ROOT CROPS IN EASTERN AFRICA

Proceedings of a workshop held in Kigali, Rwanda, 23-27 November 1980
The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre’s activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre’s headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.
Root Crops in Eastern Africa

Proceedings of a workshop held in Kigali, Rwanda, 23–27 November 1980

Cosponsored by Gouvernement de la République rwandaise, the International Institute of Tropical Agriculture, and the International Development Research Centre.
Résumé

Cette brochure traite principalement des deux tubercules alimentaires les plus importants en Afrique orientale, soit le manioc et la patate douce. Quelques communications portent sur la pomme de terre, l’igname, le taro et l’- enset - dont la consommation est considérable dans plusieurs pays de la région. Le rendement de ces cultures est limité par de nombreux facteurs. Aussi, la recherche effectuée dans le cadre de programmes agronomiques nationaux et internationaux est-elle orientée vers la correction de cette situation en Afrique. Les difficultés rencontrées en cours de travaux et les progrès réalisés sont décrits par des représentants et des consultants de l’Institut international d’agriculture tropicale d’Ibadan (Nigéria) et d’autres pays tel que le Cameroun, le Kenya, l’Ouganda, le Malawi, le Zimbabwe, l’Éthiopie, le Burundi, le Zaïre et le Swaziland.

Resumen

Esta publicación se enfoca en la mandioca y el camote — los cultivos de tuberosas más importantes del Africa oriental. Los trabajos tratan también del Solanum tuberosum, Dioscorea spp., Colocasia sp., Xanthosoma sp., y Enset sp., que son todos cultivos importantes a los países de esta región. La producción de cada uno es restringida por serios constreñimientos, y el alivio de éstos es el objetivo de varias investigaciones llevadas a cabo por los programas agrícolas nacionales e internacionales en el Africa. El progreso hacia y los problemas encontrados en llegar a este fin son delineados por especialistas representando al Instituto Internacional de Agricultura Tropical en Ibadan, Nigeria, y a los países de Camerún, Kenia, Uganda, Malawi, Zimbabwe, Etiopia, Burundi, Zaire, y Swazilandia.
Contents

Foreword 5

Participants 7

Discussion summary 10

Breeding
Historical perspectives of cassava breeding in Africa B.D.A. Beck 13
Research priorities, techniques, and accomplishments in cassava breeding at IITA S.K. Hahn 19
Research priorities, techniques, and accomplishments in sweet-potato breeding at IITA S.K. Hahn 23
Sweet-potato improvement in Rwanda M.J.J. Janssens 27
Sweet-potato improvement in Cameroon H.J. Pfeiffer 33
Strategy for developing a national potato program for Rwanda P. Vander Zaag 39

Plant protection
Increasing and stabilizing cassava and sweet-potato productivity by disease resistance and crop hygiene E.R. Terry and S.K. Hahn 47
Effects of soil fertility on cassava bacterial blight in Rwanda I. Butare and F. Banyangabose 53
Distribution and importance of Xanthomonas manihotis and X. cassavae in East Africa D.M. Onyango and D.M. Mukunya 56
Cassava mosaic disease E.J. Guthrie 59
Pest control for cassava and sweet potato K. Leuschner 60
Cassava green mite: its distribution and possible control Z.M. Nyiira 65
Biological control of cassava mealybug and cassava green mite: front-line release strategy K.M. Lema and H.R. Herren 68
The mealybug problem and its control T.P. Singh 70

Agronomy
Economics of research and development of root and tuber crops in Zanzibar, Tanzania A.J. Carpenter 75
Agronomic research on cassava cultivation in Rwanda J. Mulindangabo 78
Agronomic effects and economic importance of fertilizers on yams in Cameroon S.N. Lyonga 81
Country reports
Cameroon H.J. Pfeiffer and S.N. Lyonga 89
Kenya G.H. de Bruijn and E.J. Guthrie 95
Uganda Z.M. Nyiira 99
Malawi R.F. Nembozanga Sauti 104
Zimbabwe A.G. Rowe 107
Ethiopia Terefe Belehu 109
Burundi D. Cimpaye 111
Zaire T.P. Singh and N.B. Lataladio 114
Swaziland W. Godfrey-Sam-Aggrey 119

