Rooting out Hunger in Malawi with Nutritious Orange-fleshed Sweetpotato

Annual Sweetpotato Project Report: Year 1

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ANNUAL SWEETPOTATO PROJECT REPORT

YEAR 1
(1 October 2009–30 September 2010)

Rooting out Hunger in Malawi with Nutritious Orange-fleshed Sweetpotato

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ACKNOWLEDGMENT

We sincerely acknowledge Irish Aid for its support toward promoting the development and dissemination of orange-fleshed sweetpotato in Malawi.

CIP in partnership with relevant Malawian government departments and NGOs instituted a 4.5 year program in October 2009. Without a strong commitment from each partner, this annual report of year 1 would not have been prepared. We appreciate their excellent effort and support to successfully implement the project.

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SUMMARY

Sweetpotato is important for food security and as a cash crop in Malawi. It has the potential to contribute significantly to alleviate hunger as well as to address food and nutrition security in Malawi. Maintaining good calorie intake in Malawi has proved a challenge owing to variable weather conditions, declining soil fertility and landholding size, and high level of poverty and under-nutrition. Pro-vitamin A rich varieties are now available and can be exploited, both for home consumption and sale. One of the orange-fleshed varieties has been officially released in Malawi: *Zondeni*. Massive distribution of vines of improved planting materials underlies the transformation in estimated per capita consumption of sweetpotato.

With its commitment to facilitating effective partnership and providing technical and organizational expertise to build long-term capacity, the International Potato Center (CIP) is poised to coordinate a major food-based intervention to combat vitamin A deficiency (VAD) with orange-fleshed sweetpotato (OFSP) as the key entry point in Malawi. In October 2009, CIP launched the Sweetpotato for Profit and Health Initiative (SPHI), which explicitly seeks to unleash the potential of sweetpotato to address hunger, poverty, and micronutrient malnutrition in Sub-Saharan Africa (SSA) over the next 10 years. CIP invited Irish Aid to be one of the multi-donor supports of the SPHI. This 4.5-year project involves multiple partner organizations focuses on the development of effective delivery systems for OFSP to improve nutrition of vulnerable rural households, testing a delivery system known as "zoom-in, zoom-out." This entails conducting formative research to develop and test with a limited number of groups (*zoom-in*) the demand creation and behavioral change strategy to be used. Key messages were combined into a film and other promotion materials that would be used in the subsequent expansion campaign (*zoom-out*).

The multiple partners included:

- National Agricultural Research Services (NARS): Department of Agriculture Research Services (DARS) of Malawi, Department of Nutrition, HIV and AIDS (Office of the President and Cabinet)
- Nongovernmental organization (NGO) extension services: Concern Universal (CU), Chikwawa-Catholic Development Commission (CADECOM), the Millennium Village Project (MVP), and the Ministry of Agricultural Extension Services (MAES) of Malawi.

In the first year, in-vitro capacity for sweetpotato plantlet production and virus testing facilities were developed, so that a sustainable system of clean, disease-free planting material could be developed. The in-vitro culture activities are ongoing. Demonstration and trial sites have been established in four districts in Central and Southern Malawi: Dedza, Chikwawa, Zomba, and Phalombe.

This report presents the final work of the project implementation of Year 1. In short, a total of 2,186 Malawian were trained in the following areas: 1,994 on OFSP vine multiplication, crop husbandry, and nutritious information about the OFSP; 133 on recordkeeping; 51 on data collection and field research; and 8 on financial management. Thirty demonstration plots were established in Chikwawa and 22 farmers/farmer groups (FGs) from the four project districts participated in the OFSP variety trials with 6 Malawian varieties; two or three were promising varieties. Decentralized

vine multiplications (DVM) of OFSP were set up. Twenty-five farmers/FGs were involved as secondary multipliers at the secondary DVM, and in the tertiary DVM, 108, for a total of 133 FGs in Year 1 project implementation. The DVMs existed in all four districts mentioned above. The total area reserved as OFSP nurseries with irrigation facilities at primary multiplication (Bvumbwe Research Station) and these DVMs, was 7.72 ha. More than 6.9 million vine cuttings of the OFSP planting were potentially available. This figure could serve 23,000 households of each received 4-kg vine cuttings. In Year 1, a total of 7,097 households were subsidized to receive the clean planting materials of OFSP from the multipliers in every DVM. The high demand of planting materials of the OFSP was indicated by many farmers, and many buyers were willing to buy the OFSP planting materials. Thus from the remaining planting materials, multipliers could obtain more revenue as well as serving more Malawian on OFSP.

