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Root Crops in Eastern Africa

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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 constreñosimientos, 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.
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Strategy for developing a national potato program for Rwanda

P. Vander Zaag

The potato, which was introduced into Rwanda about 1900, has become a major food crop in only the past 35 years. Production per unit of land is low (6.8 t/ha) because of a lack of quality seed potatoes of adapted varieties; infections from Phytophthora infestans and Pseudomonas solanacearum; poor agronomic practices; poor preparation of seed potatoes; and an acute lack of technical knowledge among extension personnel and farmers. The Programme national pour l'amélioration de la pomme de terre (PNAP) was established to help remove these constraints to production. A research program with a practical approach to solving problems has been established along with a strong seed production, training, and extension program. The results after 1 year have been encouraging. On one hand, farmers are accepting seed production and storage techniques and see the utility of using fungicides and improved varieties in controlling P. infestans, and, on the other, PNAP scientists have gained valuable information from rural contacts.

La pomme de terre, introduite au Rwanda au début du siècle, ne fait l'objet d'une culture vivrière importante que depuis trente-cinq ans. La production par unité de terrain est faible (6,8 t/ha) vu le manque de tubercules de qualité des variétés adaptées, les infections dues au Phytophthora infestans et au Pseudomonas solanacearum, les façons culturales inadéquates, la mauvaise préparation des fragments de plantation, et un manque critique de connaissances techniques parmi le personnel local et les cultivateurs. Le Programme national pour l'amélioration de la pomme de terre (PNAP) a été mis sur pied pour pallier à ces obstacles. On a mis en œuvre un programme de recherches visant à trouver des solutions pratiques aux problèmes ainsi qu'un vaste programme de production, de formation et de vulgarisation. Après un an, les résultats sont encourageants. D'une part, les cultivateurs acceptent les techniques de production et d'entreposage des pommes de terre et voient l'utilité des fongicides et des variétés améliorées pour lutter contre le P. infestans ; d'autre part, les chercheurs du PNAP ont obtenu de précieux renseignements de leurs collaborateurs ruraux.

Legend has it that German colonists at about the turn of the century unwittingly planted potatoes throughout Rwanda as they traveled with sacks of potatoes thrown over their horses' backs, an occasional tuber falling and becoming established. At night, the travelers would set up camp and cook their meal, discarding damaged tubers and sprouts, which under favourable conditions would reproduce themselves.

In 1904, Belgian missionaries grew potatoes for the first time in their garden near Ruhengeri. European varieties and cultivation techniques were spread quickly throughout the country by the missionaries as they established new missions. They also familiarized the Rwandaise with the previously unknown vegetable. However, the potato was not rapidly accepted into the local diet primarily because many held the superstition that eating potatoes along with drinking cow's milk would result in the death of the cow. The local chiefs realized, after watching the Europeans, that the potato could be eaten with no risk, and potato consumption increased markedly following the famines of 1928–29 and 1944–45.

In 1930, the first European variety was introduced and tested at the request of the gov-
error of Rwanda-Urundi. Mr Dejeune, a Belgian agronomist, introduced more European varieties after 1936, which were followed by introductions by the Institut national d'études agronomiques au Congo (1951–63) and the Institut des sciences agronomiques du Rwanda (1963–79). Varieties introduced originated from Belgium, Holland, Germany, Australia, Mexico, Kenya, and Uganda.

According to the Ministry of Agriculture (in 1978), potato production has increased steadily, reaching $2 \times 10^5$ t/year from an area $3.2 \times 10^4$ ha. In the major potato-growing areas, per-person consumption is nearly 1 kg/day at present (S. Poats, unpublished data).

**Present situation**

The potato grows in every prefecture of Rwanda, with 90% of the production in the prefectures along the Nile–Zaire divide at elevations greater than 1800 m (Byumba, Ruhengeri, Gisenyi, Kibuye, and Gikongoro). At these high altitudes, the temperatures are moderate and rainfall is 1200–2000 mm, which makes these areas unsuitable for crops such as sweet potatoes, cassava, and sorghum. In the past 10 years, the volcanoes along the northern borders of Rwanda have been partially deforested, and potato production has gained primary importance on these rich volcanic soils at elevations of 1800–2800 m.