References 122
Sweet-potato improvement in Rwanda

M.J.J. Janssens

Sweet potato is a staple food throughout most of Rwanda, but production is hampered by viruses, weevils, leaf caterpillars, environmental heterogeneity, the late maturity of the crop, intergenotypic competition, and taste requirements. These constraints are the focus of the sweet-potato-improvement program in Rwanda. A main breeding population was established for evaluation of yield potential under mid-elevation Rwandan conditions, and subpopulations were used for trials on drought and cold stress. The procedure comprised selection, preliminary yield trials, multilocality yield trials, and preextension trials. In trials so far, tuber yield was highly correlated with number of tubers, and top growth was an indicator of yield quality (high starch and dry-matter content). Saccharose and starch were negatively correlated. One superior clone, Rusenya, yielded $8.1 \times 10^5$ kg/ha on average across seven environments. Groups of varieties with similar environmental adaptability could be identified. A system of multireciprocal recurrent population improvement is proposed that consists of a central breeding population, aimed at high and stable yield, and a set of interdependent breeding subpopulations corresponding to particular breeding goals.

La patate douce est un aliment de base dans la majeure partie du Rwanda, mais la production est limitée par des virus, charançons et chenilles, l'hétérogénéité environnementale, la maturité tardive des récoltes, la concurrence intergénotypique et des problèmes de goût. Le programme d'amélioration de la patate douce au Rwanda vise à corriger cette situation. On a constitué une population principale pour évaluer la productivité potentielle en moyenne altitude, et des sous-populations pour vérifier la résistance à la sécheresse et au froid. Le processus comprenait la sélection, des essais de rendement dans plusieurs localités, des essais préliminaires de rendement, et de vulgarisation. Jusqu'à maintenant, les essais ont montré une forte corrélation entre le rendement des tubercules et leur nombre, et la croissance maximale a été un indicateur de la qualité du rendement (riche en féculents et en matières sèches). La saccharose et les féculents étaient en corrélation négative. Un clone supérieur, le Rusenya, a donné un rendement moyen de $8.1 \times 10^5$ kg/ha dans sept environnements. On a pu identifier des groupes de variétés ayant les mêmes facultés d'adaptation à l'environnement. On propose un système d'amélioration de population récurrente multi-réciproque constitué d'une population centrale devant atteindre un rendement élevé et stable et de sous-populations interdépendantes répondant à des objectifs précis de sélection.

Sweet potato is the most important root crop in Rwanda. It is grown on about $1.5 \times 10^5$ ha and produces an average 7-8 t/ha. In the past, sweet-potato research for Rwanda, Burundi, and Zaire was mainly conducted at a research station in Zaire (Mulungu). Breeding focused on virus resistance, cold tolerance, and protein quality and led to the release of such clones as M46, D.Virovsky 16, and variety 5037 (Lemarchand 1956).

In Rwanda, research on sweet potato was restricted to introductions, preliminary yield trials (Camerman and van Bellinghen 1973), and comparative yield trials, with subsequent release of some of the clones. Only in 1978 did an active research program of sweet-potato improvement and breeding begin at Rubona (Institut des sciences agronomiques du Rwanda, ISAR).

Viral diseases constitute a major production problem (Lemarchand 1956). During the last 2 decades, ISAR released several clones (Anne-Marie, Mugenda, and Caroline Lee), all of which turned out to be virus susceptible. The pioneer work of Sheffield (1957) identified two strains of virus affecting sweet potatoes in Uganda. However, the wide range of
virus-like symptoms in Rwanda fields suggests that a greater number of strains affect production here.

A second major production constraint is weevils, *Cylas* spp. (Buyckx 1962). Weevils are particularly a problem for late plantings (April–May) on hill sites, because their populations expand rapidly during the dry season (July–September).

The leaf caterpillar, *Acraea acerata*, also can become a serious production problem during the dry season (Lefevre 1948). Erinose, characterized by abundant pubescence, is a minor pest caused by *Aceria* spp. (Sheffield 1962).

*Alternaria* anthracnosis is a minor disease problem (Buyckx 1962). Clones Nyiramujuna and Rukocoka, as well as their offspring, appear very susceptible, particularly under cold and humid conditions.

Although Rwanda is only about 2.8 × 10^4 km², no fewer than 12 agroecological regions can be distinguished (Delepierre 1974).

Cultural practices, too, are diverse and need to be better understood in both agronomic and economic terms.

Most of the local varieties of sweet potato mature between 6 and 8 months. However, the increasing demographic pressure in Rwanda is forcing producers to harvest the crop before maturity. Release of some early-maturing clones (about 4–5 months) would improve yields.