Two types of voucher systems were tested, one with full subsidy and the other without. The subsidized vine price was taken after considering the government's price, break-even prices, and average prices that farmers could obtain in the free markets. A theatre group was employed as one of the activities of a campaign to create demand and behavioral change strategies. Learning from Year 1 is to provide appropriate knowledge on how to manage the program in the coming years. All project partner organizations are very committed in the implementation of project activities.

1. BACKGROUND AND RATIONALE

1.1 Background

Tropical root and tuber crops fill increasingly important roles in food systems in developing countries. The volume of production and large measures of calories and nutrition per unit area that come from such crops make them attractive to smallholder farmers around the world. Sweetpotato produces far greater amounts of food per unit area per unit time than grain crops (194 MJ/ha/day for sweetpotato vs. 159 for maize or 135 for wheat; Scott et al. 2000). The crop is mostly grown in China (FAO 2009) and it is an important food and feed crop in SSA (Abidin 2004, Ebregt 2007). It fills a food security role (Abidin 2004) and has tremendous potential to contribute to reducing VAD and serve as wheat flour substitute in processed products (Nastel et al. 2006, Low et al. 2007a, b).

In SSA, sweetpotato is among the most dynamic of any crop sector, showing the highest rates of expansion relative to other staple food crops during the past decade (Scott et al. 1999). Sweetpotato is a short maturity, rustic crop that provides reliable yields under a variety of adverse conditions (Abidin et al. 2005, Abidin 2004). There are 3.3 million ha of sweetpotato grown in all sorts of ecologies, from tropical rainforest to semi-arid and arid zones (FAO 2009). The rapid growth of sweetpotato area in SSA is due to a multitude of factors.

1. Sweetpotato has grown in different locales as farmers have changed cropping patterns in response to severe disease outbreaks in cassava and banana, the need for a more drought-tolerant crop than maize, and its ability to still produce on marginal soils compared to other crops.
2. The HIV/AIDS crisis has affected the availability of adult labor in many SSA countries (Lisk 2002, Chaminuka et al. 2006, Arrehag et al. 2010). Sweetpotato, with its flexible planting and harvesting times and lower management requirements compared with grain crops, helps HIV-affected households better manage their food needs.

3. There is growing and increasing recognition of the superior micronutrient content of sweetpotato (Yamakawa and Yoshimoto 2002, Zakir 2005). All varieties of sweetpotato are good sources of B vitamins, and vitamins K, C, and E. In addition, medium- to deep orange-fleshed varieties of sweetpotato are extremely rich sources of beta-carotene, the precursor of vitamin A (Jaarsveld et al. 2006).

Malawi ranks among the world's most densely populated and least developed countries. Although in recent years the gross domestic product has increased (Fisher and Droppelmann 2010), poverty and hunger are still widespread: more than half of children under five are stunted and almost one in five wasted due to malnutrition.

The role of sweetpotatoes is substantial in Malawi as the post-Banda governments have recognized the significant contribution both crops can make to food security, especially in densely populated areas where landholding size is severely constrained. Sweetpotato expanded dramatically in the 1990s due to a massive vine dissemination initiative. Recently, Chipungu et al. (2010) indicated that the sweetpotato is already widely grown and consumed as secondary dietary source of calories.

Most varieties grown in Malawi are white- or yellow-fleshed (Chipungu 2008). With the prevalence of VAD among children under five in Malawi among the highest in SSA (59%) (Government of Malawi 2008), the potential impact of getting beta carotene-rich, OFSP varieties into the diets of rural and urban consumers, especially young children, is enormous. The vitamin A estimated average requirements each day for children and women are 250–500-µg Retinol Activity Equivalents (Nestel et al. 2006). Hence, these authors suggested that it is possible for women and children to consume up to 200- and 400-g OFSP each day, respectively, in order to satisfy the vitamin A requirement.

