

G. CASSAVA AND SWEET POTATO MULTIPLICATION²¹

1. *Funding Levels and Project Goals and Objectives*

The Cassava and Sweet Potato Multiplication (CSPM) Project No.: 690-G-00-98-00234 was obligated by USAID at \$382,334. The Southern Africa Regional Crops Research Network (SARRNET) managed the project over the period December 1, 1998 through May 16, 2001.

Project Goal: To improve food security and nutrition both at the national and household levels.

Project Purpose: To increase the supply of improved, pathogen free cassava and sweet potato planting materials and to make them more readily and widely available to smallholders.

Objectives:

- ▶ To carry out on-farm testing of elite cassava and sweet potato clones;
- ▶ To maintain the existing three selected multiplication sites and to expand to about 30 secondary sites;
- ▶ To introduce prototype cassava processing machines and to train local artisans to fabricate machines locally – 10 focal processing centers in all three regions;
- ▶ To disseminate the processing technologies and to foster rural entrepreneurship; and
- ▶ To provide training for 400 farm assistants and technical support to 800 farmers in the cassava and sweet potato traditional and non-traditional areas.

2. *Findings*

The International Institute of Tropical Agriculture (IITA) is responsible for coordinating SARRNET activities; and the International Potato Center (CIP) through its regional headquarters in Nairobi, Kenya provides backstopping activities on sweet potatoes and collaborates with IITA on various economic studies of the network. Thirteen countries of the Southern Africa Development Community (SADC) are members of SARRNET²², which also works under the umbrella of the Southern Africa Center for Cooperation in Agricultural Research and Natural Resources (SACCAR) Board.

The major goal of SARRNET Phase I (1994-1999) was to “increase income and improve household food security of resource poor farmers in Southern Africa,” with a focus on expanding the cultivation of cassava and sweet potato to provide food security and cash income for small farmers. SARRNET Phase II strategy (from 1999 onwards) was planned within a “results framework” developed jointly by representatives of member countries, IITA, CIP, and by USAID’s Regional Center for Southern Africa (RCSA) under its Strategic Objective 4, that refers to the “expanded commercial markets for improved agricultural technologies and commodities in the SADC region.”

²¹ The full title of this Project is The Accelerated Multiplication and Distribution of Improved Cassava and Sweet Potato Planting Materials and Dissemination of Post-harvest Technologies in Malawi. The shorter title Cassava and Sweet Potato Multiplication is used here for convenience.

²² SARRNET is funded as regional USAID activity. Member countries include Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe.

The Government of Malawi (GOM) fully supports the new SARRNET initiative to expand the production, consumption and commercial use of cassava and sweet potato, by declaring in 1994 that:

“Production of maize in areas that are not suited to its production, largely as a result of low rainfall, will be discontinued to give room for more drought resistant crops such as cassava and sweet potato to improve household food security.” (MOALD, 1995)

This policy was reinforced in 1999 with the following statement:

“Government should continue to promote cassava and sweet potato production through distribution of virus free planting materials. Root crops now play a much more significant role in national and household level food security. Root crops are also more drought tolerant than maize and therefore reduce vulnerability to drought.” (Republic of Malawi, 1999)

The SARRNET principal focus is on demand-driven research and development in cassava and sweet potato crops, with a strong bias on income generation, private sector participation, and food security. In Malawi, cassava and sweet potatoes suffered from an image problem of being considered as “poor mans crops”, and thus relegated to the category of “minor crops”, with negligible support for research and development. Although cassava is widely grown in South America and its cultivation has become widespread in Nigeria and in other West African countries, it was not widely promoted as a source of nutrition and cash income in Eastern and Southern Africa prior to the formation of SARRNET.

Both cassava and sweet potato are environmentally friendly crops. An established cassava stand will protect against wind erosion during the dry season, and both crops protect against water erosion during the rainy season, especially when intercropped. An additional attribute of both cassava and sweet potato is their ability to thrive on marginal soils with minimal use of purchased fertilizer inputs. However, cassava also responds well to increased fertilization and irrigation. A further advantage of cassava as a food security crop is that it can be harvested over a period of four to six months, and can thus be available during the hunger season as needed. Sweet potato, when planted in mid November at the start of the spring rains, can be harvested in mid February through March at the peak of the hunger season.

