Seed-Production Mechanisms

Proceedings of a workshop held in Singapore, 5–9 November 1990

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SWEET POTATO SEED SYSTEMS IN THE PHILIPPINES

Julieta R. Roa

Philippine Post Crop Research and Training Centre
Visayas State College of Agriculture

ABSTRACT

Sweet potato R and D received impetus with the creation of a nationally-mandated root crops center, thus recognizing the vast potential of the crop for food, feed and other industrial uses. Such rationale is strengthened as subsistence and marginal farmers are greatly affected; the improvement of their lot is a matter of national concern.

The initial major thrust centered on varietal improvement which spurred breeding activities first at the College of Agriculture and Institute of Plant Breeding of the University of the Philippines, College, Los Banos and more intensively at the rootcrops center at the Visayas State College of Agriculture. The latter's program is supported by funds mainly from the International Development Research Centre (IDRC) of Canada. The impact is viewed not only with the improved varieties released but also, importantly, with the training of technical staff and strengthened networking with the national cooperative testing (NCT) stations, the established testing protocol, and with other state colleges and universities. The principal output of organized government efforts has been the development and release of improved varieties: seven from the Visayas State College of Agriculture, three from the IPB and two screened/released by the BPI from AVRDC lines.

Despite some weaknesses, the government seed program as a whole served as a catalyst to various crop improvement activities. Currently, private sector participation is existent only with the cash crops. The system with sweet potato and other root crops is basically government-heavy. Meanwhile, various informal farmer seed schemes prevail. At least 90% of the sweet potato growers have managed for years with this local system.

The seed production-distribution schemes tried in sweet potato have been well-intentioned but lack a systematic farmer-sensitive scheme and monitoring mechanism for farmer/user feedback or evaluation. Also, the top-bottom approach followed in HYV technology generation, failing to consider farming circumstances and nature of market, imposed a heavy toll - the non-adoption of the first VSP's. Reversals in approach had to face the stigma of the variety-market mismatch. The diversity of agroecological zones where sweet potato adapts and the peculiarities of user-based farmers' choices gave rise to several established good-performing local cultivars specific to an area. Partly, this has made the acceptance of the new high-yielding varieties relatively difficult. Only the improved varieties which approximated the "good-eating quality" criteria have been adopted by farmers. Sweet potato processing technologies which specifies certain physico-chemical characteristics offer market opportunities to the HYV's. Production and distribution of an improved variety, then, is a critical concern.

New challenges face the national program in developing an innovative simple, pragmatic and user-friendly seed production-distribution scheme.

INTRODUCTION

Of all the root crops, sweet potato has received the most research attention in the Philippines, even before the official creation of a national root crops center in 1976. Not only is it the most ubiquitous and easy-to-manage crop in various cropping systems, it has played an important role in subsistence as well as commercial farming. Scientists and researchers have pointed out its potential as a diverse source of human food, feed and other industrial uses. Thus, for more than a decade (1977-1988), sweet potato research at the Philippine Root Crop Research and Training Center (PRCRTC), the nationally-mandated center for root crops based at the Visayas State College of Agriculture (ViSCA), shared at least 85% of the overall root crops budget; 96% of this in varietal improvement. It was only recently that this breeding research received 32%. But the rest of the 68% also involved mostly sweet potatoes in such disciplines as pest management, postharvest, engineering, socio-economics, information/communication and extension (Palomar, M. K., 1989).

The International Development Research Centre (IDRC) of Canada has provided the majority support to all these research activities, about 80-85% of the rootcrops budget from 1977 up to the present. Most of the support was for breeding, multiplying and distributing improved varieties of sweet potato. While breeding activities and varietal breakthroughs are documented, very little is known of the extent to which the planting material has been multiplied, distributed and has reached the farmer. Since most of these projects have emphasized as clientele the small-scale and resource-poor farmers, it is of considerable interest to the donor institution, other collaborators as well as to the research and implementing agencies themselves to assess the extent to which the planting materials have reached their targeted beneficiaries, and the mechanism by which this was achieved.

Importance of the Study

Seed or planting material is an important input in the agricultural productive process whether of commercial value as in the case of traded seeds (i.e. cereals, other high valued crops) or home-grown or "asked" seeds (i.e. friends, neighbours). For years, the staple and major cash crops have received most research attention. As a natural consequence, official seed programs also concentrate at first on major and staple crops; less prominent crops like root crops have had extremely little research done. In the Philippines there is virtually no such study done on root crops other than that done on the white potato.

There is need to initiate seed production mechanisms study for sweet potato because availability of planting materials is an expressed constraint by farmers and the drive to expand the market via processing needs a systematic propagation-production link to sustain supply. The importance of a viable seed production program cannot be over emphasized if efforts to improve crop productivity are to be successful. Whether such goes through a developed official system or a simple, pragmatically designed, decentralized village-oriented seed system depends on specific conditions and criteria purposely considered. The system developed has to be anchored on an adequate understanding of existing systems practiced by farmers since they have long been in the art and, in their sense, "science" of seed propagation to sustain life for generations.

Objectives

The objectives of this study revolve around the generation and dissemination of information which will lead to the strengthening of systems to produce and distribute improved planting materials of sweet potato.

Specifically, the study aims:

1. To estimate the amount of improved planting material distributed, the number of growers using it and the areas planted; and

2. To describe and evaluate the alternative seed production and distribution mechanisms which have been tried.

This study also hopes to provide the national seed body useful information in working out a viable seed program for sweet potato in the country.

Methodology

The study adopts a combination of methods starting with a review of related studies and reports of verification trials and testing within the formal system.

A series of informal interviews of farmers during trips to sweet potato areas (i.e. Benguet, Northern Mindanao, Tarlac, Leyte) provided rich source of information. Key informants such as the sweet potato breeder research assistants involved in the trials and some members of the root crop technical working group were interviewed especially with the technicalities of varietal improvement and the testing schemes for (national) recommendation of a variety. Related studies and secondary data were quite helpful.

Formal surveys were undertaken in the provinces of Leyte and Samar (Eastern Visayas Region), Agusan (Eastern Mindanao), Catanduanes and Albay (Bicol Region). A total of 185 farmers were formally surveyed. The areas covered for both formal and informal surveys represent different cultivation systems and agroecological zones. The following presents the classification of areas:

1. Leyte (Jaro, Dulag, Alang-alang) - commercial lowland rainfed
2. Leyte (others: Baybay, Silago, Maasin, etc.) - semi-commercial/subsistence hilly/slopes
3. Catanduanes and Albay in Bicol Region - commercial/semi-commercial lowlands and undulating slopes/marginal
4. Samar (Pinabacdao, Sta. Rita and Calbiga) - semi-commercial/subsistence uplands/marginal
5. Agusan del Sur (Afga/Sibagat) - commercial undulating slopes
6. Benguet highlands - semi-commercial/subsistence (1500 masl)

These areas are presented in the map (Figure 1).

