application.

JP 90 Talekar, N.S. 1987. Influence of cultural pest management techniques on the infestation of sweetpotato weevil. Insect Science and its Application.

JP 91 Talekar, N.S. 1987. Resistance in sweet potato to sweetpotato weevil. Insect Science and its Application.

JP 92 Talekar, N.S. 1987. Feasibility of the use of resistant cultivar in sweetpotato weevil control. Insect Science and its Application.

JP 93 Green, S.K. and D.R. Lee. 1986. Occurrence of an unidentified potyvirus of soybean in Taiwan. In: Tropical Agriculture Research Series No. 19.

JP 94 Green, S.K. 1986. Virus diseases of tomato and Chinese cabbage in Taiwan and sources of resistance. In: Plant Virus Diseases of Horticultural Crops in the Tropics and Subtropics, FFTC Book Series No. 33.

JP 95 Kuo, C.G., B.J. Shen, H.M. Chen, H.C. Chen and R.T. Opena. 1987. Associations between heat tolerance, water consumption, and morphological characters in Chinese cabbage. Euphytica.

JP 96 Green, S.K. 1987. Two poty viruses in sweet potato. Tropical Pest Management.

JP 97 Green, S.K., L.L. Hwang and Y.J. Kuo. 1986. Epidemiology of tomato mosaic virus in Taiwan and identification of strains. Journal of Plant Diseases and Protection.

JP 98 Kratky, B.A. and Y.C. Roan. 1987. A steel reinforced, concrete filled PVC pipe shelter for vegetable seedlings. p. 140-145. In: Hemphill, D.D. Jr. and N.S. Mansour, eds. Proceedings of the Twentieth National Agricultural Plastics Congress.

JP 99 Talekar, N.S. and H.R. Lee. Response of soybean to foliage loss in Taiwan. J. of Econ. Entomology.

JP 100 Talekar, N.S., H.C. Yang and Y.H. Lee. Study of morphological and physiological traits associated with agromyzid (Diptera: Agromyzidae) resistance in mungbean.

JP 101 Talekar, N.S. Resistance of soybean to four defoliator species in Taiwan.

JP 102 Yoon, J.Y. 1987. Peppers and Chinese cabbage adaptation to the tropics. Span 30(2):64-66.

JP 103 Characteristics of *Melanagromyza sojae* (Diptera: Agromyzidae) damage in soybean. J. Econ. Entomol.

JP 104 Ota, Yasuo. 1988. Introduction to the Asian Vegetable Research and Development Center. Agriculture Techniques 43(2):29-32. (In Japanese.)

JP 105 Imai, H., C.H. Ma, J.S. Tsay and S. Shanmugasundaram. 1987. Soybean yields over 4.5 mt/ha achieved in Asia with maximum yields systems. Better Crops International 3(2):14-16

JP 106 Talekar, N.S. and Y.H. Lee. A procedure for mass-rearing of bean fly (Diptera: Agromyzidae).

JP 107 Talekar, N.S. and Y.H. Lee. 1988. Biology of *Ophiomyia centrosematis* (Diptera: Agromyzidae), a pest of soybean. Annual of Entomological Society of America.

JP 108 Sajjapongse, Adisak, Mei-huey Wu and Yu-chi Roan. 1988. Effect of planting date on growth and yield of sweet potato. HortScience.

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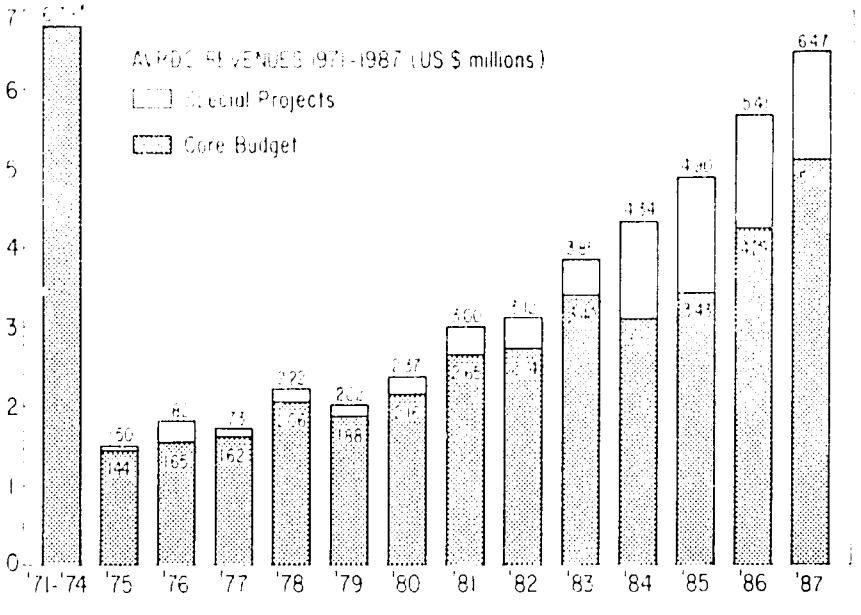

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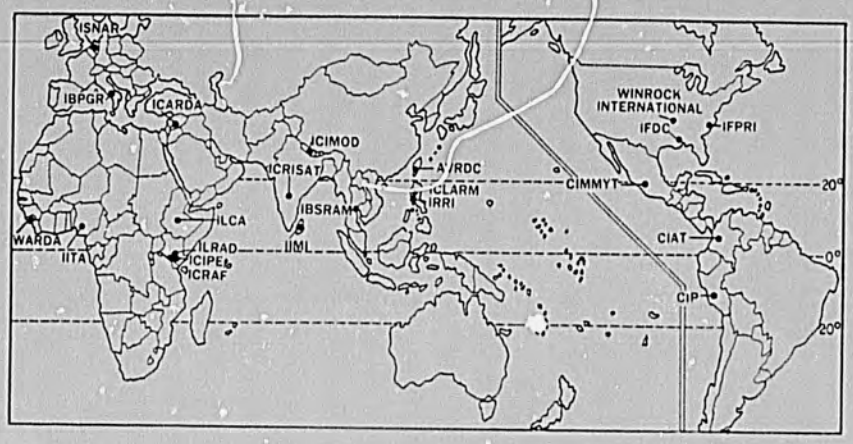

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