Objective a: Carrying out on-farm testing of elite cassava and sweet potato clones.

Traditional cassava varieties, grown under small farmer conditions, typically yielded from 5 to 9 metric tons (mt) per hectare. Improved varieties yielded from 15 to 25 mt per hectare, and cassava grown under commercial conditions with irrigation and optimal fertilizer applications, has produced yields of 60 to 80 mt per hectare. Of major importance is the fact that improved varieties achieve these higher yields over an 11 to 14 month period, while traditional varieties do not reach maturity until they have been in the ground for 20 to 24 months.

There are two types of cassava, sweet and bitter. Sweet cassava (such as the Mbundumali, alternatively called Manyokola) is non-toxic and can be eaten raw or unprocessed. A large market for sweet cassava has developed for this product in recent years in the Lilongwe area. On the other hand, during digestion as a raw product, the leaves and tubers of bitter cassava varieties release toxic hydrogen cyanide (HCN). Unless specially processed, human and animal

consumption of bitter cassava can lead to cyanide poisoning. Bitter varieties must be initially processed to remove toxicity and then be further processed for industrial use as animal and poultry feed, starch and wheat, or maize flour substitutes.

CSPM Project staff worked through MOAI research and extension departments and through the Bunda College to carry out some 20 on-farm trials of high yielding and African Cassava Mosaic Virus (ACMV) resistant cassava clones, in each of the eight Agricultural Development Divisions (ADDs). These on-farm trials were carried out within the broader SARNET regional research and development program.

The on-farm trials included some 10 varieties developed through tissue culture research, and included local varieties and some that were imported from outside Malawi. Direct participation by farmers through the on-farm trials enabled them to directly observe the differences between traditional varieties and the various improved Malawian varieties, and those introduced from outside Malawi. “Winner” varieties selected for accelerated multiplication in Malawi are listed in the table below.

TABLE 9
Improved Cassava Varieties Selected for Accelerated Multiplication

| Variety | Yield Range MT/Ha. | Comments |
|------------------------|--------------------|---|
| Mbundumali (Manyokola) | 15-25 | Local selection, high yielding, broad adaptation, sweet, highly popular for the fresh market |
| Gomani | 12-25 | Local selection, susceptible to diseases, bitter, suitable for processing into <i>nsima</i> and for starch production |
| Mkondezi | 25-40 | Locally improved variety, bitter and must be processed. Resistant/tolerant to cassava mosaic and cassava mealy bug. |
| Maunjili | 29-36 | Improved bitter variety, introduced from IITA (TMS 91934) in tissue culture form. Tolerant to cassava mosaic, green mite, and mealy bug. |
| Silira | 15-30 | Improved variety, introduced from IITA (TMS 60142) in tissue culture form. Semi-sweet, resistant to cassava mosaic and tolerant to mealy bug. |

Existing sweet potato varieties did not have the desirable yield and resistance to disease that were displayed by some of the local cassava varieties. Consequently, sweet potato tissue culture clones were imported and further developed into varieties for further on-farm field testing. Some 12 varieties were included in the on-farm testing program, from which the four varieties included in the table below were selected for accelerated multiplication by the project. The on-farm sweet potato trials were carried out in conjunction with the cassava trials. Again, working through MOAI research and extension departments, on-farm sweet potato trials took place in eight ADDS.

TABLE 10
Improved Sweet Potato Varieties Selected for Accelerated Multiplication

| Variety | Yield Range MT/Ha | Comments |
|---------|-------------------|--|
| Kenya | 15-30 | Improved variety, locally bred in Tanzania, high dry matter content with wide adaptation and consumer acceptance. |
| Semusa | 16-40 | Improved variety, introduced by CIP, with high dry matter content and wide adaptation and consumer acceptance. |
| Mugamba | 13-40 | Improved variety, introduced by CIP, with high dry matter content and wide adaptation and consumer acceptance. |
| Tainoni | 11-35 | Improved variety, introduced by CIP, with medium dry matter content. Has orange flesh which is a good source of vitamin A. |

The International Institute of Tropical Agriculture (IITA) through the Southern Africa Regional Crops Research Network (SARNET) has been working with a number of partners since the inception of the regional program in the early 1990s. The USAID grant provided the basis for expanding and deepening these relationships. As noted above, the GOM and the MOAI provided strong policy support for the expansion of improved planting materials for both cassava and sweet potatoes. Several of the NGOs and religious organizations listed below achieved notable farm level success from their activities.