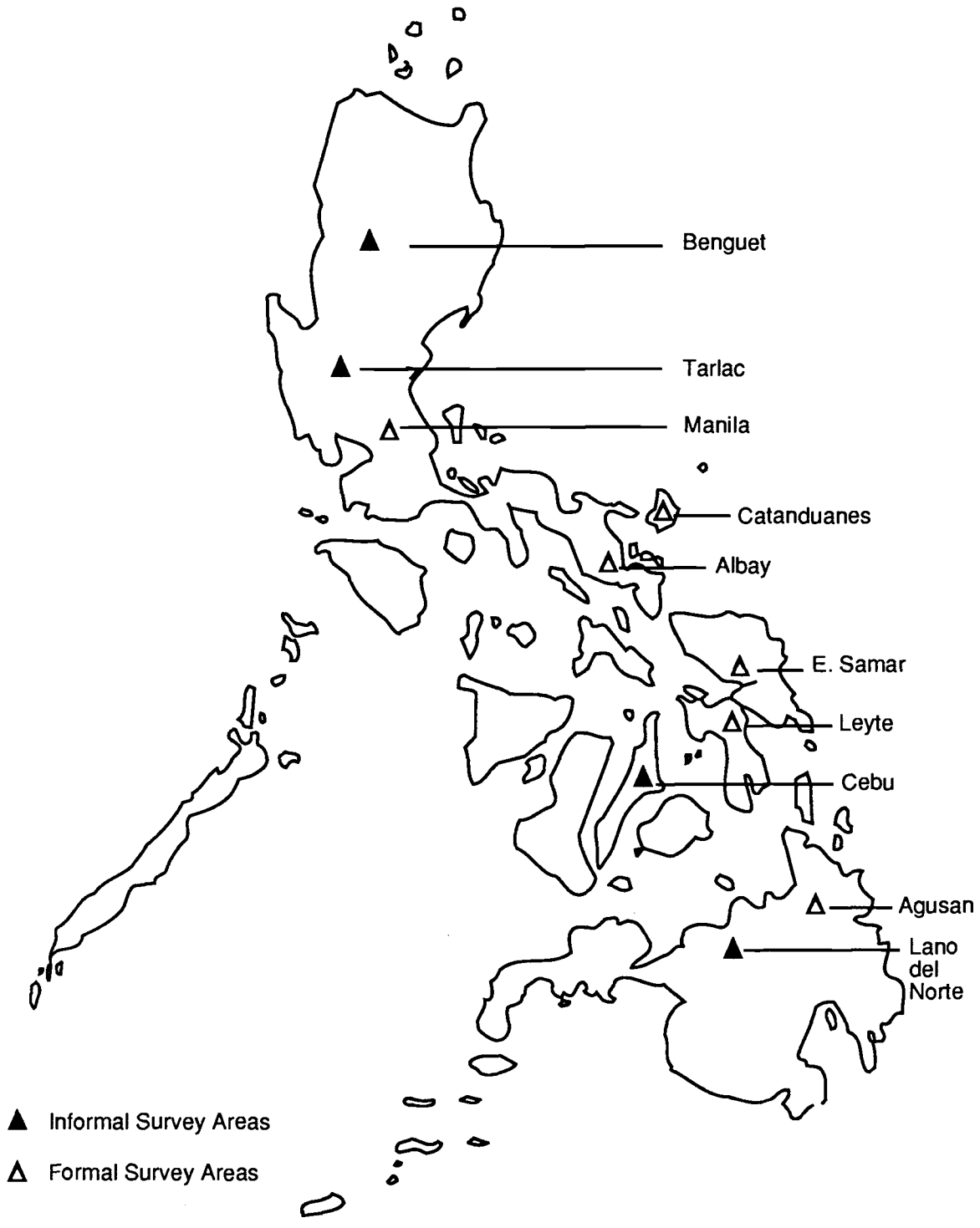


Figure 1 - Map of Survey Areas

Questionnaires were mailed to cooperating stations to determine the extent and nature of work on the HYV's. The total seed distribution was also estimated from the records of PRCRTC and the Department of Plant Breeding and Agricultural Botany at ViSCA.

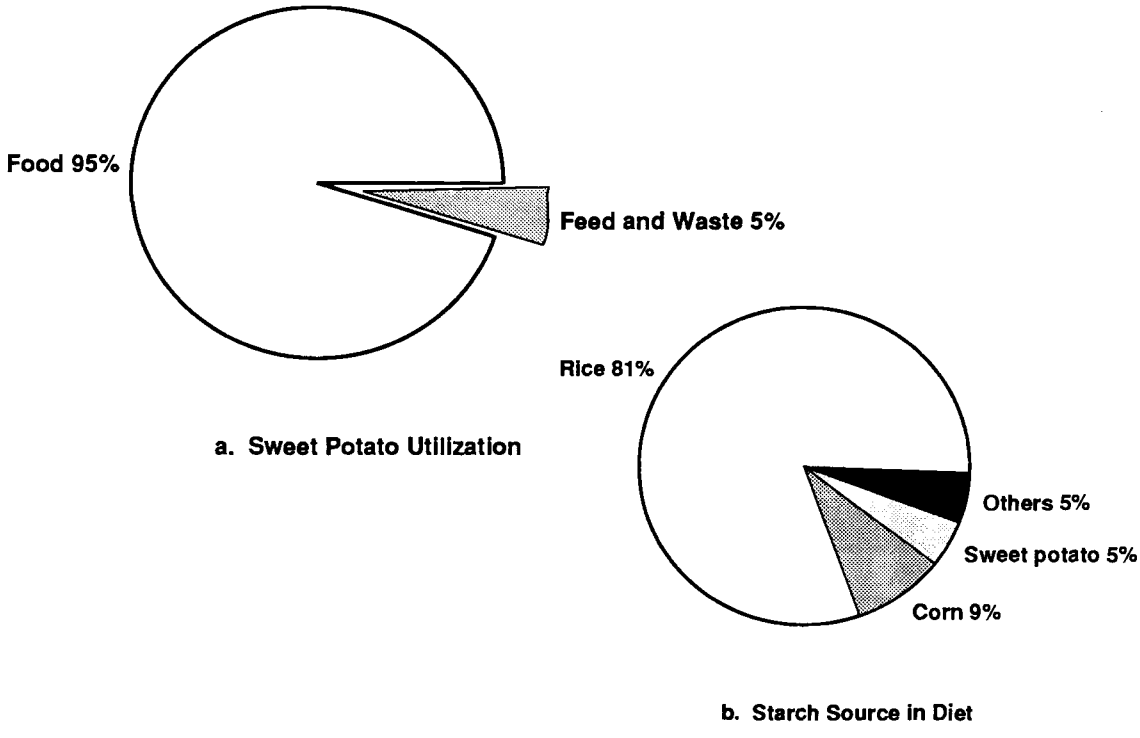
BREEDING AND VARIETY SELECTION FOR SEED PRODUCTION

Background and Rationale

Sweet potato is an important part of various cropping systems in the country: in the cereals-dominated lowland, or in the mixed systems in the uplands and highlands, performing functions of sustenance and cash source. With the advent of simple technologies, scientists and researchers have pinned hopes on the potential of sweet potato as a nutritious processed food, basic feed ingredient and an industrial earner.

Also, sweet potato has been seen as a means of uplifting the lives of resource-poor farmers. But for it to do so needs a rationalized program since the fresh sweet potato market is very limited. The first two sweet potato regions, i.e., Eastern Visayas and Bicol have the highest incidence of poverty (50-60%) in the country and are typhoon paths. Clearly, sweet potato plays an important role as a cash supplement and famine-saving crop. About ninety-five percent of production is used as human food, mostly by boiling or the simple traditional processing (Figure 2). Per capita consumption, however, is low at 4-9 kg per year (FNRI, 1984). With a rice-based diet, the Filipino gets only about 5% of total starch intake from sweet potato (81% from rice, 9% from corn).

Figure 2. Sweet Potato Utilization and Starch Source in Diet



a. Sweet Potato Utilization

b. Starch Source in Diet

Partly due to this consumption pattern and partly due to national efforts to expand the grains program (especially upland rice and corn) and diversify agricultural production, the volume and area of sweet potato production showed a declining trend in the early eighties: from 235.8 thousand hectares in 1980 to 164.3 thousand hectares in 1987 and a production volume of 1.05 million metric tons to 0.84 million metric tons, respectively (Table 1). With the average yield relatively constant (i.e. about 4.7 tons/hectare) for the period, reduction in area due to substitution or increased cropping intensity of another crop (e.g. rainfed rice, corn) offers a plausible reason.

Table 1. Area Planted and Volume of Production for Sweet Potato

	Area Planted (hectares)	Volume of Production (000's MT)
1978	227.6	1,037.0
1979	238.0	1,122.9
1980	235.8	1,047.8
1981	220.9	1,010.3
1982	209.3	1,037.6
1983	174.7	801.5
1984	170.1	820.3
1985	164.3	777.1
1986	164.8	800.6
1987	164.3	843.7

Source: Bureau of Agricultural Statistics, Department of Agriculture, Philippines.

With the existing constraints of a limited fresh roots market, development research on sweet potato follows a market expansion-diversification scheme to stimulate farmers to produce. Processing technologies have been developed including various uses of sweet potato flour, beverage, catsup, delicious SP, jam, fruit-like products, naturally fermented soy sauce, etc. Some are already in their pilot stages. The viability of processing technology, however, is premised on reasonable costs of inputs (via high yielding varieties) but that which gives the farmer sufficient returns, in addition to improving varieties for table use. Such becomes the rationale for varietal improvement. And, concomitantly, a system of propagating and distributing planting materials for sustainability of the whole process.

