

Towards Sustainable Nutrition Improvement in Rural Mozambique

TSNI Summary Progress Report #5: 1 April 2004 - 15 September 2004

1. Project Partners

Department of Agricultural Economics, Michigan State University (MSU)
Nutrition Division, Ministry of Health, Mozambique (Nutrition/MISAU)
World Vision, Mozambique (WV)
National Institute for Agronomic Research, Mozambique (INIA)
Southern African Root Crops Research Network, Mozambique (SARRNET)
Provincial Directorate of Agriculture of Zambézia, Mozambique (DPA)
Helen Keller International, Mozambique (HKI)

2. Project Objective

To determine whether a food-based intervention strategy can lead to sustainable, year-round intake of vitamin-A rich foods, reduced fluctuations in seasonal household calorie supply, and an overall improvement of diet diversity, nutritional status and diet quality in a cost-effective manner, particularly among children under five years of age.

3. Project Approach and Partner Roles

TSNI is an action research project based in Mopeia and Namacurra districts in Zambézia Province, Mozambique. The project integrates nutritional, agronomic, and socio-economic components to achieve the project objective. Project extension personnel will work with farmer groups and groups of women using a consultative approach to successfully introduce beta-carotene rich sweet potatoes and other sources of vitamin A into the young child and family diet. TSNI promotes the use of diversified new foods and also promotes market development for these products. MSU leads the socio-economic research activities, while INIA and SARRNET contribute to the agronomic research component and develop training materials related to the introduction of new varieties and improved agronomic practices. World Vision is the lead partner in the agriculture and nutrition extension activities, in collaboration with the MSU project coordinator and the DPA. HKI and MSU developed the social marketing strategy, with WV and MSU assisting in implementation. Data entry and analysis are being done in-country, emphasizing the training of two nutritionists in data analysis and report preparation.

4. Major Accomplishments and Events

Agro-climatic conditions improved dramatically from March 2004 onwards, permitting much to be accomplished in the April to mid-September period.

Following four months of irregular and unpredictable rainfall during the first growing season of 2004 (Nov-Feb), adequate rains began to fall in all study areas, except Mexixine, in March 2004. The agricultural extension program responded accordingly, distributed new planting material where necessary to compensate for two successive seasons of poor rainfall. In 2003, the project distributed 3,142 kgs of sweet potato vines (planting material) to 562 households, with on average each family receiving 6 kgs of vines. In comparison, by the end of the vine distribution in May 2004, the project had distributed 10,536 kgs of vines to 962 families, each family receiving an average of 11 kgs. The number of families receiving vines this year increased 42% and included members of farmer's groups who were not enrolled in the study. The increase in amount provided per family was to stimulate surplus production in conjunction with the initiation of a pilot commercialization program in Mopeia district.

Adequate rains from March through June 2004 resulted in the best season of sweet potato production since the project initiated. The pilot commercialization project in Mopeia District established in May 2004 with the dual goals of creating consumer demand alongside improving market outlets for sweet potato producers has met with a positive response from participating farmers groups, and to date can be judged as a successful experience, likely to be expanded in other OVATA districts in the coming year.

Results from a survey of orange-flesh sweet potato production conducted in March-April 2004 clearly indicate that of the 8 orange-flesh varieties introduced, Resisto is favored by farmers for its culinary qualities, its consistency in root size, the prostrate (as opposed to erect) nature of its vines, its attractive appearance and deep orange flesh color, and the ease with which it can be sold in the market. Its greatest weakness is the vulnerability of its planting material to survive extended periods of drought, as experienced in the project areas when the dry second growing season of 2003 was subsequently followed by a dry first growing season for 2004.

Analysis of data from new sweet potato varietal trials conducted in collaboration with SARRNET/INIA indicate that four of the 21 varieties being tested merit consideration for approval for wider distribution: 440215, Excel, SPK004, and MgCL01. In general, these varieties have higher dry matter contents than existing orange-flesh materials and appeal particularly to adult tastes.

With the assistance of project collaborator Helen Keller International, six radio programs concerning vitamin A deficiency and describing vitamin A rich foods began to be transmitted in Portuguese, Chuabo, and Lomwe on Radio Mozambique-Zambézia in mid-April. Radio transmission is to continue through October 2004.

The project also successfully launched and completed one cycle of community theater presentations in all study villages. The theater emphasized those points which village-based nutrition extensionists have found the most difficult to change, namely, providing colostrum to the newborn, the mother continuing to breast-feed when she

becomes pregnant again, and feeding young children frequently with enriched weaning foods.

Harvesting of the sweet potato crop began in mid-May 2004, which permitted the project to train its extension personnel, and subsequently conduct four training courses at the community level on agro-processing using beta-carotene rich sweet potatoes. The courses emphasized making two products (bread and doughnuts) where boiled and mashed sweet potato is used to substitute wheat flour and two products where sweet potato is the dominant ingredient and no wheat flour is needed (juice and sweet potato fries). Of all products introduced, sweet potato bread, marketed as *pão de ouro* (Golden Bread) proved to be the most commercially viable product in rural village markets.

In August 2004, the project was pleased to receive visits from two of its donors: Joe de Vries of the Rockefeller Foundation and Howarth Bouis of HarvestPlus. Joe DeVries was accompanied on his visit by two directors of breeding programs for the National Agronomic Research Institute of Mozambique: Anabela Zacarias (roots and tubers) and Pedro Fato (cereals). Both donors had an opportunity to visit field sites, to participate in taste tests of new varieties on on-farm trials, to observe the implementation of the last round of the consumption and expenditure survey, and to attend a community theater presentation, where they had an opportunity to sample village-produced sweet potato bread, doughnuts, and juice.

After several delays in scheduling to assure participation of key stakeholders, the project held an advisory group meeting on September 8, 2004. Eighteen stakeholders heard presentations on project progress to date, with the project Nutritionist, Nadia Osman, and the project Agronomist, Felipe Zano, presenting results to date of their components while the Project Coordinator described preliminary findings from the first three rounds of serum retinol analysis in intervention households.

Major accomplishments and events for each major area of the project between April 2004 through mid-September 2004 are described in greater detail below. Please refer to the attached power point file for photographs of activities accomplished during this period.