Save the Children Federation (US), through their Community Based Options for Protection and Empowerment (COPE) program, trained some 206 men and 98 women in planting material multiplication, sweet potato and cassava agronomy, processing and utilization and HIV/AIDS prevention. Working through three District AIDS Coordinating Committees, (Nkhotakota, Mangochi and Dedza) farmer sweet potato and cassava average yields increased from 9 mt to 16 mt per ha. and 9 mt per ha. to 14 mt per ha. respectively. Sweet potato and cassava nurseries of 18.8 ha. and 11 ha. respectively, were established. As a result, some 6,000 vulnerable households benefited from the planting material, growing an average of .06 ha. of cassava and .04 ha. of sweet potato. One community received a cassava grater to improve processing, with the result of reducing the processing period from 7 to 2 days. The Project provided MK 948,505 (\$17,250) to support this work.

CARE International distributed cassava and sweet potato cuttings to resource poor households in Lilongwe District (Khongoni, Kalolo and Chitukula in Lilongwe West Rural Development Project). SARNET, and other suppliers provided initial planting materials to some 1,100 farmers. SARNET staff provided training in the proper use of materials. One cassava variety (Manykola) and two sweet potato varieties (Semusa and Mugamba) were distributed to these farmers. Manykola is a sweet variety that is well suited to home consumption and commercial fresh sales. It is non-toxic and can be eaten without the special processing required for the bitter varieties. CARE officials noted that they did not want to provide bitter cassava planting material to their beneficiaries, until they were able to conduct an adequate training program in processing these varieties, in order to remove the toxicity present in the fresh product.

The Evangelical Lutheran Development Program (ELDP) operated in several districts, in areas where refugees from Mozambique were accommodated (Nkhata Bay, Dowa, Dedza, Zomba, and Chikwawa). SARRNET provided training and technical backstopping training to some 325 farmers in growing cassava and sweet potatoes, and in setting up and managing nurseries. An estimated 3,500 farm families received improved planting materials. The Project provided 379,300 MK (\$7,000) to support this activity.

Christian Service Committee (CSC) worked in the southern region in association with OXFAM. SARRNET provided 550,000 MK (\$10,000) to support the procurement and transportation of planting material, the establishment of nurseries and the training of 24 staff and 30 farmers. Over 30 ha. of cassava nurseries were established with planting material distributed to more than 10,000 farm families -- and initial work was undertaken to introduce processing equipment suitable for processing cassava for industrial use. In the north, the Christian Service Committee developed 30 ha. of tertiary nurseries in six sites in the Mzuzu and Karonga ADDs.

World Vision International (WVI) established 12 communal cassava nurseries and six sweet potato nurseries. SARRNET provided initial planting material and technical backstopping in the Chata, Chingale, and Mzimba area development programs.

Objective b: Maintaining the existing three selected multiplication sites and expanding to about 30 secondary sites.

Project resources and activities were heavily concentrated on work carried out under this objective. Formal partner relationships were created with 17 governmental and non-governmental organizations, including those whose activities were discussed above, that were involved with the accelerated multiplication and distribution of cassava and sweet potato planting materials. These partners, as of the Project completion date, managed approximately 196 hectares of primary, secondary, and tertiary nursery sites.

Planting Material Multiplication Sites: The three regional research stations at Chitedze, Lunyangwa, and Bvumbe managed four primary nursery multiplication sites, with a total of 8.5 hectares. The Department of Agricultural Research and Technical Services (DARTS), working through the ADDs in Lilongwe, Salima, Kasungu, Machinga, Blantyre, and Shire Valley, managed 15 secondary nursery sites. These sites covered 53.4 hectares. SARRNET provided 2,809,625 MK (\$51,084) to DARTS, to the regional research stations, and to the ADDs, to support the development of the primary and secondary nurseries.