BREEDING AND VARIETY SELECTION

Historical Sketch: Overall Sweet Potato Breeding Work

Before the 70's, sweet potato breeding work was rather rare and limited. The recorded pioneering breeding program of Mendiola (1921) which produced fancy strains of sweet potato was short-lived. Other sweet potato research work (i.e. occasional studies in varietal evaluation) of some agricultural colleges were also limited. This was highlighted by the release of a new sweet potato variety, BNAS 51, which became a standard check in later sweet potato experiments.

A financial research grant from the National Science Development Board in root crop research spurred attempts at sweet potato improvement in the University of the Philippines at Los Banos (UPLB) in the early 70's (Carpena, 1975). Since then, the interest on root crop research began to build-up with the creation

of the National Root Crop Research Center in 1976 (now PRCRTC). PCARRD (Philippine Council for Agriculture and Resources Research Development) granted the Visayas State College of Agriculture research funds for the collection and evaluation of the local and introduced root crop varieties. In the same year, the International Development Research Centre (IDRC) of Ottawa, Canada gave PRCRTC a grant for multidisciplinary research on root crops.

From then on, three sources of new sweet potato entries have been identified: from the (1) Philippine Root Crop Research and Training Center, ViSCA; (2) The Institute of Plant Breeding (IPB), UP Los Banos research group; and (3) the Bureau of Plant Industry (BPI) where selections from breeding lines of the Asian Vegetable Research and Development Center (AVRDC) were entered.

PRCRTC-ViSCA Breeding

The 1975 PCARRD grant (Project #259, Saladaga, 1976) enabled the collection (for a germplasm pool) and evaluation of introduced and local cultivars to identify those with promising traits for release as varieties or for use as parents in hybridization. In 1979, the project identified two varieties for mass production and distribution to farmers: BNAS 51 and San Isidro.

The sweet potato varietal improvement (first phase) was anchored on the objective of producing a variety with most, if not all, the traits desired by farmers and consumers. These traits include high root yield, high dry matter content, early maturing, resistance to weevil and other pests and diseases (e.g. scab, leaf spot), high protein content, acceptable weight loss in storage and, in general, good eating quality. The critical variables which have been considered for national recommendation of a variety by the root crop technical working group of the Philippine Seed Board are root yield, resistance to scab and physico-chemical properties as dry matter, starch, sugar and protein content.

To date seven new varieties were released for national recommendation from the breeding lines developed at PRCRTC, ViSCA (i.e. VSP 1 - VSP 7). These were based on two-season (wet and dry) results of five regional trials in different cooperating stations in the country.

In 1989, IDRC approved an integrated root crop development program where sweet potato varietal improvement is an important part. Unlike the breeding program in the past, the method currently followed reflects the bottom-up approach, integrating user-orientation in the process of generating and evaluating technologies (i.e. HYV, practices, etc.). Another bent is the giving of priority to small, subsistence and semi-commercial farmers where the agroecological zones are not the first class lowland relatively fertile zones characteristic of commercial sweet potato farmers in the country. The latter constitute only about 5-8% of total area devoted to sweet potato where they are grown as cash crops with net value added even better than either rice or corn.

Genetic Basis for Improvement

The polycross breeding technique was applied and modified to suit the needs of sweet potato for increasing variabilities. This technique allowed the production of numerous recombinant genotypes over a relatively shorter period, thus overcoming the problem of low seed set common with controlled biparental crosses. Rapid evaluation and screening procedures had to accompany this technique for efficient results.

The first three newly released sweet potato varieties, VSP-1, VSP-2, VSP-3 and succeeding releases had been genetically improved through the polycross technique. Among the parents in the polycrosses were native cultivars adapted to Philippine conditions. Recurrent selection for these traits in subsequent progenies had increased the frequency of genes for adaptability to Philippine conditions and resistance to disease (i.e. sweet potato scab). Meanwhile, the polycross technique ensured the maintenance of the highly heterozygous genetic nature of these progenies among which were selected breeding lines later renamed VSP-1, VSP-2 and VSP-3. Later releases had incorporated genes controlling traits desired by subsistence farmers and consumers, i.e. high dry matter content and long vines that produce roots along the nodes of the crawling vines for the staggered harvesting practices (Saladaga, FA., personal communication).

The nationally recommended sweet potato varieties developed from the varietal improvement program of ViSCA are presented in table 2.

Table 2. Matrix of Recommended Varieties and Characteristics of the VSP Varieties

Source: Villamayor, Federico G., PRCRTC, ViSCA

Characteristics	VSP1	VSP2	VSP3	VSP4	VSP5	VSP6
Morphological						
Root skin color	red	orange w/purple spots	red	white	red	red
Root flesh color	orange	orange, purple spotting	yellow	yellow with orange spots	purple	light yellow
Plant type	spreading	spreading	spreading	spreading	spreading	spreading
Mature leaf color	green	green	green	green	green	green
Petiole pigmentation	moderately purple	purple	green with purple tip	moderately purple	green with purple tip	green with purple tip
Agronomic						
Yield potential t/ha)	21	19	17	16	17	19
Harvest age (days)	90-100	90-110	100-120	90-100	90-100	100-120
Susceptibility to:						
Weevi	moderate	high	moderate	high	moderate	moderate
Scab	moderate	moderate	high	moderate	moderate	moderate
Tolerance to:						
Poor soils	not	not	moderate	not	not	n.d
Shade	not	moderate	high	moderate	moderate	moderate
Drought	not	not	high	high	high	high
Storage						
Weight Loss	high	high	moderate	moderate	high	n.d.
Sprouting	very low	low	very high	good?	low	n.d.
Rotting	low	very high	very low	low	high	
Physico-chemical						
DM content	26.5	33.5	34.1	34	32	37
Startch	56-73	59-75	65-83	65-82	62-82	60-80
Sugar	13.6	13.4	7.1	6.6	6.4	9.4
Protein	2.6	2.7	1.9	2.1	1.4	1.7
Recommended use:	Fo/Fe	Fo/Fe	Fo/Fe	Fo/Fe	Fo/Fe	Fo/Fe

Fo - food Fe - Feed N.D. - no data
Source: Villamayor, F.G., PRCRTC, VISCA

High yield and early maturity are the main criteria considered for national recommendation. VSP1 has the added advantage of having a high beta-carotene content and is recommended for nutrition-rich food product. VSP3, 4 and 6 are the varieties which closely fit the type for table use. VSP5 could be a cheap substitute of yam in food processing.

The profitability analyses done was mostly a comparison of the VSP's with yield as the variable factor based on experimental conditions. This was rather a limited approach since demand is a critical factor which was rather difficult to show with the first VSP's.

Two-season (wet and dry) two to three year trials in the different collaborating station are undertaken on the average after a variety has been identified in the originating institution.

III. MECHANISMS OF SEED PRODUCTION AND DISSEMINATION

The Formal Seed System: Brief Historical Background with Emphasis on Sweet Potato

May, 1954 marked the first annual meeting of the cooperative seed improvement group initiated by the Bureau of Plant Industry, the University of the Philippines College of Agriculture and Department of Agriculture to form a body to pass on or approve varieties before any crop variety will be increased. The result was the creation of the Philippine Seed Board created by Special Order No. 590 Series 1955.

The primary concern for food security figured not the immediate agenda to focus on the two staple crops, rice and corn. The varietal improvement criteria were high yield, good eating quality and desirable agronomic characteristics.

Beans and vegetables were included in 1956. In 1969, specific Working Groups were designated to work on different aspects of seed improvement such as cultural practices, fertilization and screening tests for disease resistance. 1969 also marked the inclusion of root crops especially sweet potato in the Seed Board's Improvement program.

Various revisions were made to accommodate new crops and add on critical characteristics for varietal improvement. These lead to the formation of several technical committees in 1982: varietal improvement, seed production, seed distribution and seed storage, seed certification, seed standardization, promotion and extension.