In mid-1979, upon the inception of the Programme national pour l'amélioration de la pomme de terre (PNAP), an in-depth evaluation was carried out to determine research priorities. Visits were made to the major potato-growing areas; discussions were held with the local government leaders, extension workers, and farmers in their fields. During these discussions and observations, problems that were most frequently mentioned were:

- The lack of seed potatoes of adapted varieties. Farmers utilize the small potatoes from the previous harvest for seed. Often these small tubers are from virus-infected plants or from bacterial-wilt-infected plants. Other sources provide seed for less than 0.25% of the total area planted each year.
- Late blight (*Phytophthora infestans*) and bacterial wilt (*Pseudomonas solanacearum*). The heavy rains along with ideal temperatures allow both diseases to damage the potato crop severely. The European varieties generally have little resistance to the two diseases. Although, recently, several varieties from Mexico (Sangema, Atsimba, and Montsama) have shown some resistance to late blight, farmers had not received these varieties in quantity as of 1979.
- Low yields in farmers' fields because of unsuitable practices and mixed-cropping patterns. The question is whether or not the potato varieties are at optimum total production per unit of land.
- Storage techniques. Seed potatoes simply originate from the potatoes stored for consumption. No effort is being made to store potatoes for seed separately or under conditions conducive for healthy sprout development.
- The lack of technical knowledge about potato production. Training of extension workers and farmers must receive priority if increased potato production per unit of land is to be attained.

**Priority research program**

A program of potato research having six major thrusts was established in October 1979. These thrusts are:

- Introduction and selection of new genetic material. Introductions have been broadened to include genetic material not only from Europe, Uganda, and Mexico, but also from Kenya and the Centro Internacional de la Papa (CIP), Lima, Peru. This material will be tested for resistance to late blight and bacterial wilt as well as production and quality factors. In the final stages (4th season after introduction), multiplication will commence so that a sufficient quantity of seed will be available for release. Efforts will be made to use some rapid multiplication techniques (sprouts, stems, or bud cuttings) for promising material.
- Agronomy and physiology. Experiments to test the effects of spacing, seed size, seed rate, hill size, desprouting, age of seed, rate of tuberization and development all will receive initial attention. Long-term studies will focus on fertility requirements and maintenance and cropping systems with the potato. The use of botanical seed, transplanting, and other agronomic practices will be studied in detail in the hope of transferring the technology to farmers.
Pathology. Emphasis is being placed on the control of late blight by management practices such as regulating date of planting, using appropriate fungicides, regulating the frequency of chemical application, and determining varietal resistance. Long-term emphasis will be on developing and transferring the appropriate technology to farmers and on helping them to obtain the necessary inputs (sprayer, fungicide). Bacterial-wilt control through management practices is also being investigated. The effects of removal of infected plants and the soil from around the plant, different crop rotations, volunteer plants, alternative hosts, and races of bacteria present are being monitored. The long-range goal is to obtain varieties with blight resistance.

Quality seed potatoes produced in quantity. A 40-ha seed farm at 2300 m elevation is being utilized to produce 300 t of improved seed (20 ha/year) for distribution to multipliers of seed potatoes who in turn distribute their seed potatoes to potato growers. It is hoped that, in this way, 2000 t of seed potatoes of good quality will reach the farmer; that the recipients will sell the seeds to their neighbours; and that each year different farmers will have access to the limited supply of seed. It is planned that, once every 5–6 years, all farmers will obtain quality seed potatoes.

Storage and handling. Efforts are to focus on low-cost structures designed for seed-potato storage for farmers, as individuals or as groups or cooperatives, and for communes, projects, and organizations who will multiply seed potatoes for distribution. Later, efforts will focus on improving the storage of ware potatoes and particularly address the question of storage by communes or cooperatives when the price is low. The farmers may not be able to afford these storages so some financial arrangement may be necessary — for example, an agency to purchase from the farmer at a reasonable price during the harvest seasons and to sell when the demand exceeds supply. PNAP will study and propose the design of the buildings, but the need exists for other sources to finance and to make the storages functional.

Training and extension. A concerted, long-term effort will be given to the training of all extension workers who are involved with potato production in Rwanda. Courses will be held at PNAP, Ruhengeri, for 1 week, and short courses (1 day) will be held at commune headquarters for farmers and local leaders.