The time is very appropriate to launch this kind of initiative. First, the national sweetpotato program in Malawi recently released its first OFSP variety, *Zondeni*, in 2008 (Chipungu et al. 2010), and has more OFSP varieties in the pipeline for its release in the beginning of 2011 (Chipungu, personal communication, August 2010). Second, Malawi can build on the very successful introduction of OFSP from its neighbor Mozambique. CIP has been involved in integrated food-based approaches to reducing VAD since 2002 in Mozambique, particularly in Zambézia province, which borders Malawi. Malawian traders have successfully marketed OFSP from Mozambique in Malawi and the MVP has already conducted exchange visits and begun using OFSP in its project. It is quite clear that OFSP will be widely accepted by rural Malawian communities, and there are reports it is fetching a higher price in Malawian markets than white-fleshed sweetpotato. Apparently, the *Zondeni* OFSP variety was easily accepted by farmers and consumers. It seems that *Zondeni* is replacing the missing old OFSP variety *Kamchiputu* in the eyes of Malawians, which used to figure into their diet (Alexander Kalimbira and Agnes Mwangwela, personal communication, July 2010).

With its commitment to facilitating effective partnerships and providing technical and organizational expertise to build long-term capacity, CIP is poised to coordinate a major food-based intervention to combat VAD with OFSP as the key entry point in Malawi (Figure 1).

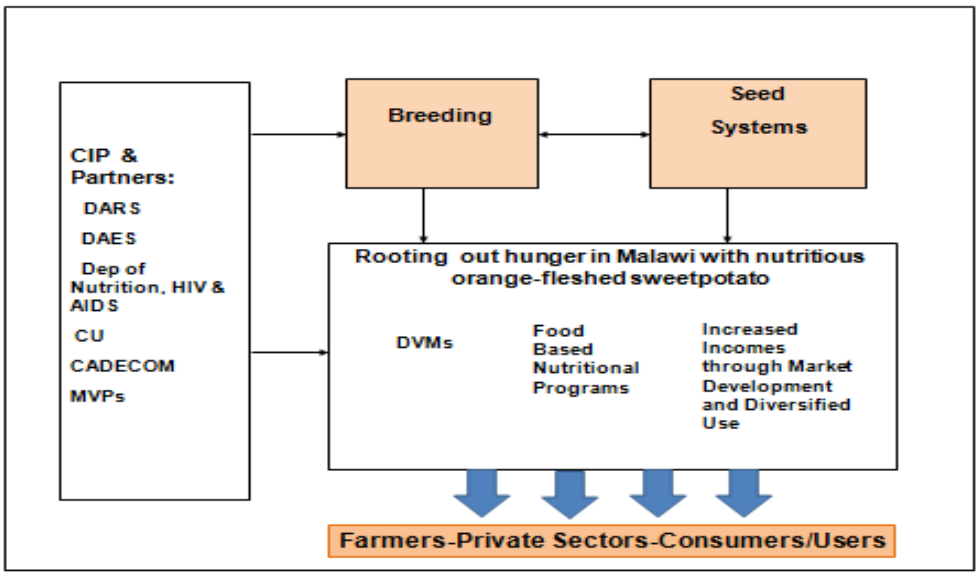

Figure 1. International Potato Center (CIP) is working with partners.

It can also link Malawian scientists and development agents to like-minded programs in other SSA countries with similar programs. In October 2009, CIP launched the SPHI project, which explicitly seeks to unleash the potential of sweetpotato to address hunger, poverty, and micronutrient malnutrition in SSA over the next 10 years. CIP invited Irish Aid to be one of the donors of the project because the objectives of SPHI align beautifully with the priority areas for action announced by the Ireland's Hunger Task force in 2008, as two of the three priority areas of the latter are:

1. To increase agricultural productivity in Africa—with a particular focus on women.
2. To improve maternal and infant undernutrition.

The third Hunger Task Force priority focuses on improving governance and leadership priorities at both national and international levels to ensure that hunger is addressed effectively and sustainably. In terms of leadership, Malawi is ahead of the curve in SSA as its current government has recognized the need to invest in agriculture; especially the need to improve productivity, as over three quarters of its population depends on agriculture for survival. Moreover, the government has explicitly recognized the need to invest in nutrition and the potential synergies by improving links between the nutrition and agriculture sectors. The key nutrition unit is even based in the Office of the President.