Consumer taste also deserves attention because, ultimately, it determines whether a new variety will become an important element in people's diets.

**Improvement program**

When the sweet-potato-breeding program was started in 1978, about 40 clones were available in Rubona — half of them local introductions and half, accessions from Zaire. Among the latter, many clones could be traced to obsolete US varieties, e.g., Caroline Lee and Red Jersey.

It was decided to generate genetic variability as quickly as possible by the introduction of seed material from abroad and clonal material from the different regions of Rwanda, as well as intercrossings of all 40 clones of the existing collection.

A progressive, nested polycross design (Janssens 1980) was used. Four sets of seven seed gardens were established. In the first set, a single recurrent parent was used for pollination of each of the seven clones; in the second set, two recurrent parents were used for pollination of each of seven other clones; in the third set, the mix contained three recurrent parents; and, in the fourth set, four pollen parents were used. A total of 10 pollen parents was used, chosen either for high-yielding capacity or for other desirable characters, e.g., early maturity or orange flesh. Hence, 38 (10 + 28) clones were intercrossed in 28 seed gardens.

The isolation distance between seed gardens within each set was about 100 m, which is far below the recommended 500 m for total isolation (Hahn, elsewhere in this volume). However, part of the contaminating pollen mix within each set is desirable. For example, a contamination of 20% in the biclonal seed gardens (i.e., first set of seed gardens with only one single recurrent pollen parent) will actually correspond to an undesirable contamination of only 10%, as the other half is desirable pollen of the recurrent pollen parent. In the fourth set, a 20% total contamination reduces to a mere 4% undesirable contamination.

Unfortunately, the flowering habit of the 38 clones was very heterogeneous. In future, this could be overcome by the use of some flowering-inducing methods, e.g., grafts of flowering clones (AVRDC 1976); some suitable root-stock species (yet to be found, for Japanese morning glory, *Pharbitis nil*, is unadapted to the Rwandan short photoperiod); application of appropriate pesticides (Jones 1977); use of phytohormones (Howell and Wittwer 1955; Suge 1977); nitrogen fertilization (Knavel and Lasheen 1969); or any suitable combination of these methods. If flowering could be controlled in a reasonable way, the progressive, nested polycross design would provide estimates of both the additive and dominance variance components through regression analysis (Janssens 1980).

One main breeding population was constituted, comprising high yielders known to be well adapted to the central mid-elevation region of Rwanda (1500–1900 m). In addition, two breeding subpopulations were constituted, one adapted for the high elevations (1900–2300 m) of northern Rwanda and the other adapted to the drier conditions (600–1000 mm annual rainfall) and lower elevations (1250–1500 m) of eastern Rwanda.
**Selection procedure (Table 1)**

Genetic variability is initiated through introductions and crossings. After scarification and pregermination, seedlings are raised in the nursery at a 10 cm × 5 cm spacing for about 2–3 months, up to the 4–6 leaf stage. For the high- and mid-elevation programs, the seedlings are transplanted to the selection fields (SFs); however, for the east Rwandan program, where conditions are drier, it has proved useful to wait until cuttings are ready to be transplanted.

The selection fields are established by the hill-plot technique. Each seedling is planted at the top of a 0.5–1.0 m² hill. After 6–8 weeks, three cuttings are taken from each seedling and planted at the base of the hill. The family structure is maintained, and, when the size of the families is adequate, the whole selection field is divided into four randomized blocks. At about 3–4 months, the whole selection field is screened for possible virus and anthracnose symptoms. The selection fields are harvested at 6 months. In future, some selection fields will be harvested at 4–5 months so that early-maturing material is identified. The selection intensity is 10%, and the grid system of Gardner (1961) is used — the 10 best hills from each successive 100 hills are selected.

The traits recorded for each seedling (hill) are: virus incidence; anthracnose symptoms; weevil damage (on a scale from 0 to 5); flesh colour; weight of vines; tuber yield; and number of tubers. Yield is the principal selection criterion, although all clones showing virus symptoms or serious weevil damage are culled. More than 6000 seedlings have been screened, including 1000 at high elevation (at ISAR-Rwerere) and 500 under subhumid conditions (at ISAR-Karama).