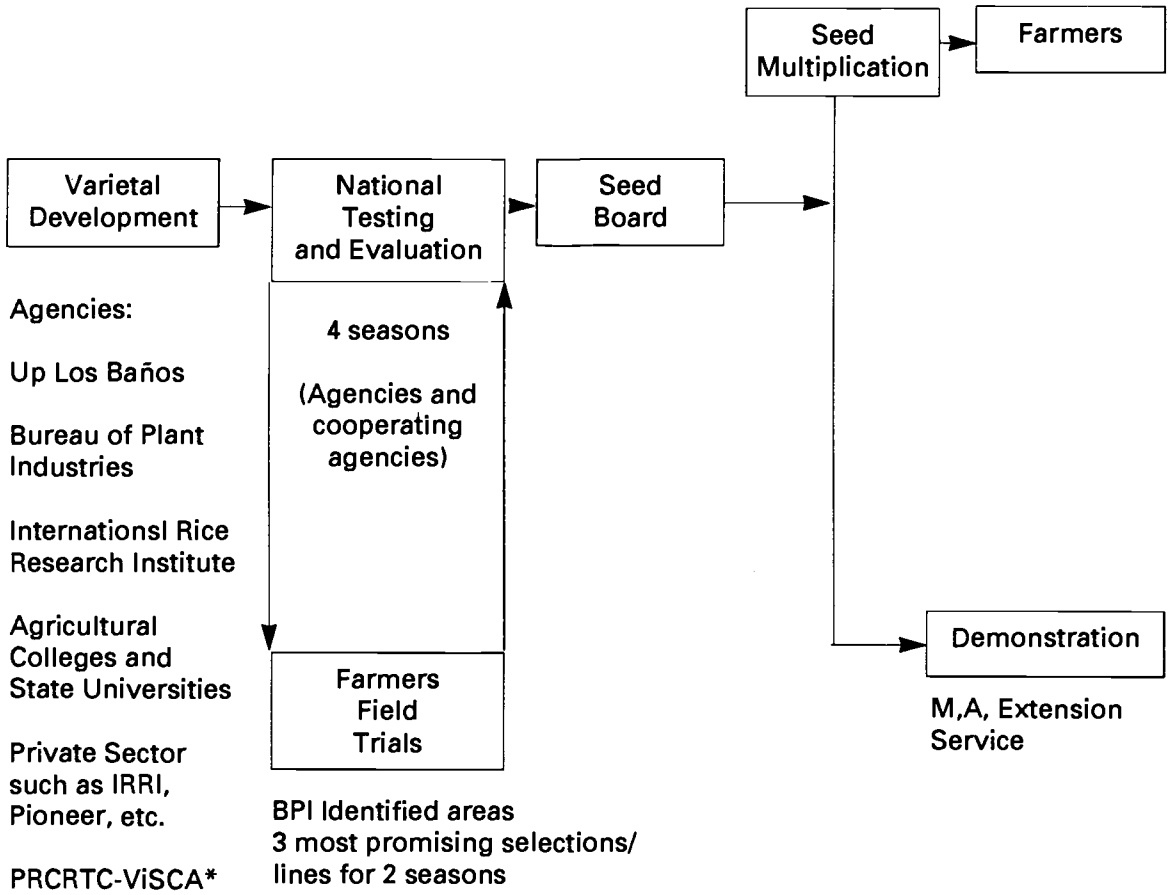
In 1982-83, the root crop technical working group requested to establish specific guidelines to consider in the conduct of various tests needed in varietal evaluation and to include cultivars grown by farmers. The relatively low adoption rate of recommended varieties despite high yields prompted the suggestion to include eating quality and physicochemical analysis of the selection for release as well as improved seed production and distribution for crops other than rice and corn. The membership of the root crops technical working group expanded to include more state colleges and universities and BPI stations for testing and evaluation. Regional recommendation of varieties was brought out of diverse agroecological conditions and thus, varietal adaptability. Part of the discussion was the suggestion and that data on farmers field trials, not only those of

experiment stations, be part of evaluation of the varieties.

Later, sweet potato varieties recommended were more attuned to the preferences of consumers. The 1988 meeting called for the review of performance of recommended varieties and suggested that a small committee from the root crops technical working group monitor and evaluate released varieties and gather information on utilization and acceptability of the varieties in coordination with the Department of Agriculture field offices. No report has been submitted yet.

In general, the varietal evaluation scheme for crops is presented below. The complete flow including certification is present only for the major grains (i.e. rice and corn) and some cash crops (i.e. some vegetables and exportable fruits). The participation of the private sector in the multiplication of certified seeds can also be seen with these crops.

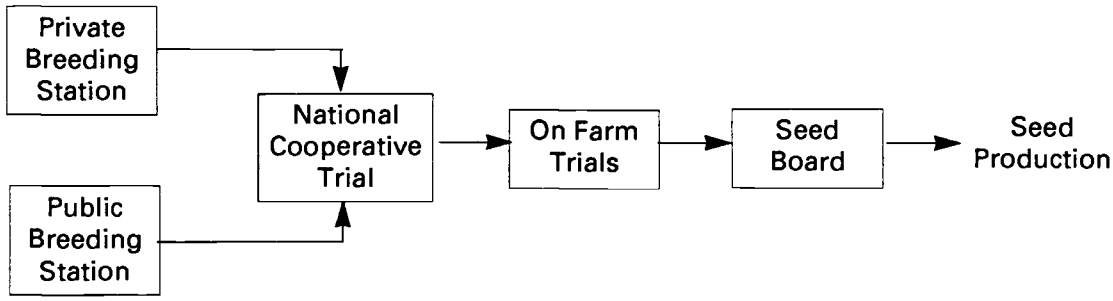
Figure 2. General Crop Varietal Evaluation Flow Scheme



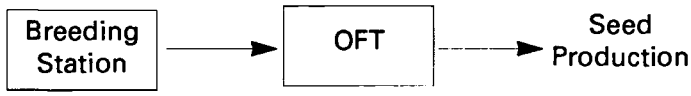
1/ Adopted from the Phillipine Seed Board files.
* national center for sweet potato/rootcrops

Figure 3. Testing Protocol

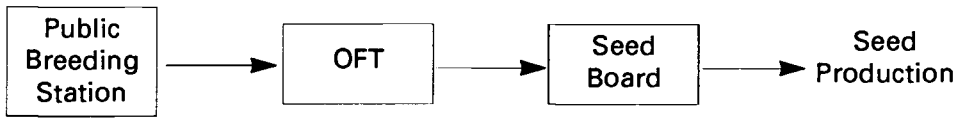
A. Rice, Corn, Some Vegetables and Legumes



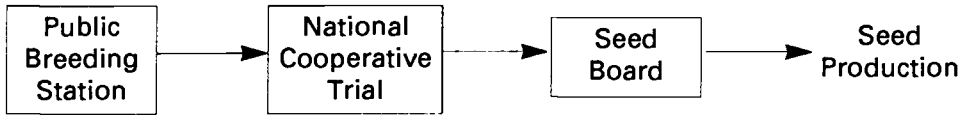
Alternative:



B. Fruits, Plantation Crops



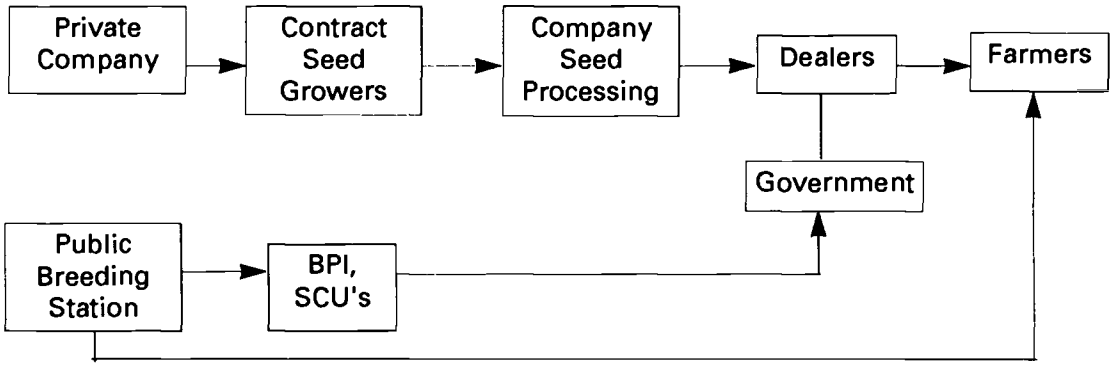
C. Sweet Potato



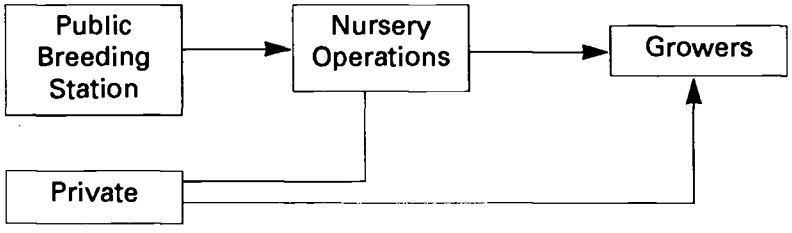
Note: A and B adopted from E.T. Rasco, Jr.