Crop diversification is now at the core of Malawi's agriculture policy. Since the 1990s it has earmarked the promotion of cassava and sweetpotato as crops that are more drought tolerant than maize, and hence are key to food security interventions. The government's commitment to improving smallholder access to fertilizers and irrigation facilities means that integrated crop management (ICM) research can be conducted with the expectation that relevant findings will not just sit on the shelf, but have a good probability of being integrated into other, major ongoing agricultural initiatives if conducted in collaboration with farmers.

CIP organized a series of workshops in 2008 to identify key issues to be addressed. Stakeholders at the "Challenge Workshop" held in Ethiopia in July 2008 defined the overall 10-year vision as repositioning sweetpotatoes in African food economies, particularly in expanding urban markets, to reduce child malnutrition and improve smallholder incomes.

A subsequent workshop held in Malawi in October 2008 brought together stakeholders from research, development, and policy arenas to identify priority areas of investment in research for development to achieve that vision in Malawi. Teams developed three concept notes: one focused on use of OFSP to address VAD in young children, one on fresh root marketing, and the third on the development of a value chain for a sweetpotato-processed product. On the basis of this workshop, CIP requested and received funding from Irish Aid to support the first year of work to build the foundation for work focused on the first two ideas: using OFSP to address VAD in young children and fresh root marketing (for improved incomes and accelerated adoption). This support complemented funding already received by the national sweetpotato program from the Alliance for a Green Revolution to support the national breeding program in Malawi and the Southern Africa Root Crops Research Network (funded by the USAID regional office) for value-chain development with the private sector. Moreover, the recently funded SASHA (Sweetpotato Action for Security and Health) project supports population development for drought-resistant OFSP in Mozambique, improved systems for maintenance, and exchange of clean germplasm, and sponsors an annual forum for sweetpotato researchers to share results and experiences. These high-end breeding materials will be supplied to all national programs as potential parents for national-level breeding programs throughout Southern Africa.

Since the focus of this project is to impact the vitamin A intake of vulnerable women and young children, the project has focused on meeting the needs of rural households, their food security, and nutritional well-being.

1.2 Rationale

Sweetpotato is already an important crop for food security in Malawi, in large part due to the government committing itself to diversification away from maize following devastating drought in the early 1990s. Massive distribution of vines of improved materials underlies the transformation in estimated per capita consumption of sweetpotato from 12 kg/capita in 1970 to 88 kg/capita in 2003. Moreover, the Ministry of Agriculture and Food Security of Malawi indicated sweetpotato production estimates of 2,685,878 metric tons in 2009 (Chipungu et al. 2010). However, maintaining good caloric intake in Malawi has proved a challenge due to variable weather conditions, declining soil fertility and landholding size, and high levels of poverty and undernutrition. Sweetpotato has the potential to contribute much more to alleviate hunger and address simultaneous address food and nutrition security in Malawi. Pro-vitamin A rich varieties are now available and can be exploited, both for home consumption and sale. Good foods and better health services can be purchased, and raising incomes through improving household incomes either through increased sales of roots or building value chains for new, sweetpotato-based processed products has true potential in this densely populated, landlocked country. Emerging market opportunities would drive the need for improving productivity of the crop, so rural households can meet their domestic needs *and* have surplus to sell. With the Malawian government's commitment to improve smallholder access to small-scale irrigation and affordable inputs (Government of Malawi 2006), policy conditions are favorable for investments in

productivity-enhancing research that will have considerable pay-off. Combined, these interventions will truly unleash the potential of sweetpotato to reduce hunger and undernutrition among rural households and diversify and improve the diet quality of urban households.