A. Research Component

- ! Production and Income Source Survey for 2003 was completed in April 2004 and double entry digitation was completed in May 2004. Key elements of the survey were capturing the experience producing sweet potato in 2003, major sources of income in 2003, crops produced and sold in 2003, and the current demographic composition of the household. In addition, the NUTRIPROX consumption indicator survey was repeated, along with the 7-day recall for intake of vitamin A rich foods by the study child.

- ! A quick analysis of radio ownership, and key listening times was done on data collected as part of the Round 2 survey. Results indicated that Radio Mozambique-Quelimane was the only major station listened to throughout the study areas. Information from this assessment was immediately used to select the best times for broadcasting the six programs on vitamin A in Portuguese and dominant local languages beginning in April 2004.

- ! Continued analysis of first round of consumption & expenditure data. In addition to the continued work of Maria Lurdes Santos on her thesis using the 24-hour recall data for her *Licenciatura* thesis, policy analyst trainee (Ministry of Agriculture and Rural Development) Benedito Cungara spent 1 week in April 2004 and 2 weeks in June/July 2004 learning data cleaning procedures and assisting in the analysis of both the consumption and expenditure data. He completed the preliminary analysis of the first year non-food expenditure data.
- ! The third round of data collection on morbidity, serum retinol status, and anthropometric indicators of nutritional status was conducted in May and June 2004. As was the case for Round 2, a vaccination team from the Ministry of Health accompanied the survey team to assure that vaccination services were provided to all children (not just study participants) in the study areas. As envisioned in the original protocol, data were obtained from intervention households only, and reference children received a placebo in lieu of a vitamin A capsule. Serum retinol dry spots were analyzed by Craft Laboratories, North Carolina. Results of the analysis were received on 23 August 2004, one month later than expected. The six children with serum retinol levels under 0.20 $\mu\text{mol/dl}$ were subsequently provided with a vitamin A capsule, as specified in the study protocol.
- ! The nutrition extensionists under the direction of Nadia Osman continued group interventions and in half the sample, household visits. The latter were divided into 2 sub-groups for a given visit: $\frac{1}{2}$ based on reported practices and $\frac{1}{2}$ based on actual observations of meal preparation for the young child and hygienic practices. Nadia also began collecting additional data for her dissertation research on evaluating the communication process that starts with exposure to a message and ends with the actual change in behavior. In August and September extensionists began assessing skill acquisition, memorization, and recall in the preparation of enriched weaning porridges.
- ! The final round of consumption and expenditure data collection began in August 2004 and will be completed by 8 October.
- ! A preliminary analysis of serum retinol results for the 508 intervention children measured in all three rounds was presented to the Advisory Group at the Maputo meeting held 8th September 2004.

B. Nutrition Extension

The nutrition extension work in the two study districts continued to progress. Lectures using the counseling cards on the diet of a child from birth to five years of age were completed in April 2004. From May through the end of the intervention period, four additional topics were covered:

- ! Understanding the relationship between weight gain and undernutrition, using flipcharts demonstrating what can be done to stop a fall in weight when a young child confronts an episode of diarrhea, the hunger season, and the cessation of breast-feeding

- ! Hygiene practices, using role plays and pictures to emphasize understanding the routes through which a person can become contaminated with diarrhea and how to avoid and treat diarrhea.
- ! Diffusion of the key recommendations (the same ones used in the household visits made by extensions) by having participant mothers teach other mothers about desirable child feeding practices
- ! Demonstrations of how to prepare beta carotene rich juice, using orange flesh sweet potatoes.

A drop off in group attendance was noted in several groups during the busiest parts of the agricultural season, particularly at planting and weeding times. To encourage greater participation, and to reinforce mother's understanding of the importance of regular and consistent weight gain, the project decided to award small prizes (a plastic plate and plastic cup) to mothers who between April 2004 and the end of July 2004 had children showing overall weight gain (based on monthly monitoring of weights of reference children by extension personnel) or who had perfect attendance records at all group meetings. These small prize items often are lacking in the household and enhance the mother's ability to comply with the recommendation to feed each young child on a separate plate.

The strategy of using small prizes has paid often & group attendance has improved significantly. Reference children continue to be monitored at each monthly group visit for weight gain.

Beginning in July, extension agents demonstrated how to make beta-carotene-rich sweet potato juice in each group. This processed product was selected for promotion at the group level since it is easy to make and requires no wheat flour, a product that is only readily available in urban areas. Extensionists report that in general, mothers have enjoyed learning how to make juice out of sweet potato because the recipe is simple and the ingredients used (orange flesh sweet potato, sugar, and either lemons or oranges) are not hard to find. Some households are already preparing it in their homes.

The other major group activity completed by mid-September, emphasized having mothers participating in group meetings reach out to other women in their community to teach them key messages regarding complementary feeding of young children. Osman produced a graphic design which enabled each mother to select 3 out of 6 messages regarding improved child feeding practices she wished to impart to 10 of her neighbors. Each mother uses the laminated graphics sheet as an instrument to help her remember how to describe the different foods and their possible combinations. It is envisioned that the mother's own knowledge will be solidified as she repeats key messages to her neighbors.

While each mother's experience with this activity will be assessed in the final survey round, reports from extension personnel indicate that its implementation has not been as successful as hoped. Mothers who choose to disseminate the messages are typically reaching out to 2-3 other mothers, instead of 10. In some areas, they report non-project mothers being reluctant to accept their advice due to being jealous of project mothers who they feel receive benefits that they do not have access to. While most groups are open to receiving new members, additional enrollment in the study

sample itself is not possible and hence, some members of the community are jealous of those who receive “analysis” (serum retinol sampling).

In the original protocol, nutrition extension activities were due to end by early October. This will occur in all but one research locality, Posto Campo/Lualua. Unfortunately in that locality, the nutrition extension agent damaged her knee in a motorcycle accident in July 2004, which prevented her from continuing with her field duties. After 2 weeks of attempting to locate a suitable replacement from outside the project, a decision was made to have the most qualified nutrition extensionist, Nivalda Sidane, split her time between Posto Campo/Lualua and her own area, Malei, and extend the intervention period until the end of October. While not ideal, this will assure consistency in the execution of the extension program.

The three remaining nutritionists will participate in the last round of survey schedule to initiate the first of November, with two of the three involved in the collection of serum retinol and hemoglobin samples.