Sixteen tertiary nursery sites were managed by nine NGOs, including one farmers' group, and one private sector business organization. These tertiary nurseries covered an area of 134.5 hectares. These NGO partners included: the Christian Service Committee, (CSC), Evangelical Lutheran Development Project (ELDP), Save the Children Federation US (SCF), CARE International, World Vision International (WVI), Sustainable Livelihood Project (SLP), the Ntendere Catholic Parish in Dedza, the Lutheran Mobile Clinic, the German Technical Assistance Agency (GTZ), and the Chilaza Farmers Group. Universal Industries Limited also operated a small tertiary nursery of 1.5 hectares.

All project supported planting material multiplication sites provided both cassava and sweet potato planting material. Cassava planting material consists of stems, which are cut from the

cassava stalk into one-meter pieces. The stems are further cut into planting sizes of 12 to 15cm long. Multiplication rates are quite low, ranging from a ratio of 1:7 to 1:11. Sweet potato multiplication is also done through the cutting and replanting of fresh stems. Multiplication ratios for this crop at 1:15 to 1:20 are somewhat higher than for cassava. The Project Terminal Report summarized the planting materials distributed from Project supported nurseries, as shown in the following table.

TABLE 11
Clean Cassava and Sweet Potato Planting Materials Distributed from Project Nurseries and Estimated Area Planted 1997 – 2001

| Season/Year | Stems Distributed (Meters) | Area Planted (Hectares) | % Increase from Previous Year |
|---------------------|----------------------------|-------------------------|-------------------------------|
| Cassava | | | |
| 1997/98 | 487,940 | 161 | ---- |
| 1998/99 | 1,133,736 | 375 | 233 |
| 1999/00 | 3,537,734 | 1,170 | 312 |
| 2000/01 | 8,131,200 | 2,688 | 230 |
| Sweet Potato | | | |
| 1997/98 | 82,460 | 9 | ---- |
| 1998/99 | 434,422 | 47 | 817 |
| 1999/00 | 998,715 | 108 | 230 |
| 2000/01 | 3,816,000 | 413 | 382 |

Multiplication of Cassava Planting Materials: Cassava planting materials were primarily distributed to farmers from the 16 tertiary nurseries operated by the organizations listed above. These nurseries managed approximately 135 hectares as of 2001. From the above table, it can be seen that Project supported cassava multiplication activities provided cleaned and improved planting materials sufficient to plant 161 ha. in 1997/98. By the project completion date, 35 nurseries managing 196 ha. of primary, secondary and tertiary nurseries provided farmers with planting material sufficient to plant approximately 2,688 ha.. CSPM staff estimated that the improved varieties provided average yield increases of about five mt. per ha.

In addition to the tertiary nurseries operated by the direct project partners, project staff estimate that private farmers operated more than 300 ha. of additional tertiary nurseries. These farmer-managed nurseries, which were often operated as community nurseries, distributed an additional 13.9 million stems in 2001, which is sufficient to plant 4,600 ha.

An important characteristic of cassava is that it can yield both planting materials and provide a food crop at the same time. When the root is harvested, the stems can also be cut and used for planting material. As a result, all fields managed by farmers can be considered as tertiary nurseries that are able to: a) provide planting materials for own use and for sale to others; and, b) provide tubers and leaves for human and animal consumption purposes.

In contrast to the tertiary nurseries, secondary nurseries operated by MOAI District Extension Officers, provide planting material year after year, without harvesting the root materials. Fertilizer is added annually to maintain soil fertility and plant vigor²³.

In summary, over the four years of the Project life, distribution of improved cassava varieties increased from materials sufficient to plant 161 ha. to providing materials sufficient to plant some 7,200 ha.. Estimated area planted to cassava in 2001 was 202,338 ha., compared with 102,938 ha. in 2002. This indicates that project supplied planting materials were sufficient to meet from 3.7 to 7.1 percent of the total area planted to cassava.²⁴.

Multiplication of Sweet Potato Planting Materials: As shown in the table above, sweet potato planting material made available to farmers by project partners, was sufficient to plant some 413 ha. in 2000/01. This compares to an estimated 192,457 ha. planted to sweet potatoes in that period. The estimated area planted to sweet potato in 2001/02 was 86,780²⁵.