During the initial 2 years, demonstration plots will be established with the collaboration of extension workers so that PNAP staff can determine the utility of farmer methods and, further, determine the constraints for adopting improved technology. Through these demonstration plots, the research program will remain relevant, as the focus is on farmers and their problems of production. PNAP’s objective is to do research that will help farmers and that will be adopted by them.

The demonstration plots will be a learning mechanism for PNAP, the extension worker, and the farmer. The priorities for these demonstration plots include the development and use of:

- Seed-production techniques that employ simple steps to select healthy plants for seed, to identify diseased plants (those with virus and bacterial wilt), and to control infections.
- Fungicidal sprays, resistant varieties, and schedules for planting that help control late blight.
- Improved agronomic practices and mixed-cropping techniques.
- Improved storage of seed potatoes.

After the first 2 years, the initiative for demonstration plots will be in the hands of extension personnel and agricultural projects. PNAP will provide technical assistance as needed and be present for large-group training sessions at the demonstration plots organized by extension workers.

The collection and dissemination of information on the potato and its production will be a continual priority of PNAP. The training and extension thrust will occupy between 20% and 30% of the time of each PNAP scientist.

Program functioning

National scientific staff in the program comprise three university graduates (Ing. Agron.) and two agricultural-diploma holders. CIP has stationed two scientists in Rwanda for a maximum 5 years to assist in establishing PNAP. Their time is also devoted to establishing a national program in Burundi and assisting Uganda and Zaire in their programs. The identification of individuals to fill support roles, such as secretary, bookkeep-
er, storekeeper, mechanic, driver, field observer, and labour captain, has been difficult; however, most positions have now been filled. Support staff are very important, as they are permanent and carry on the daily activities. Well-trained, self-directed support staff are essential.

Each thrust of research has a leader and a co-leader, who, together, must develop an annual program of activities in keeping with the overall goals of PNAP. The proposed activities are discussed by the PNAP scientists and approved or revised. Then, weekly meetings are held for discussions on progress, problems, and new ideas related to the thrust.

Each scientific staff member has some administrative responsibilities: one is responsible for the functioning of the seed farm (support staff included), one for the research station, and one for the office and lab (personnel and equipment).

With this division of administration, all scientists can spend 80% or more of their time on scientific responsibilities and no one person is totally lost in administration. Furthermore, this allows all to gain some experience in administration to prepare for what is often the inevitable — a scientist functioning solely as an administrator.

The facilities at Ruhengeri research station include four houses for the scientists; another building houses the program — eight offices, an adequate laboratory, a handling room for potatoes, a store room, and a dormitory with a capacity of 10–12 beds. A greenhouse provides the space for pot experiments. A screen house is to be used for multiplication of promising clones destined for the seed farm. About 2 ha of land is available for experimental work.

The Kinigi seed farm, which covers 40 ha, includes a house along with two apartments for staff and a permanent storage with a capacity of 150 t of potatoes. Also, some storage facilities made from local material have been constructed for tests on how seed potatoes can be cheaply and effectively stored.

Three pickup trucks (2-t capacity) along with three motorcycles (trail) serve as the means of carrying out the program, which includes a considerable amount of travel for the training and extension thrust.

The Belgian government (Administration générale de la coopération au développement) provided 25 million francs (RWF) for the construction of the facilities and provides 5 million RWF for the functioning of the program annually (US $1 = 92 RWF). It is anticipated that the Rwandaise government will match the Belgian contribution. The CIP staff are completely supported by CIP.

**Temptations to avoid**

Because of its limited facilities and personnel, PNAP has a comparative disadvantage in doing a breeding program. Institutions like CIP and American and European institutions have the personnel and a broad base of genetic material to do an effective breeding program. CIP has as its priorities the development of varieties that are resistant to late blight and bacterial wilt — the two principal problems in Rwanda. Furthermore, it may take one breeder 10 years to develop an improved variety. For example, the USA started a national potato-breeding program in 1929, and researchers there have not yet produced a variety superior to the Russet Burbank, which existed before 1929 and is today the most popular variety.

By receiving each year a large number of CIP tuber families, PNAP staff can screen and find good material, in a short time, with resistance and good yield characteristics; thus, selection is much more practical and appropriate than breeding.

Like a breeding program, a sophisticated virology program is not appropriate at PNAP. In Rwanda, potatoes are grown at elevations higher than 1800 m where viral diseases are secondary in importance. The seed-production program is based on visual screening for viruses. With this approach, farmers can obtain seed of improved varieties that will triple production. A detailed program of using plant tests to screen for viruses would result in the elimination of basic seed potatoes that are much better than what the farmer has at present.