C. Agricultural Extension and Research

Sweet potato Multiplication and Area Expansion.

As mentioned in the previous progress report, in November and December of 2003, the agriculture extensionists gave a presentation to all their groups on how to ensure sweet potato availability throughout the year using combined strategies of staggered planting of vines (that is, opting for opening small areas under sweet potato every month when rainfall is adequate in lieu of just planting one larger field once or twice a year), and storing sweet potato once harvested either as fresh roots or as dried chips. Erratic rains during the first growing season made it difficult to implement the staggered planting strategy. The Early Warning monitoring system reported that precipitation between 1 November 2003 and 10 January 2004 was 53% of normal in Mopeia District and 20% of normal in Namacurra District.

The start of the second growing season can occur anywhere between March and July, depending on when rice is harvested in the dambo areas (*zonas baixas*). Fortunately, rainfall in the second season was much greater in quantity and regularity than in the first. As mentioned above, by the end of the vine distribution in May 2004, the project had distributed 10,536 kgs of vines to 962 families, each family receiving an average of 11 kgs. This was achieved by having vines for distribution from 0.95 hectares multiplication plots in 2004 complemented by obtaining additional vines as needed from the large-scale multiplication plot maintained by TSNi collaborator SARRNET/INIA in Namajavira.

In 2004, 0.04 hectares of the multiplication plots were managed by 2 farmers groups and 0.01 hectare by an individual who sold the project vines at 1000 MT per kilogram. The farmers group in Mopeia was also encouraged to sell vines to a trader for 1500 MT/kg, who in turn, re-sold them for 3000 MT/kg. The project also experimented with selling vines wholesale to local traders from the Central market in Quelimane, who re-sold them to clients coming to purchase foodstuffs in the market. The experience revealed that there was a strong demand for vines when rainfall conditions were propitious for planting and that future distribution programs should consider selling

vines from the outset and not engage in free vine distribution to promote the sustainable establishment of vine producers/sellers in local areas.

Extension agents actively encouraged each participating family to plant at least 500 square meters to orange-flesh sweet potato in 2004. By mid-August 2004, 134 farmers in Malei, 60 farmers in Catale, 18 farmers in Posto Campo/Lualua, and only 3 farmers in Mexixine had attained this goal. Extensionist agents began assessing total area planted to orange-flesh sweet potato in September 2004 and area measurement should be completed by mid-October 2004. Of all project sites, Mexixine continues to be the most problematical. Sweet potato planting was delayed as it cannot be planted until after rice is harvested and rice harvesting was very delayed this year due to the late start of the growing season. Moreover, other non-rice sites appropriate for sweet potato production in Mexixine are often farther from the homestead than is the case in other localities.

Sweet Potato Storage

By the end of August 2004, extension personnel had completed establishing demonstrations of fresh sweet potato root storage in all farmer's groups. The demonstrated technique was superior to the model tested last year. The storage pit continues to have alternate layers of dried straw and fresh roots, but now a bamboo tube has been added in the middle of the pit to facilitate root respiration and the entire pit is covered with a small thatched structure to prevent rainfall coming in contact with the storage pit itself. The group inspects the trials every 2 weeks to check and remove any rotted roots. After 2.5 months most pits continue to show high quality roots. The few sites where roots have rotted before reaching 2 months of age have been sites where too much humidity was present in the surrounding soil, indicating poor site selection by the extensionist. Monitoring of the sites will continue through November 2004.

In September 2004, agriculture extension agents began promoting the production of dried sweet potato chips through holding group meetings during which each member would contribute a given amount of OFSP to be dried in the shade. During the previous year, 25% of Mopeia participants and 31% of Namacurra participants had dried sweet potato. The aim of the extension project this year is to increase the number of families drying orange flesh sweet potato while ensuring beta-carotene retention.

While extension agents report that farmers are impressed with the how the quality of the fresh roots is maintained in the covered storage pit, they are more likely to store sweet potato in dried than in fresh form because the later system requires more labor to set up & a greater quantity of sweet potato root to justify using the technique (a typical pit as demonstrated required 1.5-2 sacks of fresh roots).

In 2003, a drying trial had been conducted in which the variety Resisto was sliced in the "traditional" way (thin slices, leaving the skin on) and dried using 3 different methods: (1) on a mat on the ground in the shade of a tree, (2) on a mat on the ground with the shade by provided by another mat, and (3) on a mat on the ground with the shade provided by a mat wrapped in black plastic to prevent ultraviolet light penetration. Samples were analyzed by Paul van Jaarsveld's team at the Medical Research Council Laboratory in Capetown, South Africa. Results shown in Table 1

indicate that all samples retained excellent amounts of beta-carotene, but that the sample dried under the simple shade of the tree retained most.

Table 1. Results from Drying Sweet Potato Chip Analysis (variety Resisto)

Sliced Sweet Potato Variety Resisto 4 days drying under:	ug beta-carotene/gram dry wgt	ug beta-carotene/100 grams	Retinol Activity Equivalent (RAE)/100 grams
shade of tree	126	12600	1,050
woven mat	117	11700	975
woven mat covered with black plastic	107	10700	892

The main drawback to drying under the shade is that drying times average 3.5-4 days compared to 1-2 days under direct sunlight. While few farmers do *not* seem to view the increased drying time as a major constraint, the more prolonged drying time probably increases the likelihood that dried materials could be affected by fungus, reducing dried product quality.

In August and September 2004, 4 additional drying trials were conducted to try to reduce drying times yet retain beta-carotene content and to obtain information on the second most popular introduced orange-flesh variety after Resisto, CN-1448-49. Two trials were done with variety Resisto, two with variety CN-1448-49. In these trials, six comparisons are being made:

1. roots sliced with the "traditional" width, on a mat on the ground in the shade of a tree or building.
2. roots sliced with the "traditional" width, in the direct sunlight, under leaf cover
3. roots sliced with the "traditional" width, on a mat raised on a table in the shade of a tree or building.
4. roots chipped finely with a machine, on a mat on the ground in the shade
5. roots sliced more thickly (1-1.5 cm width), on a mat on the ground in direct sunlight
6. roots sliced with the "traditional" width, on a mat on the ground in direct sunlight.