Figure 4. Seed Production and Distribution

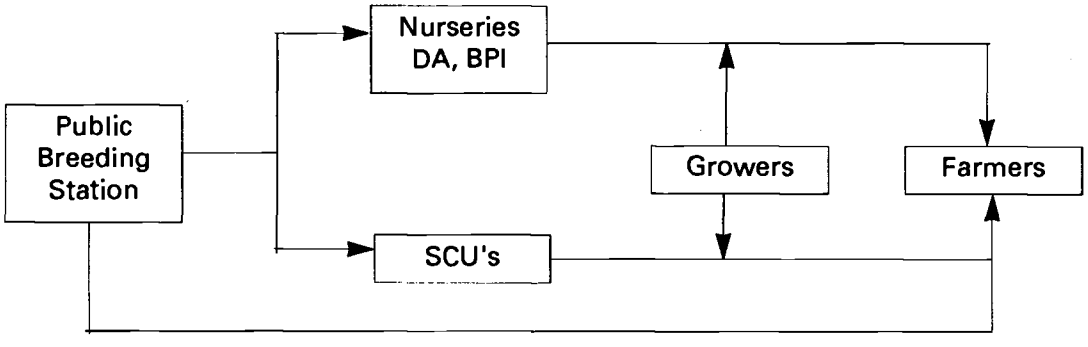
A. Rice, Corn, Some Vegetables and Legumes



B. Fruits, Plantation Crops



C. Sweet Potato/Root Crops



It is only in the grains, vegetables, some legumes, fruits and plantation crops where participation of the private sector is evident for seed production and marketing. The sweet potato/root crops system is government-heavy for the whole breeding-evaluation-distribution flow. Recent developments call for a greater farmer and private sector participation but this is still in the developmental phase.

Distribution through the National Cooperative Testing Network

This is a network of thirteen experiment stations of the different regions throughout the country where crops, including root crops, are tested and evaluated for national or regional recommendation. These consist mostly of the Bureau of Plant Industry of the Department of Agriculture stations and some state colleges or research centers.

The NCT stations also serve as propagation centers where nearby farmers or agencies can request. The estimate of planting material distributed is very conservative since most stations could not respond due to lack of monitoring system.

The PRCRTC-ViSCA Production-Dissemination Program

The components include the breeder's trials, training, extension projects and varietal testing outside the National Cooperative Testing (NCT) Network.

Breeder's trials. On-farm trials to verify experiment station results and for propagation have since the start been an informal means of disseminating the VSP's. These were mostly researcher-managed and funded by government or an external donor (to a large extent) through Center projects. During the first phase of the sweet potato varietal improvement program which produced the first two VSP's (i.e. VSP 1-2), trials were done in the sweet potato growing areas in Leyte which were mostly lowland farms. One or two cooperators (i.e. either a farmer leader or a MAO technician) were selected for each site on the basis of contact and initial interest. The results showed the high-yielding and early maturing characteristics of the VSP's which triggered other farmers to get cuttings from the cooperators or bought these at P0.03-0.05 per cutting from ViSCA or through the DA technicians. At least 300 farmers in these areas were served in the first phase. However, the market became an acid test: the orange, moist-fleshed sweet potato did not fit the fresh market demand. The ViSCA-developed delicious SP processing in a nearby city (i.e. Tacloban) saved the fate of the 1st VSP's - the daily need was at least 500 kg of VSP1. The untimely demise of the operations (i.e. non-recovery of the factory after fire) greatly lessened the stimuli to grow the VSP's. Farmers simply maintained a small portion for home use or just as not to lose the variety. Scab disease in 1987 caused a total eradication of the varieties.

Currently, the breeder's trials (i.e. researcher-supervised/farmer-managed) are intensified in Matalom, Leyte - a location which approximates the agroecological zones of subsistence and semi-commercial root crop farming (i.e. uplands, marginal lands). Pinabacdao, Samar, the first pilot site of the new IDRC program in the Philippines also carry on these trials (i.e. on-site station and farmers' fields).

Training: Training served as the main vehicle in the dissemination of the VSP's. Participant/recipients were mostly farmers, technicians and some private entrepreneurs and non-government organizations (NGO's). The production training which started in 1985 consisted mainly of introducing the varieties and the management practices recommended. Usually, each participant is given free 20-50 cuttings for each variety. There was a high mortality rate of the cuttings when training was Center-based due to distance. Most on-site training did have better results.

Extension projects: The transfer of sweet potato technologies such as storage and food processing usually integrates seed distribution. This was done by the project/study leaders themselves or in collaboration with local agriculture

technician. These include several towns in Leyte and Southern Leyte (e.g. Silago, Maasin, Bontoc, Malitbog, Padre Burgos, Capoocan, Baybay and Dulag).

Outside NCT Trials. PRCRTC runs a project of testing the adaptability of recommended varieties and promising accessions in other locations in collaboration with state colleges and universities not covered by the National Cooperative Testing (NCT) Network. These SCU's include the Catanduanes State College (CSC), Tarlac College of Agriculture (TCA), Pangasinan State University (PSU), University of Southern Mindanao (USM), Central Mindanao University (CMU), Isabela State University (ISU), Don Mariano Marcos State University (DMMSU), Northern Mindanao Institute of Science and Technology (NORMISSIST) and Misamis Oriental State College of Agriculture and Technology (MOSCAT). The trials (researcher-managed) consisted of single rows to replicated trials at their experiment stations or farmers' fields which also served as propagation areas and distribution points.

Farmers' Field Day/Exhibits. The farmers' field day is one of the highlights of the College anniversary where the root crops center traditionally takes this as an opportunity to disseminate information on technologies including the distribution of planting materials.

National (e.g. Philtrade fair) and local (e.g. town fiesta, anniversaries) exhibits provide yet other venues for distribution, usually free.

The Department of Agriculture Extension Activities

The role of the DA in planting material distribution works in any or a combination of these ways: (1) as an outgrowth of the experiment station trials in cases where DA-BPI is an NCT member, (2) as part of an emergency response to flood or typhoons, or (3) as part of DA-led or linked special projects involving root crops.

The first one is discussed in the NCT Network. Sweet potatoes as stop-gap to famine or lack of food is a familiar measure in areas seriously hit by typhoons or floods like Region V (Bicol) and Region VIII (Eastern Visayas). This was especially so in the mid-80's where the VSP's were first popularized from the recommendation of the Philippine Seed Board. Local DA's secured the improved varieties from ViSCA. The areas served were northern towns of Leyte, Eastern Samar, Catanduanes and Albay in Bicol.

No estimates could be reached and these were not recorded nor monitored. Also, the DA usually requested cuttings from ViSCA for flood or typhoon victim propagation and this must be recorded at the ViSCA level.

Private Sector Projects; Informal Exchange Between Farmers

Enterprising farmers who initially got their cuttings from ViSCA did propagate in their own farms and maintained those varieties mostly preferred. Some farmers in Cebu, Leyte, Cotabato, Pampanga, Tarlac, Albay and Catanduanes were traced. Not less than half a million cuttings were distributed in a smaller (a few hundreds per time) or bigger scale (by hectares per time). Noteworthy to mention are private sector propagation initiatives in Cebu, Pampanga - Tarlac and Cotabato - Davao.