In addition to direct project supported nurseries, private farmers managed an additional 240 ha. of sweet potato nurseries. These nurseries produced planting material in 2000/01 sufficient for 3,600 ha.. Thus, the Project directly and indirectly, supported the distribution of improved sweet potato planting material for 4,013 ha. in the 2000/01 season, compared with an initial starting point of 9 ha. of improved planting materials. This constituted some 2.5 percent of all available sweet potato planting materials. CSPM staff estimated that the improved varieties provided average yield increases of about three mt per ha.

Cost of Managing Cassava and Sweet Potato Nurseries: Primary and secondary nurseries were managed by state research and technical organizations, including the National Agricultural Research System (NARS) and the DARTS. Primary nurseries were located in Kandiyani, Chitedze, Zombwe, and Kasinthula. Project supported secondary nurseries were located in all but the two northern most ADDs.

Akoroda and Mwabumba in their 2000 study²⁶ of cassava development in Lilongwe east RDP, provide an indication of costs and returns for nurseries maintained by the project and for those managed by farmers. Reporting on records maintained by a community farmers group in the Kolonga village of Chitsime EPA, the one-year cost of managing a .4 ha (1 acre) tertiary nursery was 6,350 MK (\$115 at the prevailing 2000 exchange rate of 55 MK to \$1). Four hundred fifty bundles (50 stems per bundle) of planting materials were obtained, which is sufficient to plant about 7.5 ha..

The authors report that a Cassava and Sweet Potato Multiplication Project (CSPM) supported nursery in the area (Nathenje) sold planting material at 50 MK per bundle, while farmers sold

²³The secondary nursery at the Nathenje District Office has provided high quality planting material from its original planting in 1991 through to 2001. Unfortunately, this nursery was vandalized during the 2001-2002 hunger season and the plants were uprooted. The area has subsequently been replanted with new material and will provide planting material for the 2002/03 season.

²⁴Area planted data is from the MOAI annual crop production survey. It is noted that problems with field survey sampling procedures led to a systematic over estimation of area planted to both cassava and sweet potato from the early 1990s through to 2000/01. This was corrected for the 2001/02 agricultural season leading to the lower estimates of area planted.

²⁵See previous footnote.

²⁶M.O. Akoroda and M.L. Mwabumba, *Sweet Success: Cassava in Lilongwe East RDP*, SARRNET, August 2000.

material from their nurseries at 60 MK to 75 MK per bundle. This suggests that a farmer was able to net from 20,650 MK to 27,400 MK (\$375 to \$498) or 32 MK to 47 MK per bundle, from the sale of cassava planting material from .4 ha. of land.

The same study also provides cost of production data for the Nathenje tertiary nursery. This nursery was started under SARRNET, prior to the start of the CSPM Project and then was brought within the CSPM Project scope. Under full costing (including salaries for government staff, motorbike fuel, fertilizer, etc, which were not incurred by the community farmer nursery), total expenses for 1 acre were 32,461 MK. Because of the higher planting density and the use of fertilizer, the estimated yield was 1,957 bundles, assuming that the same sales price range per bundle yields a net income per bundle of 27 MK to 42 MK. It must be pointed out that in addition to the inclusion of production related wage and salary costs in the Project nursery, these nurseries had an extra cost for security services and for security fencing, which were not needed for the community nurseries.

Objective c: Introducing prototype cassava processing machines and training local artisans to fabricate machines locally – 10 focal processing centers in all three regions.

The Project imported prototype post harvest processing equipment and carried out a testing program on four pilot centers, identified potential local manufacturers, and provided training to the general public on the use of the equipment to improve post harvest processing. The equipment was imported from the International Institute of Tropical Agriculture in Uganda. Equipment that was found most suitable for use in Malawi was power chippers, graters, and starch graters using small gasoline powered engines. Manual chippers and presses were also found useful. (Pressers are used with graters to compress the mash overnight to remove toxicity and speed up fermentation.) However, this equipment is not suitable for processing bitter cassava into a form suitable for many of the potential industrial uses.