Results from the Medical Research Council Lab in South Africa are expected by the end of February 2005.

Results from Collaborative SARRNET/INIA Sweet Potato Research Trials.

Between the last week in July and the end of the second week of August 2004, three of the four adaptive research trials of 16 sweet potato varieties were harvested. The fourth trial, planted in Catale, was lost due to insufficient rainfall in the period immediately after planting.

Results showing yield, percent germination rate, percent of roots that can be commercialized, extent of sweet potato weevil infestation, and percent of roots with severe cracking are provided in three tables in Appendix A. Based on these results, combined with forthcoming results from on-farm trials for 2004, three varieties have emerged as potential candidates for release, and a fourth merits further investigation. All of these varieties have higher dry matter contents than many of orange-flesh

varieties currently being distributed, which appeals to adult consumers. Key characteristics of each variety are described below:

1. Variety 440215

This variety generally produces among the highest yields in the trials (ranging from 7.9 to 26.1 tons/hectare) and among the most drought tolerant of varieties included in the trials. The percentage of roots produced suitable for commercialization is reasonable, and its taste acceptable but not outstanding for most consumers. Its major disadvantage is its vulnerability to sweet potato weevil attack. Since its roots grow close to the soil surface, weevil penetration is common under dry conditions. Hilling up is an essential cultural practice to prevent weevil infestation in this variety.

2. Excel

While not as productive as 440215, Excel always produced higher mean yields than local varieties included in the adaptive trials. Its vines are sufficiently vigorous, once they have been established, but the variety requires adequate moisture during the germination phase to avoid significant plant loss. In terms of taste, Excel always ranks among the top 6 varieties in any taste test of the 16 varieties. Like 440215, it is very susceptible to weevil attack under dry conditions.

3. SPK004

Like Excel, SPK004 always produced higher mean yields than local varieties included in the adaptive trials. Its taste is acceptable but not outstanding. It is deeper rooting than 440215 and Excel, hence being less vulnerable to weevil attack. A high percentage of its roots are of adequate size and quality to be sold commercially. Its major disadvantage has been its vines being susceptible to drought in several sites.

4. MGCL01

MGCL01 is a variety warranting further investigation as it has shown highly variable yields, but its vines are among the most vigorous and resistant to drought of all those being tested in the adaptive trials. Experience to date indicates that it produces adequate to high yields of roots during the first growing season, and very poor root yield in the second season. Like Excel, MGCL01 always ranks among the top 6 varieties in any taste test of the 16 varieties. However, the shape of its roots is typically elongated and a high percentage are not of commercial size when harvested at five months, indicating that this may be a slower maturing variety than others in the trial. Future investigations of this variety should consider comparing roots harvested at 5, 6, 7, and 8 months.

D. Social Marketing and Commercialization Campaign

In working with HKI consultants and SARRNET/INIA, an attempt was made to combine awareness campaigns regarding the importance of consuming orange-flesh sweet potatoes (OFSP) and other vitamin A rich foods with a strategy to improve the efficiency of sweet potato marketing and encourage surplus production for sale among participating farmer's groups. Four different activities are being pursued 1) Use of radio programs to reinforce messages in study areas and promote greater consumption of vitamin A rich foods throughout the province 2) Village theater on specific topics conducted by volunteers from existing farmer groups, 3) Painted walls and market stalls within markets with messages promoting increased sale and

consumption of vitamin A rich foods, and 4) Development and testing of orange-flesh sweet potato processed products to create more demand for sweet potato, which in turn will assure more regular markets for OFSP roots.

For the market stall built in Lualua, the painted wall campaign was linked to a pilot commercialization promotion scheme. Only 12% of households in the intervention areas sold any sweet potato in 2002. That percentage increased to 16% in 2003. The objective underlying the pilot commercialization promotion effort was to increase the percentage of households marketing sweet potato. This entails encouraging surplus production of OFSP that should enable a higher percentage of intervention households to market some of their sweet potatoes.

Progress in each of the four social marketing and commercialization activities is summarized below:

Radio Programs on Vitamin A

The series of six radio programs concerning the importance of vitamin A, vitamin A rich foods, and the production and preparation of beta-carotene rich sweet potato began in April 2004, one month prior to initiating Round 3 of the nutritional status assessment in intervention areas. Women interviewed in Round 3 were asked about their frequency of listening to the radio (even if they didn't own one) during the past month and if they had listened, whether they had heard any program mentioning vitamin A or the orange flesh sweet potato. Responses to those questions are shown in Table 2.

Table 2. Percent of Study Households Who Listened to a Radio During the Month Prior to the Interview and Whether They Heard a Program Mentioning Vitamin A or Orange Flesh Sweet Potato

		ALL HOUSEHOLDS IN INTERVENTION AREAS		DISTRICT			
				MOPEIA		NAMACURRA	
		Count	Col %	Count	Col %	Count	Col %
HOW MANY TIMES DID YOU LISTEN TO THE RADIO LAST MONTH?	DIDN'T LISTEN AT ALL	290	56.4%	155	60.5%	135	52.3%
	LISTENED EVERY DAY	163	31.7%	65	25.4%	98	38.0%
	AT LEAST 3 TIMES PER WEEK	5	1.0%	3	1.2%	2	.8%
	1 TO 2 TIMES PER WEEK	28	5.4%	18	7.0%	10	3.9%
	IRREGULARLY	28	5.4%	15	5.9%	13	5.0%
DID YOU HEAR A PROGRAM MENTIONING VITAMIN A OR ORANGE-FLESH SWEET POTATO?	NO	32	6.2%	17	6.6%	15	5.8%
	YES	192	37.4%	84	32.8%	108	41.9%
	DID NOT LISTEN TO THE RADIO	290	56.4%	155	60.5%	135	52.3%

Baseline data indicate that 30% of intervention households own radios. Therefore, it was not surprising that in May-June 2004, over half of the households did not listen to any radio program. Most of those that did listen, however, heard vitamin A or orange-flesh sweet potato being mentioned.

Village Theater.