The Informal System: Farmer Seed Systems

At least 90% of sweet potato growing thrives through the informal distribution system. Farmers, whether subsistence or commercial, are in their own right natural breeders and nursery operators. Their main considerations for selection are user's preferences and fit in their cropping systems. Yield, early maturity and resistance are important, though not necessarily the first priority. Their method of propagation and sources of planting material are dependent on their scale of operation, space availability and cropping pattern; the latter being a function both of the environment and the value and relative importance of the crop to the household demands for consumption and other socio-economic needs.

The various farmer seed systems identified by using both focused formal and informal surveys (in Luzon) are described below.

Farmer/barter exchange scheme. Farmers within or in neighbouring localities exchange planting materials of varieties known to perform better and introduce them into their own fields. Over the years, farmers have been undertaking a "breeding" scheme and select for the more stable and preferred cultivar. In the traditionally commercial sweet potato areas, the farmer-traders carry some planting materials to other places and exchange them with popular cultivars in other areas. Another point of exchange is when two areas have different growing seasons and both widely popularize a certain cultivar. When planting material propagated is not enough, farmers seek for the materials in another area about to harvest. And the latter's farmers do the same in the reverse of the season.

Plot propagation/transplant scheme. This is practised mostly by commercial farmers in cropping systems where sweet potato is rotated with rice (rainfed), corn, vegetables or legumes. A portion of the sweet potato field is left after harvest as source of planting materials for the next season. Since harvest is timed at the onset of the dry season, the transplanting (for a wider plot propagation estimated by the farmer as enough for his intended area of production) is done when the rain starts to come or when adequate moisture is expected. The area prepared is either the adjacent plot or another plot (usually conveniently nearby) and ranges in size from 10-200 m^2. In bigger production areas (e.g. Paniqui, Gerona, et.al. of Tarlac province) transplanting is usually twice or thrice (starting in May-July) and the plot is a clean rectangular etching in the middle or side of the rice field (rainfed) which transforms into a sweet potato field from November to April. In the sweet potato-corn-vegetables/legumes commercial cropping systems (e.g. Agusan, Leyte, Lanao del Norte, Batangas, etc.), the plots are relatively smaller than those in Tarlac ranging from 10-50 m^2 and usually are in the peripheries or nearby the cornfield.

Backyard/Peripheral Patches. In subsistence and semi-commercial sweet potato production where farm sizes are small (0.25 or less), the intensive use of land to provide for sustenance makes irrelevant to the farmer the provision for propagation plots. The best means of preserving planting materials for the next season is to let the sweet potato grow in the peripheries of the next crop or maintain them in backyard patches or home gardens. A conservative estimate of 80% of sweet potato-growing farmers apply this system.

Direct Planting Scheme. In commercial and semi-commercial sweet potato producing areas, where the distribution of rainfall is relatively uniform and there is no pronounced dry spell, sweet potato is directly planted to already prepared growing areas. A parcel can have two cropping intensities for SP. With 2-3 parcels per farmer, sweet potato is directly planted to another parcel when a farmer needs a corn or a legume for a third crop. The rotation is repeated in the

other parcels. This system provides the farmer the produce he needs for home and market and preserves the fertility of the soil. In this system, sweet potato is grown all year round (e.g. Agusan and Lanao del Norte).

Cooler/Shady Location Propagation. In areas with pronounced dry spell or drought-prone areas, farmers preserve planting material by propagating in small patches (5-10 m^2) under the shade of trees (e.g. coconut, etc.) or in cooler upland areas.

Farming Circumstances

General Characteristics. The areas surveyed produce sweet potato in a semi-commercial to commercial scale with the Butuan-Sibagat producing area bend (Agusan) as mainly commercial. Sweet potato is planted to 25-30% of total farm area. The rest are shared either as intercrop or rotating crop with crops such as rice, corn, vegetables and with supplemental crops such as bananas and other root crops. Coconuts are important cash sources. In the Bicol region, sweet potato is mainly a monocrop. The cropping patterns adopted by farmers is a clear indication of the farmers' ability to cope with the given physical environment, farming household needs, resource constraints and market potentials. Sweet potato is largely an important supplemental cash crop in these areas.

Sources of Planting Materials. Most farmers depend on their own farms (70-92%) for the next season's requirement of planting materials. Neighbouring farmers are also important sources. A few farmers in Leyte and Samar (4-11%, respectively) bought planting materials from P0.07-0.15 per cutting. In Albay, the BIADS, a cooperative of farmers, became an important source of planting materials at P0.10 per cutting.

Other farming conditions are summarized in the following table 3.

Table 3. Summary of Background Characteristics in Survey Areas and of SP Planting Material Propagation.

	LEYTE n=24S	AMAR n=61	AGUSAN n=26	CATANDUANES n=6	ALBAY n=10
Major Crops:	rice, coconut, vegetables, corn	rice (upland) corn, vegetables	bananas, corn, rice, coconuts	rice, coconuts	rice, coconut, corn
Supplemental Crops:	bananas, root crops (sweet potato)	bananas, sweet potato	vegetables sweet potato pineapple	root crops (Mainly sweet potato	sweet potato
Root Crops:	sweet potato gabi cassava ubi	sweet potato cassava gabi ubi	sweet potato gabi cassava yautia ubi	sweet potato cassava	sweet potato cassava
Type of SP Market Orientation:	semi-commercial	semi-commercial/ subsistence	commercial	semi-comercial/ commercial	semi-commercial/ commercial
Ave. Farm Size:	1.0 - 1.51	0 - 1.51	0 - 1.51	0 - 1.51	.0 - 1.5
Ave. SP Farm Size:	0.25 - 0.50.	25 - 0.50.	25 - 0.50.	25 - 0.50.	25 - 0.5
Years in Farming:	21	23	20	27	21
Cropping System: (Main)	Intercropping 58%, Crop rotation 29	Intercropping (57) Crop rotation (30)	Crop rotation (27) Intercropping (50) Monocropping (19)	Monocropping (mainly)	Monocropping (mainly)
Others:	Monocropping 8 Mixed 4	Mixed (7) Monocropping (5)	Mixed (4)	Intercropping, crop rotation	Intercropping
Characteristics of SP Farms:					
- Soil type	clay loam (100)	Clay loam (74) Sandy loam (26)	Clay loam (73) Sandy (23) Silt loam (4)	Clay loam (83) Sandy (17)	Sandy loam (50) Clay loam (50)
- Topograph	flat (100)	flat (26	flat to	flat (17)	flat to
	hilly/rolling)	hilly/rolling (74)	rolling (100)	rolling/hilly (83)	rolling (100)
- Climate	distinct dry and wet	distinct dry and wet	uniform rainfall	distinct dry and wet season	distinct dry and wet season
Sources of Planting Materials:					
- own farm	92	79	73	70	76
- neighbours	8	21	15	45	57
- others	-	-	11	17 (landlord)-	35 (BIADS)
Bought Planting Materials:					
- Yes	4	11	-	-	50 fr.(BIADS)
- No	96	89	100	100	-
Price, if buy:	P0.10 per cutting	P0.07-0.15 per cutting	-	-	P0.10 per cutting
System of Planting Material Propagation:	* Cuttings are let to stay for about 3 days in a cool, shady area before planting (71%)	* Direct planting after harvest (59%) * Plant cuttings on prepared plot before transplanting to a bigger area (41%)	* Direct planting (100%)	* Direct planting * Certain portion of \field is left unharvested as source of planting materials * Plant in peripheries of corn fields backyard plots of $10m^2$ after last harvest (common practice)	* Not harvest a portion of field - let grow for propagation * Plant in peripheries * Propagate in plots under coconut ($10x10\ m^2$ or $5x5\ m^2$)
Plot sizes, if practiced (most common)	-	$2 \times 4\ m^2$ $2 \times 2\ m^2$ usually backyard plots	-	$10\ m^2$	$5 \times 5\ m^2$ $10 \times 10\ m^2$

Tried Improvements to Limiting Factors The earlier informal and formal feedback on the non-acceptance of the first moist varieties spurred attempts to find uses and capitalize on the positive aspects of the new varieties and, in general, to work approaches at improving development, production and dissemination of new varieties.