The project objective to provide 10 focal processing centers distributed among the three regions, was not met, but at least one center was set up in each region and supplied with appropriate post harvest and processing equipment technology. The equipment did not arrive in Malawi until the second year of the project, thereby reducing the results gained under this objective. However, the centers served effectively as sites for training DARTS, Extension and NGO staff in all phases of cassava and sweet potato planting material multiplication, and in production, harvest, post harvest and processing techniques.

Four pilot processing centers were set up: Milonde (Mulanje RDP), Chitheche (Nkhata Bay RDP), Zidyana EPA (Nkhotakota RDP), and Nsambo (Lilongwe East RDP), and prototype machines were set up for use by farmers. Project staff estimated that some 14,000 individuals, including government policy makers, private sector, NGO, and members of the farming community were introduced to the use of the equipment.

Objective d: Disseminating the processing technologies and fostering rural entrepreneurship.

Specific capacity building training in the use of equipment to process and store cassava and sweet potato were provided to almost 1,000 persons, with emphasis on extension and NGO

technical staff. These staff introduced the concepts and practices to their own beneficiaries. In addition to this training, 10,500 people participated in SARRNET sponsored field days in 11 different sites around Malawi. At these field days, SARRNET staff and persons trained in the above mentioned capacity building sessions, demonstrated cassava seed multiplication techniques, cultivation practices, household processing, storage and utilization, and product development.

SARRNET staff reported that several local industries took advantage of increased cassava production to introduce processed cassava products as a substitute for imported processed maize and wheat products, mostly on a trial basis. Properly processed cassava of the right type can provide lower cost substitutes for maize starch used in textile processing and for wheat flour used as an adhesive material in wood processing activities. Cassava leaves and root material can also be converted into animal feeds, chips as a snack food, and can be substituted for maize in producing *nsima*.

Industry leaders interviewed by the team generally expressed caution regarding the short-term expansion potential of bitter cassava for industrial processing, especially starch. For example, local starch import substitution requirements can be met from about 500 ha. of cassava planting, suggesting that the development of this industry beyond one major processor requires ready access to export markets.

At the same time, at least one company is substituting a portion of the flour made from sweet cassava in the production of cookies (biscuits) and is using small amounts in animal and poultry feeds. They are also in contact with a South American company that has developed technology for processing bitter cassava into animal feed, and they currently grow some 20 ha. of cassava on their own land. Outsourcing of product through small growers was attempted by this company but abandoned, as the small growers consumed most of the product themselves and preferred to sell the remainder in the higher priced fresh market. It is noted that this respondent indicated that the currently available bitter cassava varieties have taste characteristics that do not support their use in producing products for human consumption, but that the taste characteristics of the sweet variety, Manyokola, is suitable for this purpose.

SARRNET staff are currently undertaking trials of animal feeds that use cassava, in cooperation with the USAID funded Dairy Business Development Program that is managed by Land O' Lakes Inc. Some other potential users of processed cassava for human food production indicated that they would be interested in continuing product trials, if outside funding were available.

SARRNET staff is also working with the Najewa estate near Lilongwe in field testing new varieties. Some 60 ha. of Manyokola cassava is planted on this farm and is ready for harvest starting in December 2002. The owner originally had intended to install starch-producing equipment, but is now planning to sell planting material and fresh roots in the Lilongwe area and to use additional product for producing animal and poultry feed.

In summary, several textile, timber, food processing, and animal feed companies have introduced processed cassava products on a pilot basis, as a substitute for wheat and maize products, but to-date there has not been any successful large-scale cassava industrial application.

Objective e: Providing training for 400 farm assistants, and technical support to 800 farmers in the cassava and sweet potato traditional and non-traditional areas.

Training provided to extension and NGO personnel in the use of improved post harvest equipment and techniques, addressed cassava and sweet potato planting material multiplication, and appropriate cultural practices, in addition to post harvest and farmer processing technologies, and product development and utilization activities. As noted above, almost 1,000 extension, DARTS, and NGO technical personnel participated in this formal capacity building training. Through the direct and indirect distribution of planting material to farmers and their training in proper cultivation practices, the Project directly impacted some 105,000 farm families. The indirect impact from the distribution of improved and cleaned cassava planting material added an additional 176,000 farm families, resulting in a total project impact in 2001 of some 281,000 farm families²⁷.