In mid-May, the project interviewed four different theater groups in Quelimane and selected the group led by Felipe Castro to use in the development and implementation of the community-level theater intervention. Nadia Osman worked with Felipe to develop a 25 minute skit consisting of two parts. The themes of the skit emphasized practices which are difficult for mothers to alter without the understanding and support of other family members and elders in the community at large. The key topics touched on in the skit were:

- 1) whether it is good or bad to give colostrum to the newborn,
- 2) whether one should give traditional medicines or herbs provide by the local healers to the newborn or other liquids besides breastmilk to the newborn during the first four months of life,
- 3) why women should continue to breastfeed their under 2 year old if they become pregnant,
- 4) the importance of growing a diversity of foods to provide sufficient nourishment to the family,
- 5) the need to feed weaning age children frequently during the day, and
- 6) the need to diversify ingredients in the young child's porridge beyond manioc flour and sugar, including the use of egg—an ingredient that many still consider taboo for young children.

The skit called for three actors and two actresses. Once the Quelimane theater group had perfected the skit in the local language (Chuabo), a program was designed to train local theater groups in three of the four study localities. The implementation of the village theater training program required five days in each locality. The first day, the Quelimane theater team performed in a centrally located village. During the morning prior to their performance, they circulate around the community advertising the upcoming theater performance, which reinforced the notification previously disseminated by village leaders through the resident extensionist. Upon concluding their performance, the group leader recruits attendees at the performance who would like to be trained as actors and perform the theater piece in other villages in their community. Between 8 to 15 community members responded positively. In all groups, more than half of the volunteers were not members of project farmer's groups. Subsequently, Felipe and one other colleague of the Quelimane team would remain in that central village for 3 days to train the local theater group to perform the piece and guide them on principals of how to choose their group leader and organize their own practice sessions. That Friday of the same week, the local theater group would make their first performance.

Following the completion of the three week training program (7 June-26 June 2004), a two month and one-half month schedule of performances was initiated. The Lualua theater group performed every Thursday, rotating every other week between villages in Catale and villages in Posto Campo/Lualua. The Malei theater group and the Mexixine group performed on alternate Saturdays in villages in their respective areas. The local teams were always accompanied by Felipe Castro, who assisted in introducing the piece and preparing the audience for the performance. The nutrition

extensionist of the area was also on hand to respond to queries generated by the theater piece.

The concept of training local theater groups proved to be an excellent strategy. Turnout overall was excellent, and reactions of the vast majority of the audience indicated that they enjoyed the theater piece and paid attention to its content. Local theater group members were always ready and eager to perform (unless ill), and at the end of the exercised asked when the next theater piece would be initiated. Performers did receive a small per diem (20 contos (approx. 90 cents)) to cover their food costs during the day.

All performances at the village level were completed on 2 September 2004. In addition, two performances were held at major markets in two study localities: Lualua market, and Namacurra market. Market performances were conducted on Saturdays to maximize the potential size of the audience. The market setting proved to be a more challenging environment than the village setting. In Lualua, the head of the market assisted in organizing the crowd, so that all could see and hear. In Namacurra, such assistance was not available, and the presence of drunk individuals in the audience hampered the ability of the actors to perform. In addition, the male:female ratio of attendees is much higher in market-based performances than village-based.

Market Stall Promotion and Pilot Commercialization Experiment

The design of messages painted on walls in two Quelimane markets and a market booth in Lualua market in Mopeia district was described in the last progress report.

The Lualua market has the advantage of being adjacent to the major paved highway in the province leading to the provincial capital of Quelimane. Construction of the stall was completed in March 2004 and a contract signed with local trader Jaime Lobate Cassete that permitted him exclusive use of the painted stall for 6 months if he agreed to follow project guidelines concerning the purchasing and selling of orange-flesh sweet potatoes (OFSP).

The project agronomist instructed Jaime on how to calculate profit, and maintain records recording his OFSP purchases and sales. He received an initial loan from the project of 500,000 MT (approximate \$21.25) to enable bulk purchasing of roots, with a weekly interest rate of 25,000 MT. Jaime was required to implement a grading scheme when purchasing sweet potato, in which the purchase price for 1st quality sweet potato (each root at least 200 gms in size, no weevil holes or significant cracking present, whole roots only) was higher per kilogram than that for 2nd quality (each root at least 100 grams in size, some weevil holes permitted, cut roots permitted) and the purchase of roots under 100 grams in size was not allowed. Based on price data analysis from 2003, originally the difference between the two grades was to be 400 MT/kg. However, because only 500 MT, 1000 MT, and 5000 MT coins are available in Mozambique, the protocol was altered so that farmers selling OFSP to Jaime at his booth were to be paid 1500/MT for 1st quality roots, and 1000 MT/kg for 2nd quality roots. Jaime resold the 1st quality roots for 3000 MT/kg and 2nd Quality roots for 2500 MT/kg.

Project personnel introduced Jaime to farmer's groups participating in the Project, but Jaime arranged his own transport to purchase roots at farmers fields. The price paid to farmers was much lower per kilogram if Jaime had to purchase the roots at the farm gate.

Due to delays in planting OFSP because of late rains, sales to Jaime began only in mid-May. Total sales through the end of August 2004 are shown in Table 3. Sales tend to be spread out during the week as opposed to occurring on one or two days.

Table 3. Amount of Orange-Flesh Sweet Potato (OFSP) Sold by Lualua Trader in 2004

MONTH OF SALE (2004)	KGS SOLD OF 1ST QUALITY OFSP	KGS SOLD OF 2ND QUALITY OF OFSP	GROSS RECEIPTS (MT)	PROFIT (MT)	PROFIT (USD)
MAY (19TH ONWARDS)	21	63	220,500	128,100	5
JUNE	267	282	1,504,000	850,200	36
JULY	154	149	834,500	454,500	19
AUGUST	276	237	1,420,500	775,500	34
TOTAL TO DATE	718	731	3,979,500	2,208,300	94

Sr. Jaime is able to market all of his OFSP at the roadside center. He is not purchasing in large enough quantities to justify transporting the roots into Quelimane. (Calculated estimates show that he would need at least 8 sixty kg bags of sweet potato to justify the transport cost to Quelimane). Some farmers prefer to market the sweet potato without going through Jaime to capture higher margins.