Sweet Potato Processing. Food technologists at ViSCA worked around the relatively high beta-carotene content and attractive color of VSP1. The focus of developing nutritious products from sweet potato became the fit to this highest-yielding variety among the VSP's. Efforts resulted in the making of the sweet potato beverage (currently adopted by a big corporation), delicious SP (similar to dried mango), catsup, jam and SP chips and sticks (snack products). The demand for VSP1 has not been served and definitely, a seed production-distribution scheme should be in order. The creation of a demand for this earlier rejected variety via processing has niched out the critical concern on market.

The Advent of Social Science. The recognition of the importance of social science in the whole chain of technology generation to transfer led to the creation of the socioeconomic section in the last quarter of 1987 at the root crops center. Being ultimately skeletal, it works with affiliates from other social science departments at ViSCA. The minimal advantage is that a core staff works fully on root crops. With this trend, social science approaches has been heightened and integrated in various projects.

Seed Production and Distribution Integrated in Pilot Projects

The use-specificity of the new varieties demands the inclusion of production and distribution of planting materials in processing pilot projects. A case in point is the try-out scheme followed in the naturally fermented sweet potato soy sauce project. Utilizing the relative strength and reasonably good linkage between the local agriculture extension agent and the beneficiary farmer group, a few hundreds of planting material and a simple use-awareness of the varieties through various consultation meetings were all it took for the project team on this component of piloting. All the work was done basically by the farmer group with the assistance of the local technician assigned - from the selection of propagation areas and demo plots, propagation and linkage with other farmers who needed the materials. Farmers, too, set their own terms. This important component of the project was largely eased out of the team who had more pressing technical matters to face. Highlighted in this particular case is the importance of the capability of extension agents and farmer groups in working out a village-based scheme.

Rationalization of Training and Extension Program

The need to be relevant and sensitive to users' circumstances has led to the strengthening of the rootcrops training and extension program. Salient features include carefully designed on-farm trials, simplified training for farmers and would-be processors, use of appropriate dissemination media, strengthened linkages with local groups and a built-in projects' monitoring scheme. These are currently seriously considered for adequate and continuous Center support, not co-terminus with projects as in most cases in the past. A critical concern is the provision for support (defined as to nature of project) during the transition phase of period-completed pilot cases. The sustainability question could hinge on other support services identified in the process. Referrals and further strengthening of linkages may be necessary.

IV. ASSESSMENT OF DIFFUSION AND ADOPTION

The attempt to evaluate how fast and to what extent the varieties have been adopted is relatively difficult particularly in a system where monitoring is not built-in. Estimates of areas grown and the quantity of planting materials distributed are largely drawn from records and surveys, both informal and formal (n=58). Survey results are summarized in the table at end of section.

The Diffusion Process

To the cooperators, the ViSCA project/study leaders in their trials or extension projects were the main source of information (60%) as well as planting materials (60%). The agriculture technicians are also important vehicles of information relay in all cases. The informal exchange among farmers proved effective. Fifty-eight percent of the non-cooperator/adopters got the technology through this process.

The cuttings were mostly given free and in some cases at a cost of P0.03-0.10 per cutting.

Extent of Adoption of VSP's

Respondent cooperators grow on the average 1.4 hectares of sweet potato, about 42% of total farm size cultivated. Fifty percent of the sweet potato area is planted with VSP's and the rest on the popular local cultivar. For non-cooperator/adopters, 0.7 hectare or 21% of total farm size is grown with sweet potato. About 43% of the sweet potato area is devoted to VSP's. A conservative nation-wide estimate of area seeded to the VSP's is a little less than 1% of total sweet potato area, most are commercial or semi-commercial.

Most VSP's tried were the first four released varieties, VSP 1-4 with VSP 1 and 2 the least popular in Leyte area where commercial growing serves mostly the fresh food-traditional use food market. The opposite is true in Bicol where sweet potato catsup processing is tried out; VSP 1 and 2 stood out. VSP 4 is already gaining wider market acceptance, and thus, farmer adoption is most areas where introduced. Dulag, the only town in Leyte known for commercial sweet potato production, has widely accepted VSP 4 with traders gaining repeat orders from city buyers. In other Leyte towns, Pangasinan, Pampanga, Bulacan and Bicol, VSP 3, 4 and 6 are also gaining acceptability. These varieties approximate the eating qualities desired by consumers. VSP 3 has been especially recommended for sweet potato-cassava-feedmill project (Pangasinan). Some farmers prefer VSP 1 as feed to pigs because of their relatively high vitamin A content. In the southern towns of Leyte VSP 3 and 4 are also accepted together with the earlier ViSCA varieties introduced, the BNAS-51 and V2-42.

The collaborating stations in Mindanao have been propagating and distributing cuttings in the provinces of Bukidnon, Misamis Oriental, Agusan, Cotabato and Zamboanga. No adequate farmer feedback was given but preliminary reports suggest positive gains for VSP 3 and 4. The same is true for Cebu in Central Visayas where an enterprising farmer has kept sufficient supply of the VSP's. On the whole, VSP 3 and 4 fared well in areas where they had been tried.

The current increasing demand for VSP 1 is due to the transfer of processing technologies such as the sweet potato beverage in Pampanga (which links with the commercial sweet potato farmers in Paniqui, Tarlac - Central Luzon region) and the sweet potato catsup processing in Catanduanes and Albay (Bicol Region).

Others have learned to make catsup with other cultivars by simply playing with the formulation and color.

The VSP's in general did not perform well in the highlands of Benguet where high-yielding local cultivars dominate. The VSP's were products of lowland breeding. Most sweet potato farms are typically upland. This lack of agroecological fit was a source of risk and frustration.

In general, the acceptability of the VSP's stood in direct correlation to use and market acceptability. While farmers were impressed by their yields and early maturity, the new varieties have to stand the test of the market and users. The negative image of the VSP's which resulted with the first introduced moist types is now gradually phased out as awareness of different varietal types, their respective characteristics and uses are being emphasized in extension and distribution activities.

Also, the existence of good performing local cultivars in the different sweet potato areas made the inroads to acceptance of the VSP's relatively difficult. Examples are shown below:

Area	Cultivar	Maturity	Yield (t/ha)	Eating Quality
Leyte	Miracle	3-4	12-14	Good
	Karingkit	5-7	6-8	V. good
	Siete Flores	5-7	6-8	V. good
Benguet	Kalbooy	5-7	20-25	V. good
Tarlac	Bureau	2 1/2-3	16-18	V. good
	Taiwan	3-4	16-20	V. good
Agusan del Sur	Katimpa	4-5	8-12	V. good
	Kasima	5-6	8-12	V. good
	Senorita	4-5	8-12	Good (Chinese)
Iligan	Makapuling	5-6	14-18	V. good
	Imelda	5-6	14-18	V. good
	Chinese	5-6	14-16	Good (Chinese)
Batangas	Sinuksok	4-5	10-12	Good
Quezon	Taiwan	3-4	14-16	V. good
	Miracle	3-4	10-14	Good
Bicol	Tres Colores	5-6	10-12	V. good
	Sinimet	5-6	10-12	V. good

Sixty percent of the cooperators are still growing the VSP's compared to thirty-eight percent of the non-cooperators/adopters. The main reason for not growing is the dearth of planting materials due to extreme weather conditions (drought or severe rain). Farmers complain that the VSP's are sensitive and cannot withstand extreme conditions. They report, too, that continuous cropping of the VSP's without substantial inputs yield lesser output. The creeping local cultivars can be conveniently grown for longer period and, thus, less work-intensive.

Other constraints in the adoption process include lack of resources to purchase required inputs (i.e. fertilizer), lack of adequate information of the HYV technology and the unavailability of technical assistance when needed.

Estimates of Material Distributed

Based on records at ViSCA and responses from the stations and collaborating institutions, a conservative estimate of distribution is shown below.