Orange-fleshed seedlings are generally low yielding and more susceptible to weevils. Selection fields arising from IITA seed material have more dropouts because of poor adaptation to Rwanda; therefore, selection intensity was increased to 2–3%. Moreover, IITA progeny show high virus susceptibility under Rwandan conditions, in spite of the fact that most IITA parents originated from a strong selection against virus (Hahn, elsewhere in this volume). This finding strongly suggests that viruses or their vectors are different in Rwanda.

Preliminary yield trials (PYTs) consist usually of four to five randomized blocks in which the selected clones are compared. Each clone is planted on a 1-m² hill plot, three cuttings at the top and five cuttings at the base. No border rows are planted between the different hill plots because in Rwanda sweet potato is always grown in varietal mixtures of at least four to five clones (Cameron and van Bellinghen 1973). Hence, one ought to select clones that exhibit high-yielding capacity under severe intergenotypic competition (Schutz et al. 1968).

A selection intensity of 10% is adopted at harvest. The selection criteria are the same as in the selection fields, although root shape is also noted. A sample of each clone is taken for taste rating and for analysis of dry-matter content, protein, saccharose, and starch. The best 10% of the clones are immediately multiplied. After multiplication, these clones are tested in multiclonality yield trials (MLYTs) throughout Rwanda, during both the November and the March planting seasons. Some test sites are in swamps, and the Rubona planting site is duplicated with high inputs of fertilizer. Because of the scarcity of large testing sites in Rwanda and because of the extremely heterogeneous soil conditions, block sizes have been minimized so that the differences between them will be as few as possible. Plot sizes also have been reduced to four 1-m² hills/plot in a square configuration. Again, there are no border rows between plots. The number of main blocks has also been reduced to two, and two tiny blocks have been joined to the main experiment, and, within them, the clones are evaluated for their ability to compete with other genotypes. Each clone is allotted a mini-plot (80 cm × 30 cm) on which two cuttings are planted without a border row.

The same selection criteria as in the earlier selection stages (SFs, PYTs) are applied. Moreover, the clones are rated for environmental adaptation and stability, drought and cold tolerance. About 15 localities have been tested, including Kisosi (Institut des sciences agronomiques du Burundi, ISABU) and Mulungu (INERA, Zaire). In future, it is hoped to include Uganda and Tanzania.

The best 20% of the clones over all sites are selected. In addition, the best 20% of the clones at high elevations are added to the specific high-elevation subpopulation. Similarly, the best 20% drought-resistant clones are added to the drought-resistance sub-
Table 1. Sweet-potato-selection procedure used at ISAR.

<table>
<thead>
<tr>
<th>Timing (year, month)</th>
<th>Selection stage</th>
<th>Clone population</th>
<th>Experimental layout</th>
<th>Selection criteria</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8</td>
<td>Germination</td>
<td>12500</td>
<td>Incubator at 30°C</td>
<td>Germination</td>
<td>Germination is ~80%</td>
</tr>
<tr>
<td>1.8</td>
<td>Nursery</td>
<td>10000</td>
<td>30 m x 1.2 m beds, 10 cm x 5 cm spacing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.11</td>
<td>Selection field (SF)</td>
<td>10000</td>
<td>4 randomized blocks, 0.5-1.0 m² hills, 1 seedling + 3 cuttings/hill, grid system</td>
<td>Resistance to virus, anthracnose, weevil (scoring 0-5); yield of tubers and vines; number of tubers; flesh colour</td>
<td>Selection intensity is 10% within each grid of 100 hills</td>
</tr>
<tr>
<td>1.5</td>
<td>Preliminary yield trial (PYT) in swamp (dry season)</td>
<td>1000</td>
<td>4 randomized blocks, 1-m² hill plots, 8 cuttings/hill (32 cuttings/clone), &lt;250 entries/PYT</td>
<td>Same as for SF; also skin colour; taste; dry matter; starch; protein; saccharose</td>
<td>Selection intensity is 10%</td>
</tr>
<tr>
<td>2.11</td>
<td>Multiplication</td>
<td>100</td>
<td>na b</td>
<td>Virus resistance</td>
<td>Selection intensity is ~80%</td>
</tr>
<tr>
<td>2.3</td>
<td>Multilocation yield trial (MLYT) 1st season</td>
<td>80</td>
<td>~15 sites, 2 randomized blocks, 4 x 1-m² hills/plot, 2 tiny randomized blocks for intergenotypic competition</td>
<td>Same as for SF; also environmental adaptation; stability</td>
<td>Selection intensity is 10% for each agroecological region</td>
</tr>
<tr>
<td>3.11</td>
<td>MLYT, 2nd season</td>
<td>80</td>
<td>Same as for MLYT, 1st season</td>
<td>Same as for MLYT, 1st season</td>
<td>Same as for MLYT, 1st season</td>
</tr>
<tr>
<td>3.3</td>
<td>Cultural practices</td>
<td>8 a</td>
<td>As appropriate</td>
<td>Farmers’ criteria</td>
<td>3-4 best clones/region are retained for release; not more than 10 clones for the whole of Rwanda</td>
</tr>
<tr>
<td>3.3</td>
<td>Intercropping</td>
<td>8 a</td>
<td>As appropriate</td>
<td>Farmers’ criteria</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Taste panel</td>
<td>8 a</td>
<td>As appropriate</td>
<td>Farmers’ criteria</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Multiplication</td>
<td>8 a</td>
<td>As appropriate</td>
<td>Farmers’ criteria</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Farmers’ trials (FTs), 1st season</td>
<td>8 a</td>
<td>24 farmers (2/region), 2 randomized blocks, 10-12 m² plots</td>
<td>Farmers’ criteria</td>
<td></td>
</tr>
<tr>
<td>4.11</td>
<td>FTs, 2nd season</td>
<td>8 a</td>
<td>Same as for FTs, 1st season</td>
<td>Farmers’ criteria</td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Release</td>
<td>3-4</td>
<td>na</td>
<td>na</td>
<td>Release is through extension services and multiplication centres</td>
</tr>
</tbody>
</table>