While Jaime would like to see greater quantities of roots being sold to him, he is highly satisfied with the profit margin he makes on the sweet potato he sells. In general, the stall has done its task of increasing awareness and demand for OFSP. More farmers outside of existing groups are procuring OFSP vines for the coming season. Moreover, the use of quality criteria encouraged farmers to adopt recommended agronomic practices to avoid weevil infestation and to harvest the roots with greater care to avoid cutting them. To date, the pilot commercialization initiative is proving to be an effective means of creating demand linked to increased market development and commercialization of OFSP roots.

The market stall promotion in two markets in Quelimane was a six-month pilot initiative to promote the selling of vitamin A rich foods at a single location within the market, with educational paintings on the wall to help consumers identify vitamin A rich foods and learn how OFSP consumption contributes to good health and eyesight. The project held a contest for the right to use the painted stalls, and winners had to agree to sell the appropriate products and maintain the area clean. In return, for six months, the project paid ½ of their daily market fee. The painted stalls are inside of the covered portion of the building and the idea was one stall would be dedicated to OFSP sales, another to dark green leaf sales, one or two to vitamin A rich fruit and vegetable sales, and another to the selling of eggs.

In practice, the concept has been difficult to implement. Sellers who originally were outside in the open air (dark green leaves and sweet potatoes) found it difficult to transfer inside, where they felt the flow of clients was lower. Also, dark green leaf sellers need to wash their leaves and access to water is easier outside. Sweet potato traders also occasionally market fresh roasted maize, and fresh manioc. It is impossible to roast food inside the building, and fresh manioc does not match with the criteria of the booths. Thus, dark green leaf traders did not remain in the initiative, and sweet potato sellers only use the designated booth when they have OFSP available. The booths tend to be dominated by carrot, egg, and pumpkin sellers, with fruit sellers appearing during appropriate seasons. Selected sellers have also rarely complied with the cleanliness regulation specified in the contract. Thus, when the pilot six-month period came to an end, the project decided to cease subsidizing the designated booths.

Although the Quelimane market initiative has not proceeded as planned, it remains to be seen how effective the wall paintings have been in educating consumers about the importance of vitamin A rich foods. Collaborating partner HKI will identify an expert to evaluate the effectiveness of the social marketing component of the project, scheduled to take place in January 2005.

Demand Creation through Sweet Potato Processed Product Development.

Sweet potato roots are generally boiled or steamed and occasionally mashed to prepare porridges. Diversified processed products using sweet potato are virtually unknown in Zambézia. Developing processed products having orange-flesh sweet potato as a key ingredient could lead to increased demand for sweet potato roots, *if* that product proved to be highly desired by consumers. Consumers must like the taste of the proposed product, and its retail price needs to be within the range of average consumer purchasing power.

To initiate the processed product component of the project, Eng. Abdul Naico and technician Lurdes Faria from SARRNET/INIA conducted a training course from 27 May through 30 May 2004 for all project extensionists and senior supervisors on agro-processing of OFSP, including fresh root storage, processed product development, and practical sessions making actual products. Extensionists used recipes developed by SARRNET/INIA for southern Mozambique to make sweet potato cookies, cake, bread, fries, and juice. Two recipes using manioc were also included in the course.

Course participants were also trained on how to assess the profitability of processed products already being sold in the market. A practical exercise at the local market revealed that limited purchasing power in Quelimane restricts product processors to selling their food items for either 500 MT or 1000 MT. Urban consumers are very price conscious and will switch to another processed product if an attempt is made to sell that product for more than 1000 MT. Daily profit margins for small scale sellers ran from 14000 MT to 71000 MT per day. By the end of the course, it was evident that many of the recipes from Maputo included ingredients that would push the cost of each product unit above the purchasing power of the average urban Zambezan consumer.

Consequently, the project conducted cost and returns assessments among key bread and fried doughnut producers in the most important markets in the rural study

locations. Based on that information, simplified recipes for bread and fried doughnuts were designed, which just modified the amount of wheat flour being used in existing recipe. Different amounts of OFSP were substituted in baking trials until the appropriate portions of OFSP: wheat flour were achieved.

In all, four recipes were selected as promising for our intervention zones: OFSP bread (referred to as *pão de ouro*, golden bread), fried donuts (marked as *fiosses de força*, donuts of strength), OFSP juice, and OFSP fries. Four training sessions were held (Lualua, Mexixine, Malei, and Quelimane) in August and September at which half of the 8-10 participants were already processed product producers and the other half were members of a farmer's group who had expressed interest in learning to make and sell processed products.

To date, the most profitable product is sweet potato bread. As shown in Table 4, the Lualua bread maker Carlitos selling 250 bread rolls made using his normal recipe earns 50,000 MT in profit. By substituting 38% of the wheat flour used to make that bread with boiled and mashed orange-flesh sweet potato, the daily profit margin increases to 96,000 per day. To date, 2 processors are making sweet potato bread and occasionally donuts in Mexixine, 2 are making OFSP bread in Lualua, 4 are making OFSP bread in Licuari, and 1 is making OSFP bread in Malei. The sweet potato bread typically is heavier (80 gms) than its equivalent all wheat flour counterpart (62 gms), but is moister and lasts longer. A heavier bread is judged to be a plus by most consumers.

A consumer acceptability survey conducted in Licuari market on 11 September indicated that the color and taste of the OFSP bread was preferred to the pure wheat flour product. Moreover, the round form of OFSP bread is preferred to the elongated form.

To date, the major challenge is to assure adequate root supply every day. Project personnel are currently experimenting with rehydrating dried OFSP chips for use in bread recipes in lieu of fresh roots. If successful (in terms of quality and beta-carotene retention), processors could more easily maintain a stock of dried SP chips to use as needed and cut down on time spent procuring fresh roots.

4. Dissemination Activities

On May 5-7 2004, the Project Coordinator attended a meeting in Rome sponsored by HarvestPlus on Reaching End Users. This provided an opportunity to share experiences with others working on micronutrient dense crops on how to disseminate new varieties in areas often lacking formal distribution systems and techniques to promote behavioral change.

The Advisory Group meeting held on 8th September 2004 at Pensão Martins in Maputo provided an opportunity to update key stakeholders on progress-to-date and obtain their perspective on what should be collected during the last round of data collection beginning in November 2004.