1. Breeding Station* (FA Saladaga's Record)	Year	No. of Cuttings	Particulars
VSP 1-3	1983	134,350	Various Farmers
VSP 1-3	1984	940,630	Various Farmers
		126,900	DA (Regs. 7 & 8)
			Research Stations
			DCCLS (Tacloban)
			Walk-in request
		284,700	MAF Rehab
			Operating Program
VSP 1-4	1985	1,118,765	Farmers
		312,312	DA
		748,800	Philphos
			DCCLS
			LSBBA
			Walk-in requests
			MAF Rehab
			Operating Program
VSP 1-5	1986	193,547	Farmers
		30,000	MAF
		4,247	Walk-in requests
		34,140	Others
VSP 1-6	1987	103,050	Farmers
		30,000	DA
		161,200	LSBAA
			Philphos
			DCCLS
			Walk-in requests
VSP 1-6	1988	37,660	Walk-in requests including farmers experiment station
VSP 1-6	1989	53,900	Walk-in requests including farmers experiment station.
	Sub-total	4,314,201	
2. Training			
VSP 1-6	1986-87	2,250	farmers/technicians
VSP 1-6	1988	8,120	farmers
VSP 1-6	1989	4,545	farmers
VSP 1-6	1990	940	farmers/cooperators
	sub-total	15,855	
3. Extension projects/Farmers' Field Day ViSCA Exhibits (PRCRTC Source)			
VSP 1-6	before 1989	5,000	farmers
VSP 1-6	1989	4,060	farmers
VSP 1-7	1990	20,810	farmers
		700	BAMA/DCCLS
	sub-total	30,570	

4 Distribution by Non-NCT Cooperators (SCU's)

Catanduanes State College	(VSP 1-6, hybrids 3-190 15-70, 20-429)	32,000[1/]	farmers/DA
Central Mindanao University		50,000[2/]	farmers/other agencies
Northern Mindanao State Institute for Science and Technology		20,000[2/]	farmers/walk-in requests
Others		100,000[2/]	undetermined/some staff

5. Distribution by NCT

UP La Granja		30,000
CSSAC		210,000
Tiaong Experiment Station		37,090
DA, Bruane, Ilngao		600
	Sub-total	277,690
	Overall Total	4,840,316

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* Includes all distributed taken from FA Saladaga and those distributed for ViSCA exhibits (Philtrade, Agro-fair, fiesta, etc.).

[1/] Does not include planting materials taken by farmers from experimental areas and those taken from the College of Agriculture not recorded by student assistants.

[2/] Conservative estimates

Data show that almost 90% of planting material distributed come from the breeding station and the highest agency recipient is the Department of Agriculture which in turn distributes to farmers or grow them in their respective propagation plots. Evidence seems to suggest a combination of relatively high mortality rate and non-adoption. Of the conservatively estimated 4.8 million vine cuttings distributed, at least 5000 hectares should have been seeded with the VSP's (i.e. assuming 33000 requirement per hectare and a cropping intensity of one). At present, less than one percent of total sweet potato area (about 1000 hectares) are seeded with the new varieties - mostly commercial and project/trial-linked areas.

Summary Characteristics of VSP Growers in Albay and Leyte, Cooperators and Non-Cooperator/adopters1/

Variables		Cooperator	Non-Cooperator/Adopter
Years in farming general (yrs)		22	27
SP farming		22	23
Total farm size (hectares)		3.3	3.3
No. of parcels		3-4	2-3
Tenure:2/	Owner-operator	60	51
	Part-owner/amortizing	-	11
	Tenant	60	75
Average total area planted to SP: (hectares)	VSP	0.7	0.3
	Local	0.7	0.4
SP % of total farm size		42%	21%
VSP % of total SP		50%	43%
VSP % of total farm size		21%	21%
VSP's tried:	1	80	43
	2	80	40
	3	80	9
	4	80	36
	5	60	15
	6	20	-
Still growing:	Y	60	38
	N	40	62
VSP Characteristics liked:			
early maturing		67	35
high-yielding		67	45
good eating quality		33	15
good market/acceptable to consumers		33	30
sweetness		33	75
Why not growing anymore?			
no more cuttings (severe rain)		50	21
no more cuttings (drought)		50	3
no market for wet SP		-	42
Source of knowledge: VSP's			
DA technician/extension		40	30
ViSCA project leaders		60	9
Landlord		-	4
Brgy, Capt.		20	-
Farmer-cooperator		-	24
Other farmers nearby		-	34
Source of planting materials			
SP buyer		-	2
ViSCA (requested)		60	4
Technician (ViSCA)		20	-
ViSCA project leaders		20	-
DA/MAO		-	19
Farmer-cooperator		-	43
Neighours/farmers nearby		-	30
Landlord		-	4
Cost of cuttings: free		40	70
sample		20	2
0.10/cutting		40	2
exchange		-	2
0.03-0.05		-	24

1/ Sample size, n, for cooperators is 5; n=53 for non-cooperators/adopters.
2/ Reflects parcels cultivated by a farmer have different tenurial arrangements.

IV. IMPLICATIONS

A study of the sweet potato seed production mechanisms is premised on the fact that it plays a critical role in the overall development of the sweet potato agro-industry. While such is recognized, there is little documented information on the various seed systems of sweet potato in the country. This study is an attempt to describe the indigenous production-distribution systems practiced by farmers, the official system established to evaluate and propagate improved planting materials and other alternative systems tried out to reach a greater number of beneficiaries. In addition, an attempt is made to assess the diffusion and adoption of the sweet potato HYV technology developed at ViSCA.

Findings show that only at best ten percent (10%) of sweet potato production has been linked to the formal seed system (i.e. HYV's); at least ninety percent (90%) thrive on the informal or indigenous farmer seed system. The reasons are: (1) the existence of a greater diversity of sweet potato across various agroecological zones in the country, each with an already existing farmer-selected good-performing cultivar; and (2) the lack of a systematic production-distribution scheme inherent in the weaknesses of a government-heavy set-up; and the lack of farmer-user participation and feedback. The bottom-up approach in varietal development and participatory method of seed production-distribution and monitoring lessen the risk of non-adoption.

The need to revise the official system to effectively develop and disseminate improved varieties had already been discussed in the early eighties triggered by low adoption of modern varieties and the dearth of quality seeds. The continued reliance, however, on the conventional, centralized, government-heavy formal system could bear heavily on scarce government resources, create a negative bias against farmer-user participation (thus, a higher risk of non-adoption), and a longer gestation for usefulness of the improved variety. The strictures imposed by the existing testing and evaluation protocol and of certification may not at all be relevant in a crop with a wide diversity like sweet potato. The evidence of unique adaptabilities of the crop to specific agroecological zones (e.g. upland, rainfed lowland, highland) renders the system of testing via the network's stations for national recommendation almost irrelevant and cost-inefficient. Even the stirrings for a regional recommendation seriously need caution. With the sweet potato farming circumstances, it is relevant to define region in terms of agroecological characteristics.

If the system of national recommendation is a means of recognition for achievement and national testing is then carried out, then a definition of desired characteristics for specific intended use and a description of testing zones are important for inclusion in the dissemination package, simply and clearly designed. In general, the system of evaluation for recommendation of sweet potato varieties could consider refinements in such aspects as: (1) criteria for recommendation qualified as to intended users (i.e. table vs. processing); (2) the basis for the selection of regional trial sites reflective of the typical sweet potato growing areas; and (3) choice of check variety or cultivar which should not miss the most widely grown or best performing cultivar of the test area. Performance failures of some high-yielding varieties in the stations are partly due to the relative lack of clear description of the recommendation domain.

The existing farmer seed systems have operated at a certain level of efficiency under existing scale of operations. These indigenous systems need to be considered in working out an innovative and simplified seed production-distribution scheme not excessively dependent on government but managed by

farmers and supported by research and extension programs in the respective influence areas. With respect to this system, design may be area and use specific. A clear understanding of the size and nature of the seed demand, capabilities and strength of the farmer groups and local extension agencies, farming circumstances, and the fit of the improved variety to the market or use are critical inputs for an effective system.

Considering the enormity and nature of the tasks at hand, technical and social scientists need to collaborate and effect a medium by which a fuller synergy of constructive conflicts can be channelled - in the end, to help resource-poor farmers and rural entrepreneurs.

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