3. Conclusions

The CSPM Project has made a major contribution toward increasing production and consumption of cassava and sweet potato in the diet of rural Malawians. The inauguration of the USAID funded regional SARRNET research and development system in the early 1990s, provided the initial impetus for small grower expansion of cassava and sweet potato. From the early 1990s through 1998, new varietal improvement was undertaken for both crops. Some 10 cassava varieties and 12 sweet potato varieties had been improved and distributed in all ADDs for on-farm testing, prior to the start of the current project. From this work, four cassava and four sweet potato varieties were introduced for rapid multiplication.

Early projections, based on survey data collected by the MOAI, that cassava and sweet potatoes have become highly significant consumption items in the diets of rural Malawians -- have proven to be overly optimistic. Similarly, leaders of most private sector companies that would utilize cassava for industrial processing remain skeptical that bitter cassava can rapidly become a major new cash crop for smallholder rural households.

These initial results suggest that the further introduction of processed cassava in human food products, for animal and poultry feeds and for starch substitutes are possible. However, the lack of raw material supply for industrial application, limited direct consumer demand in Malawi, and the lack of readily availability export markets, continue to hamper the short-term expansion in the industrial use of cassava.

At the same time, the impact of the project on the introduction of cassava and sweet potato into the diet of rural households as commodities that can provide needed caloric intake during the November to March hunger season, is significant. Operating within the SARRNET umbrella the CSPM project:

²⁷ The estimated project impact was calculated by using the average plot size of .026 ha. per farm family that was reported by Akoroda and Mwabumba for the Lilongwe East RDP and multiplying this by the volume of Project calculated improved planting materials that were distributed by Project supported nurseries and from private farmer multiplication sites.

- ▶ Increased awareness of government, private sector leaders and farmers to the positive nutritional qualities of cassava and sweet potato, when appropriately processed;
- ▶ Strengthened GOM policy support for continued expansion of cassava and sweet potato as a source of rural household nutrition and cash income;
- ▶ Provided multiplication of the new varieties to almost 300,000 farm families by expanding primary, secondary and tertiary nursery sites;
- ▶ Expanded the existing three secondary multiplication sites to 15 sites comprising some 46.4 ha. of planted nursery, and formed 16 secondary nurseries with 135 ha.;
- ▶ Distributed some 8,131,200 meters of cassava stems and 3,816,000 of sweet potato stems to farm families;
- ▶ Trained more than 1,000 government, NGO and private sector technical staff in production and processing techniques of cassava and sweet potato for food and commercial use;
- ▶ Increased the use of cassava and sweet potato by rural households to augment rural nutrition during the annual hunger periods;
- ▶ Introduced low cost hand and power driven farm level processing equipment to expand the food and processing uses of cassava;
- ▶ NGO, DARTS, and Extension staff held field days in 11 sites, where some 14,000 persons were provided with an understanding of using the new processing equipment.
- ▶ Increased farmer and private sector entrepreneurial awareness of industrial uses for cassava as a source of household income.

While the project successfully maintained the three existing primary cassava and sweet potato nurseries and added one more, it did not meet the stated objective of forming 30 secondary sites. This was largely because a greater emphasis was placed on the formation of tertiary nurseries able to directly provide farmers with new planting materials.

Cost comparisons for producing planting material in farmer managed community nurseries and in tertiary nurseries maintained by project and government staff, show that farmer nurseries were more cost effective producers, earning from 12 to 18 percent greater net income from sales of planting materials grown on similar sized plots. However, it is noted that the government managed secondary nurseries produced a greater amount of planting material per ha. and did return a significant surplus over production costs.

The CSPM spent about \$1.36 for each farmer directly or indirectly impacted by the improved cassava planting materials for all project activities. The ratio of USAID Project funds that were allocated to increased total crop value resulting from increased yields from direct and indirect farmer plantings of improved cassava and sweet potato varieties is 1:6.7. That is to say, for each dollar of USAID project funds provided to the project, directly and indirectly impacted farmers gained an additional \$6.70 in added value from the harvest of improved cassava and sweet potato varieties.