a Along with eight selections, two local varieties are tested in each region for comparison.
b na = not applicable, not a trial.
population. In future, selection intensity will be increased to 10%.

The best MLYT clones are submitted to pre-extension trials (PETs), including trials on cultural practices and in farmers' fields done simultaneously along with taste-panel testing and large-scale multiplication.

In the trials on cultural practices, different levels of fertilizer inputs and planting density are combined, the goal being to determine the optimum agronomic environment for the best clones. The effects of interspecific competition are studied in intercropping trials (ICTs) with the best clones.

Farmers' trials (FTs) include the same clones, which are planted in farmers' fields all over Rwanda. A taste panel (TP) is organized with 20 farmers to rate the best clones for taste, and the clones are multiplied on a large scale under phytosanitary control.

These preextension trials enable the choice of three or four very good clones to be released for each of the 12 agroecological regions of Rwanda. Because there is some overlap in the conditions in the 12 regions (Delepierre 1974) and some environmental stability in the new selections, it is hoped that the total number of clones for release and multiplication can be reduced to about 10.

**Recent experimental results**

In a preliminary yield trial with 20 clones conducted in 1979, a correlation analysis was performed on eight traits. Tuber yield was positively correlated with average tuber weight \( r = 0.88^{**} \) as well as with number of tubers per unit of surface \( r = 0.78^{**} \). This finding confirms earlier work by Jones (1970) and Mahungu (1979) indicating that multiple tuberization increases yield.

Top growth is a component of yield quality, as it is positively correlated with starch content \( r = 0.49^{**} \) and negatively correlated with water content \( r = -0.46^{*} \). This explains why Rwandan farmers prefer starchy varieties, which are associated with low-water content, i.e., better storage and higher nutritive value.

In a multilocality yield trial in 1979 with 19 clones on seven sites throughout Rwanda, one clone, Rusenya, showed clear superiority over 18 others. It yielded, on average, \( 8.1 \times 10^3 \) kg/ha over a 6-month growing period, compared with a grand mean of \( 3.9 \times 10^3 \) kg/ha. Two other clones showed good yield potential: Caroline Lee \( (5.7 \times 10^3 \) kg/ha) and Bukarasa \( (5.2 \times 10^3 \) kg/ha).

The genotype \( \times \) environment interactions, which were highly significant, were plotted graphically, and a cluster analysis was performed. It was possible to identify groups of varieties adapted to ideal conditions (e.g., Bukarasa), cold conditions (e.g., Ruseny, D.Virovsky 16, var. Peruvian), and dry conditions (e.g., Nyirakayenzi, Nyiramujuna), which were then added to the appropriate breeding subpopulations.