1.3 Combating Vitamin A Deficiency in Malawi

During the past five years, further evidence has been obtained regarding the potential impact of OFSP on the vitamin A status of young children. A South African study (Jaarsveld et al. 2005) demonstrated that OFSP is bio-available and efficacious in improving vitamin A status in children. Significant improvements in vitamin A intake and serum retinol concentrations (a proxy for vitamin A status) were obtained from an action-research study (Low et al. 2007a) of an OFSP-based integrated agriculture-nutrition-market intervention in a very resource-poor setting in Central Mozambique. The latter study emphasized the importance of having all three components (agriculture, nutrition, and market interventions) to ensure improvement in intakes of vitamin A in young children and sustained adoption of the new material (Figure 2). The intervention approach is thoroughly described in Low et al. (2007b). A third study (Haskell et al. 2004) using the isotopic tracer deuterated retinol to estimate total vitamin A stores in 14 Bangladeshi men determined a conversion factor of 13:1 for OFSP when it was cooked and pureed with a small amount of oil.

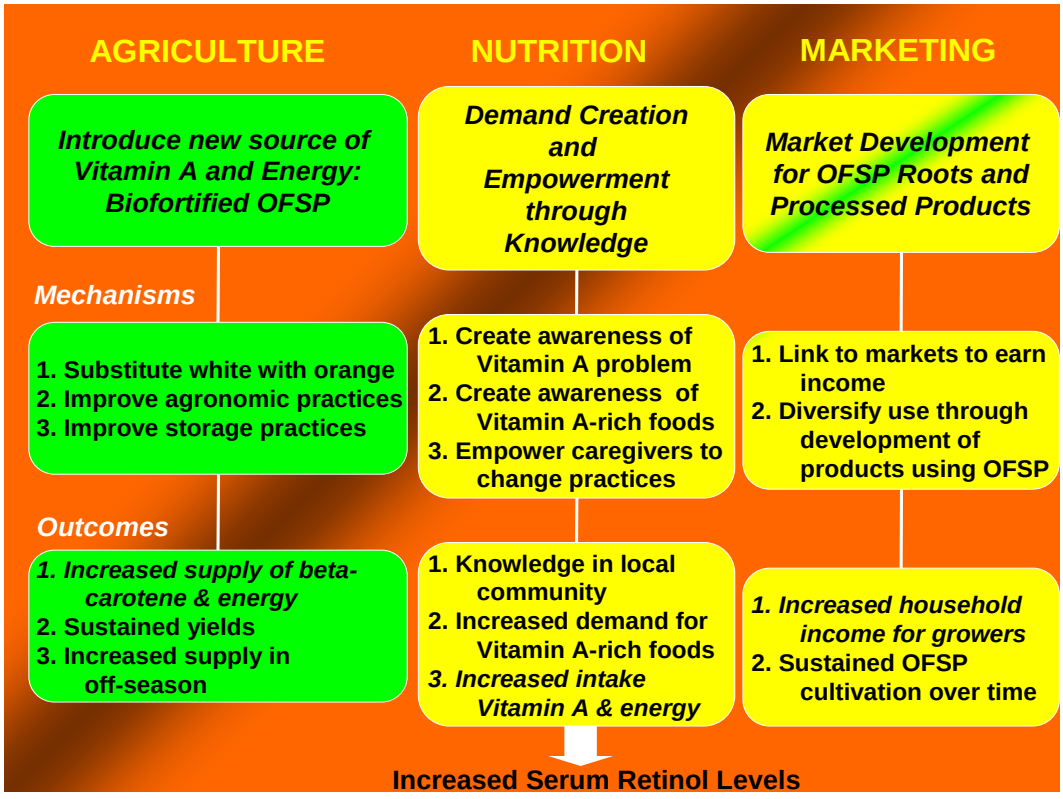

Figure 2. Conceptual framework for an integrated, OFSP-led food-based approach.

OFSP as a staple food has an advantage over most vegetables in that it can supply significant amounts of vitamin A *and* energy simultaneously—thus helping to address both VAD and undernutrition. OFSP is an example of a biofortified crop in which the micronutrient status of staple foods is enhanced through plant breeding to the point where impact on micronutrient status can be achieved (Bouis 2002, Nestel et al. 2006). Since the poorest households typically obtained over

60% of their energy needs from food staples, this strategy is particularly suited to poor rural households that cannot access purchased fortified food products but could grow OFSP.