In addition to informing members about progress in implementing the extension program, project nutritionist Nadia Osman was able to present preliminary findings on

a sub-set of 99 children born to study mothers since the enrollment of the reference children to see whether mothers are reporting any changes in care and feeding practices with these young infants. Agronomist Felipe Zano presented the state of the agricultural extension program and results from the pilot commercialization project, in addition to providing results from both the SARRNET/INIA research trials as well as the on-farm trials. The Project Coordinator presented preliminary findings on results from the serum retinol analysis for the 508 intervention children measured during all three rounds. All study findings presented at the Advisory Group meeting will be included in the forthcoming technical report for the 2nd year of the study.

At the provincial level, the project is collaborating with the provincial SETSAN (Food Security and Nutrition Committee— a multi-sectoral coordination body) committee to organize a one-day seminar on 14th October entitled *Diet Diversity for Health*. At that seminar, all non-governmental organizations and key extension departments of agriculture, nutrition, and social action working in Zambezia are invited to present the key lessons learned from their experiences to diversify diets and change dietary practices. This will provide an excellent forum to disseminate project findings to a wider audience.

The 16th of October 2004 is World Food Day and the SETSAN group is organizing a major fair to celebrate the day at the District Headquarters of Mopeia, which is a project intervention district. The project will arrange for sweet potato bread processors to participate as well as one of the community theater groups.

5. Conclusion

Considerable progress has been made during the last six months largely due to the improvement of agro-climatic conditions. The overall time frame of the project is quite short for an agriculturally based intervention, and results on improved nutritional status and changed behaviors will be heavily dependent on what has occurred during the past six months when the sweet potato supply considerably improved. The last round of serum retinol collection is due to begin on 1st November, and in this final round hemoglobin status will be re-measured as well.

Two multiplication sites have been identified in Nicoadala, the control area, for the multiplication of orange-flesh sweet potato vines for the coming season. This is being done in close collaboration with district agriculture officials and World Vision-OVATA to assure that material is distributed to control participants.

The current project is due to end on 31 March 2005. The project coordinator is trying to raise additional funds (through August 2005) to ensure that a complete write-up of the findings occurs. Discussions are also under way regarding how the experience of this project to date could serve as a basis for designing a scaled-up intervention in other districts in Zambézia.

Table 4. Comparison of Costs and Profits of Pure Wheat Flour Bread and Golden Bread in Lualua Market (2004)

A. WHEAT FLOUR BREAD PRODUCES 250 UNITS

EACH UNIT SELLS AT 1000 MT

TOTAL RECEIPTS (MT): 250000

INGREDIENT	QUANTITY	UNIT OF MEASURE	GRAMS PER UNIT OF MEASURE	TOTAL GRAMS	VALUE PER UNIT OF MEASURE	TOTAL VALUE IN METICAIS
WHEAT FLOUR	20	PLASTIC WATER JUGS	785	15,700	8164	163,280
YEAST	2	LEVEL MATCH BOXES	15.12	30	1512	3,024
IMPROVER (SOLD TO BREAD MAKERS)	1	LEVE MATCH BOX	16.7	17	1670	1,670
SALT	1	TABLESPOON				1,000
DAILY MARKET FEE	1	DAY			2000	2,000
WOOD	1	STACK			5000	5,000
CHARCOAL	0.25	SACK			15000	3,750
PERSONAL TRANSPORT TO QUELIMAN	0.25	RETURN TRIP: LUALUA-QUELIMANE			60000	15,000
TRANSPORT OF WHEAT FLOUR SACK	0.25	TRIP FROM QUELIMANE TO LUALUA			20000	5,000
				TOTAL COSTS		199,724
<i>NOTE: WHEAT FLOUR CAN ONLY BE PURCHASED IN THE PROVINCIAL CAPITAL QUELIMANE. ONE SACK LASTS FOR 4 DAYS.</i>						
					PROFIT	50,276

B. GOLDEN SWEET POTATO BREAD PRODUCES

EACH UNIT SELLS AT 1000 MT

TOTAL RECEIPTS (MT): 264,000

INGREDIENT	QUANTITY	UNIT OF MEASURE	GRAMS PER UNIT OF MEASURE	TOTAL GRAMS	VALUE PER UNIT OF MEASURE	TOTAL VALUE IN METICAIS
WHEAT FLOUR	12	PLASTIC WATER JUGS	785	9,420	8164	97,968
YEAST	12	LEVEL MATCH BOXES	15.12	181	1512	18,144
IMPROVER (SOLD TO BREAD MAKERS)	6	LEVE MATCH BOX	4.16	25	416	2,496
SALT	2	TABLESPOON				1,486
BOILED AND MASHED ORANGE FLESH SWEET POTATO (FROM 30 MEDIUM SIZE ROOTS (EACH 225 gms))	18	300 ML PLASTIC CUPS	319	5742	1167.54	21,016
DAILY MARKET FEE	1	DAY			2000	2,000
WOOD	1	STACK			5000	5,000
CHARCOAL	0.2	SACK			15000	3,000
PERSONAL TRANSPORT TO QUELIMAN	0.2	RETURN TRIP: LUALUA-QUELIMANE			60000	12,000
TRANSPORT OF WHEAT FLOUR SACK	0.2	TRIP FROM QUELIMANE TO LUALUA			20000	4,000
				TOTAL COSTS		167,110
<i>NOTE: A SACK OF WHEAT FLOUR NOW LASTS 5 DAYS INSTEAD OF FOUR, REDUCING OVERALL TRANSPORT COST.</i>						
					PROFIT	96,890

Annex A. Results from Collaborative SARRNET/INIA Research Trials in 3 Sites (2004)

Table A1. Adaptive Trial of 16 Sweet Potato Varieties in Lualua, Mopeia District (Collaborative Research with SARRNET/INIA)

Province: Zambézia District: Mopeia Administrative Post: Posto Campo Locality: Lualua Planting Date: 27-02-04 Harvest Date: 26-07-04