In many developing countries, government seed-certification programs have been attempted, but most have not been successful. The standards set have been too high — thus not realistic. They have led to dishonest practices and, hence, to seed that is not of the quality it is supposed to be. In countries like Rwanda, the stress must be on obtaining seed potatoes that are better than what the farmer has now and supplying him or her with them; demand is so great that, even now, nearly 75%
of the requests for seed potatoes are refused because of a lack of supply. The stress must be on developing a sound reputation as a seed-potato producer and on providing both improved quality and a large quantity to meet the needs of the country.

What is relevant for research depends on the setting of the scientist. In developing countries, it is frequently observed that the desire exists to do research on topics that are not relevant to the constraints to increasing food production. There is peer pressure and pride in doing sophisticated laboratory work. This type of research may be interesting and may produce acceptable publications in international journals, but it does not change the subsistence level of the farmer. For example, the development of nuclear devices by some developing countries at great expense has given them prestige as being technologically advanced; yet, within the same countries, starvation remains a constant reality.

At PNAP, the focus (80-90% of time) must be on the priorities established to improve and increase potato production. However, to ensure that professional interest is maintained and pursued, one may spend 10-20% of the time on research that may not have direct application in the country. Scientists often fail to see the important results of their relevant research and fail to publish them. Thus, the gap between sophisticated research and farmers increases, and the literature does not reflect research that addresses the needs of African farmers.

Few research institutions make direct contact with farmers in developing countries. Meanwhile, the extension worker is blamed for the poor farming practices and the low productivity of the land. Government leaders continually proclaim that the extension worker must show farmers how they can increase production, and the extensionist is blamed for the failure of the farmer to increase production. This failure, however, is often the fault of researchers who:

- Fail to do relevant research that will help the farmers.
- Fail to test the acceptability of their research results in the farmers' fields.
- Fail to inform extension personnel of their research program and train them with the appropriate skills to multiply the successful results obtained.
- And fail to determine the needs of the farmer and resolve them.

The researcher is tempted to avoid the realities of farmers because the research appears routine when in fact it is complex. Agricultural scientists believe this work is for the social scientist, whereas there are real agronomic and pathological questions. Researchers often believe that the extension worker is to help the farmer by adapting research-station results to farmer needs, but the researcher, along with the extension worker, must determine the needs with the farmer and solve the problems as a team. The researcher must be an integral part of technology transfer and not isolated behind the fences of the research station.

**Impact**

The impact of a development project is often difficult to assess. However, PNAP seems to have made many direct and indirect impacts during its 1st year. For example, 65 t of improved seed potatoes were produced for use in the program and for distribution to seed-potato multipliers. In other words, PNAP has operated the first organized selection program against diseases in Rwanda, using only healthy plants.

Demonstration plots have been established in 13 communities, in farmers' fields. These plots have helped introduce and transfer technology for the selection of healthy plants for seed potatoes, bamboo sticks being used as the markers. The identification of plants infected with virus or bacterial wilt has been demonstrated, as have measures for disease control. Also, the use of fungicides in the control of late blight has been shown on the plots. The best variety currently available, Sangema, was introduced at each site, showing good late-blight resistance and, at the same time, making seed available to the farmer or cooperative. Seven demonstration plots showed that yields could be tripled simply by the use of improved varieties and a fungicide to control late blight. The result has been increased demand for PNAP to produce a large quantity of improved seed potatoes.

Low-cost seed-potato storages have been designed and tested and are now being adopted by farmers and cooperatives who are constructing them with technical assistance from PNAP. Finally, training courses have
been provided to 80 extension workers and have been aimed at preparing the trainees to assist the farmers.

These are some of the major direct impacts from demonstrations that will have long-term effects. The research program has, to date, only had an indirect impact but is providing resource information, developing new varieties, and improving agronomic practices that may be transferred in the near future.

Rwandaise farmers have had a direct impact on the PNAP scientists by revealing how challenging it is to produce potatoes with no inputs other than their own resources. The interest and the demand for seed potatoes and training have been overwhelming, suggesting that there is truly a great need for PNAP's existence.

The views and opinions expressed in this paper are my own and do not necessarily represent those of either CIP or ISAR.