**Future breeding strategy**

Reciprocal recurrent selection was first proposed by Comstock et al. (1949) as a means of selecting simultaneously for both general and specific combining ability. The method was modified by Eberhart et al. (1967) into a "comprehensive breeding system" whereby recurrent selection for favourable characters is performed within each of two or more populations, and the two or several improved populations are intercrossed. The usefulness of population breeding has been adequately demonstrated by Suneson (1956).

Jones (1965) proposed that a random-mating population be maintained and sub-populations selected toward different goals. He later reported that after only six random-mating generations some desirable agro-economic characters within the population had decreased — vine diameter, root weight, skin smoothness, resistance to Fusarium — and vine length had increased (Jones 1972). However, a higher degree of resistance against Coleoptera was found (Cuthbert and Jones 1972).

At IITA, short-range (weevil and virus resistance) and long-range (large genetic variability) population improvement is undertaken simultaneously.

**Multireciprocal, recurrent population improvement**

A central, breeding-population pool will be constituted for trials on yield potential at mid-elevation conditions (1500–1900 m) where most of the sweet-potato cropping is done. Concurrently, a set of interdependent-breeding subpopulations will be constituted, each subpopulation corresponding to a particular breeding goal (Jones 1965), e.g., resis-
stance to cold, drought, hydromorphic conditions, virus, and weevil; early maturity; and content of saccharose, carotene, protein, starch. There will be continuous multi-reciprocal exchange of suitable genotypes between the central breeding pool and each of the respective subpopulations, as well as between the subpopulations themselves. Hence, in each population the frequency of the desired genes is likely to increase steadily (Eberhart et al. 1967).

Each population will comprise:
- A recurrent-breeding population of parents known to be outstanding with regard to a particular trait; this recurrent-breeding population (subcollection) will be enriched gradually with proven material selected from yield trials;
- A fluctuating breeding population constituted by the clones, selected in the preliminary yield trials; and
- A random-mating population of 1000–2000 seedlings — the amount depending on land availability.

However, to reduce genetic drift toward undesirable characters (Jones 1972), there will be a seasonal 10% enrichment of the random-mating population by the MLYT clones retained for farmers’ trials. Hence, each season a random-mating population will comprise about 90% seedlings and 10% clones.

Reciprocity between the central breeding pool and each of the subpopulations is easy to achieve: in each of the recurrent-breeding populations (subcollections), clones known for their high-yielding capacity will be interplanted for pollination of the subcollection; seed harvested on these pollinators will be taken back to the selection fields of the central breeding population. Moreover, some selections from the central PYT will be diverted to the PYT stage of specific populations, and vice versa. Similarly, PYT selections with specific characters will be interchanged between the corresponding subpopulations.

**Selection procedure within the central breeding population**

Within the central breeding population, the improvement program will incorporate several steps in addition to those in the overall improvement program (Table 1):
- Seed will be harvested from the whole breeding population; two or three seeds will be taken for each plant in the random-mating population (RMBP) and will be bulked together; all available seed for the fluctuating breeding population (FBP) will be harvested and bulked together; the recurrent breeding population (RBP) seed will be harvested, and the progeny structure, whether open-pollinated or control-pollinated, will be maintained according to an appropriate mating design.
- The clones selected under PYT will be advanced into MLYT; some PYT selections will be added to the PYT stage of specific subpopulations; moreover, all MLYT clones will be put into a crossing block and will constitute the next fluctuating breeding population; in addition, one cutting of each MLYT clone will enrich the random-mating breeding population.
- The clones selected after MLYT will not only be advanced to PET but also be added to the recurrent breeding population, and some of these PET clones may be added to specific RBPs.
- Flowering-induction techniques will be used wherever breeding populations (RMBP, FBP, RBP) are grown.
- At harvest, the RMBP will be considered just as another selection field.
- The RMBP will be initiated by the collection of 10–20 seeds from each of 50–100 parents.
- New clonal introductions will be added straight to the PYT stage, whereas seed introductions will first be screened into SF.

**Selection procedure within each specific subpopulation**

The selection procedure for each specific subpopulation is as for the central population. However, a few particular measures are to be taken:
- The selections arising from PYT will join the PYT stage of the central population.
- The clones arising from given subpopulations and reaching the FT level will enrich the relevant specific subcollections (RBP).
- In each of the RBPs (subcollections), the central RBP (aimed at yield potential) will be interplanted for interpollination.

I wish to acknowledge the Belgian Overseas Aid Program (Administration générale de coopération au développement, Brussels) for financing sweet-potato research in Rwanda.