Variety	Root Color	Yield (ton/ha)	% Germination	% of plants harvested	Total Kgs harvested	Kgs per plant harvested	No. of Commercializable Roots	No. of Non-Commercializable roots	% kgs. Commercializable	% kgs. Roots Non-commercializable	% with weevil attack	% with cracking
440293	b	18.4	80	46	49.6	0.7	142	168	77.2	22.8	25.8	21.9
Excel	I	14.1	78	75	38.1	0.7	112	79	87.8	12.2	43.5	4.2
Zapalo	I	9.6	95	74	26.0	0.4	76	174	62.2	37.8	12.0	1.6
Chingova	c	9.1	90	59	24.5	0.3	83	131	69.4	30.6	40.7	16.8
SPK004	I	8.1	82	64	21.9	0.3	67	165	66.0	34.0	12.9	0.4
440215	I	7.9	97	70	21.4	0.3	79	224	56.5	43.5	49.2	0.3
Tib4	I	7.2	95	53	19.4	0.2	81	156	69.1	30.9	45.9	6.3
440287	b	7.1	79	68	19.1	0.3	50	172	57.1	42.9	32.0	4.5
MGCL01	I	6.3	77	75	17.1	0.3	48	298	40.9	59.1	23.7	0.9
Cocora (local)	b	6.1	82	71	16.4	0.3	40	119	62.8	37.2	27.0	1.9
440288	I	5.8	85	72	15.6	0.2	54	176	50.8	49.2	17.0	1.3
Costanero	I	5.4	85	57	14.7	0.2	60	112	63.3	36.7	22.7	12.1
Mozwhite	b	4.6	86	44	12.5	0.2	45	98	61.8	38.0	37.0	0.7
Saliboro	I	4.3	68	72	11.6	0.2	42	109	62.3	37.7	39.1	8.6
Cordner	I	2.0	47	66	5.4	0.1	11	156	37.0	63.0	16.8	1.2
420001	I	1.9	58	49	5.2	0.1	12	58	48.5	51.5	48.6	21.4

Root color: b- white I- orange c-crème

Table A2. Adaptive Trial of 16 Sweet Potato Varieties in Mexixine, Namacurra District (Collaborative Research with SARRNET/INIA)

Province: Zambézia District: Namacurra Administrative Post: Macuse Locality: Mexixine Planting Date: 05-03-04 Harvest Date: 04-08-04

Variety	Root Color	Yield (ton/ha)	% Germination	% of plants harvested	Total Kgs harvested	Kgs per plant harvested	No. of Commercializable Roots	No. of Non-Commercializable roots	% kgs. Commercializable	% kgs. Roots Non-commercializable	% with weevil attack	% with cracking
440215	I	26.1	100	89	70.5	0.8	282	362	78.8	21.2	44.1	0.0
440287	b	22.1	100	80	59.6	0.7	184	268	75.8	24.2	65.7	14.4
440293	b	21.7	100	83	58.6	0.7	173	113	91.3	8.7	46.2	0.7
Mozwhite	b	20.5	100	90	55.3	0.6	147	173	85.9	14.1	83.8	1.3
SPK004	I	19.6	100	83	52.9	0.6	189	214	80.3	19.7	18.1	2.0
Zapalo	I	19.0	100	87	51.1	0.6	162	173	84.6	15.4	26.0	9.3
Excel	I	18.2	100	80	49.1	0.6	180	154	84.1	15.9	44.9	0.6
MGCL01	I	17.8	100	96	48.1	0.5	170	357	67.6	32.4	52.7	8.3
Chingova	c	16.8	100	89	45.4	0.5	172	154	84.1	15.9	21.8	29.8
Tib4	I	14.3	100	88	38.7	0.4	138	209	73.6	26.4	48.1	9.8
440288	I	14.1	100	91	38.0	0.4	111	316	59.5	40.5	37.5	1.3
Nharinga (local)	b	13.0	100	67	35.0	0.4	144	135	81.7	18.3	39.0	7.2
Saliboro	I	11.3	100	69	30.5	0.4	99	246	61.3	38.7	50.7	8.4
Cordner	I	9.8	100	71	26.4	0.4	123	268	64.0	36.0	22.5	0.5
Costanero	I	8.8	100	89	23.8	0.3	78	389	48.7	51.3	32.3	2.9
420001	I	5.3	100	45	14.4	0.3	38	94	75.0	25.0	19.7	9.8

Root color: b- white I- orange c-crème

Table A3. Adaptive Trial of 16 Sweet Potato Varieties in Malei, Namacurra District (Collaborative Research with SARRNET/INIA)

Province: Zambézia District: Namacurra Administrative Post: Malei Locality: Malei Planting Date: 06-03-04 Harvest Date: 06-08-04

Variety	Root Color	Yield (ton/ha)	% Germination	% of plants harvested	Total Kgs harvested	Kgs per plant harvested	No. of Commercializable Roots	No. of Non-Commercializable roots	% kgs. Commercializable	% kgs. Roots Non-commercializable	% with weevil attack	% with cracking
440287	b	4.6	99	28	12.4	0.14	44	152	45.3	54.7	67.3	1.5
440215	l	4.0	86	83	10.7	0.13	27	183	29.0	71.0	77.6	0.0
MGCL01	l	3.1	82	85	8.3	0.10	15	170	25.5	74.5	83.2	0.0
440293	b	2.8	92	85	7.5	0.09	24	117	28.0	72.0	74.5	2.1
Chingova	l	2.6	86	89	7.0	0.09	22	132	20.0	80.0	63.6	4.5
Cumparule (loc)	b	2.6	90	67	6.9	0.12	13	53	43.3	56.7	63.6	0.0
Excel	l	2.6	78	76	6.9	0.11	19	156	37.7	62.3	58.9	0.0
SPK004	l	2.4	73	86	6.4	0.09	21	137	39.1	60.9	83.5	0.0
Saliboro	l	2.2	90	43	5.8	0.08	17	103	48.3	51.7	74.2	0.0
440288	l	1.8	99	50	4.8	0.05	21	125	33.5	66.5	72.6	0.0
Mozwhite	b	1.8	99	77	4.9	0.06	14	71	54.6	45.4	61.2	0.0
Cordner	l	1.5	62	58	4.1	0.06	6	146	14.6	85.4	76.9	0.0
Costanero	l	1.2	92	65	3.3	0.05	9	62	27.3	72.7	50.7	0.0
420001	l	1.0	38	69	2.7	0.10	8	33	41.9	58.1	46.3	14.6
Tib4	l	1.0	67	88	2.6	0.06	8	49	19.0	81.0	80.7	1.8
Zapalo	l	0.6	93	59	1.7	0.34	1	56	17.6	82.4	47.4	19.2

Root color: b- white l- orange c-crème