4. Recommendations

Several aspects of the CSPM Project should be carried forward or expanded as part of future cassava and sweet potato multiplication activities. They include:

Recommendation 1

The formation of additional secondary nurseries operated by DARTS and ADDs in areas targeted for expanding planting material to new small-scale farmers. This can provide a direct initial approach to implement government policy in areas where cassava and sweet potato production has not yet been taken up by the private sector. Donor funding should be made available for the first year to cover startup costs, with MOAI providing all subsequent nursery maintenance funds out of earnings coming from the sales of planting materials.

Recommendation 2

Continued NGO support for the introduction of tertiary nurseries in areas where private farmers have not yet established a sufficient supply of planting materials. Donor funding should be used to support SARRNET, MOAI, and NGO training and technology transfer activities to support expanding the amount of farmer produced planting materials.

Recommendation 3

Continuation of the current GOM program to promote the increased use of cassava and sweet potato to supplement caloric intake during the severe hunger months. Although the expanded use of these crops has not approached the previously reported high adaptation levels, the usefulness of cassava and sweet potato to overcome seasonal caloric deficiencies is clear, and its further use in the diet of rural residents should be pursued.

Recommendation 4

Active participation by SARRNET, MOAI district staff, and NGOs to train rural households in the proper preparation of bitter cassava for home consumption. Households should be encouraged to utilize appropriate technology equipment produced in Malawi to support this training.

Recommendation 5

Set a reasonable target for the optimum level of cassava and sweet potato in the national food balance sheet. Cassava and sweet potato can provide an important nutritional dietary input, but because of their high starch and low protein content, their use as a primary staple food should be approached with some caution.

Recommendation 6

Carry out an economic analysis to determine the long-term feasibility of processing and marketing cassava for industrial use under Malawian conditions, and develop a concerted strategy to achieve this objective, if it proves to be viable.

5. *Lessons Learned*

Implications from the successful CSPM project leads to several important lessons for future consideration:

- ▶ It seems feasible that ADDs should continue to take primary responsibility for introducing and managing secondary cassava and sweet potato nurseries. Secondary nurseries, managed by District Extension Officers have provided, in the past, the major source of planting materials in areas where cassava and sweet potato production has not yet been introduced. As a result, they appear to be an effective way for government to implement a proactive strategy to expand the supply of cassava and sweet potatoes for household consumption in areas not previously exposed to these crops. Moreover, available information suggests that these nurseries can be financially self-supporting. However, a system of private sector secondary nurseries requires formalization of quality standards and means of enforcing them. Development of such standards and enforcement modalities can well be included as part of a new follow-on project activity.

- ▶ Once cassava and sweet potato crops are established in a given area, private farmers can efficiently provide planting materials for themselves and for other farmers. Cost analysis of farmer operated tertiary nurseries indicates that sufficient incentives exist for future tertiary nursery establishment to take place completely in the private sector. A major factor leading to this positive outcome is that these crops provide both planting materials (from stems) and food (from root materials) at roughly the same time. Therefore, it is not necessary to establish a large number of dedicated farmer or community owned sweet potato and cassava nurseries that provide only planting materials. However, ADDs and SARRNET should, accordingly, expand their training and technology transfer support to provide the educational base for further expansion of sweet potato and cassava among rural households, to provide both food and planting material.

- ▶ Discussion with private sector industry leaders suggest that there is currently only a limited potential for large scale commercial processing of cassava for industrial uses. Cassava products can partially substitute for wheat and maize flour in food processing for human consumption, for producing animal and poultry feed, and as a general starch substitute. However, at this time, a large local demand for these cassava products is not apparent in Malawi. Similarly, the current supply of bitter cassava does not appear to be sufficient to warrant the introduction of large-scale industrial processing equipment. Additional economic analysis is needed to assess the conditions under which the industrial processing of cassava becomes profitable. Cassava is a bulky product and therefore needs to be processed close to production sites, in order to reduce transportation costs. Moreover, as a bulky product that is needed in large quantities for industrial processing, it would appear that small-scale producers would be at a cost disadvantage over estate producers, where yields could be higher and costs of collecting into quantities for shipment to processors would be lower.