Malawi has one of the highest rates of chronic and VAD child undernutrition in the world, as 57% of those under five are stunted and 59% vitamin A deficient (Chipungu et al. 2010). Moreover, a majority of rural households are food insecure for at least four months of the year. Both government policy and donor support to agriculture in Malawi focuses on improving food security from the national to the household level. For many donors and NGOs, this strategy is being implemented through food security projects. These take the form of crop diversification, introduction of improved production technologies, smallholder irrigation, and improved access to markets. There is, however, often little targeted focus on improving household nutrition, particularly the nutrition of vulnerable groups (i.e., pregnant and lactating women and children under five). Principal nutritional deficiencies include insufficient carbohydrate sources and micronutrient deficiencies, particularly vitamin A and zinc—with a particular note that zinc is also a principal limiting nutrient in young children's growth. Food-based approaches to improving nutritional deficiencies are especially justified in Malawi and the introduction of OFSP has particular potential for improving nutritional status of vulnerable groups. Early interest was seen by the MVP in Southern Malawi. It participated in exchange visits with ongoing OFSP work in Zambézia Mozambique in 2008 and then began working with Bvumbwe Research Station on the introduction of the integrated agriculture-nutrition model in Zomba District.

There were several key lessons learned from the Mozambique experience that could guide the design of the intervention in Malawi. First, in drought-prone areas, the key limiting factor was having adequate amounts of quality planting material at the beginning of the rains. Second, the use of trained DVMs lowers the cost of provision of materials to communities and using vouchers for first-time distribution was an effective method. Third, awareness of the nutritional qualities of OFSP could be significantly raised in just one season through effective demand creation campaigns. Fourth, actual behavioral change in child-feeding practices was more difficult, and it paid to invest in culturally specific, formative research in new target areas. Fifth, farmers did respond to improved market opportunities by expanding area under production and adopting practices to enhance root quality. Fresh storage techniques were not widely practiced in most settings and needed to be included in any extension program.

There were also several major differences with Central Mozambique that should make the uptake and use of Malawi much faster than in Mozambique. First, population density was much higher (139 persons/km^2 in 2008 in Malawi vs. 26 in Mozambique), which means the cost of service delivery was lower and informal farmer distribution rates (4.2 indirect beneficiaries/direct beneficiary in Mozambique) were likely to be higher (at least 10 indirect per direct beneficiary—similar to rates measured in East Africa). Second, sweetpotato was much more widely grown in central and southern Malawi than in Mozambique. Third, female literacy rates were much higher in Malawi (49.8%) than in Mozambique (32.7%) (World Nations 2006; http://www.mrdowling.com/800literacyfemale.html). Fourth, health, road, and market infrastructure and services were much denser and more developed in Malawi than in Mozambique. Fifth, trust and community coherence were much higher in Malawi than in Mozambique as the latter suffered from a devastating 17-year civil war, which severely damaged social relations, subsequently impeding the emergence of cohesive community-level organizations.

The proposed 4.5-year project focused on the development of effective delivery systems for OFSP to improve nutrition of vulnerable rural households, testing a delivery system known as "zoom-in, zoom-out." This entails conducting formative research to develop and test with a limited number of groups (*zoom-in*) the demand creation and behavioral change strategy to be used. Key messages were combined into a film and other promotion materials that would be used in the subsequent expansion campaign (*zoom-out*). Media efforts in Years 2–4 would focus on radio, showing of videos using existing public sector mobile vans that would show movies at night in the villages, and promotions at markets and other public settings.

1.4 Implementing Partners

The implementing partners are CIP, NARS (i.e., DARS of Malawi, Department of Nutrition, HIV and AIDS: Office of the President and Cabinet), NGO extension services (CU, CADECOM, MVPs), and MAES.

1.4.1 The International Potato Centre

CIP has the worldwide mandate for the collection and maintenance of germplasm and development of the potato and sweetpotato crops. CIP seeks to reduce poverty and achieve food security on a sustained basis in developing countries through scientific research and related activities on potato and sweetpotato. CIP has an active program in SSA, with regional office in Nairobi. It has a wide experience in collaborative research and development activities with the NARS and extension systems in SSA. Since January 2006, CIP has operated in Southern Africa from its two offices in Lilongwe, Malawi, and in Maputo, Mozambique. That same year, CIP, in collaboration with the Malawian national research services, initiated potato activities in the domains of seed systems improvement, germplasm introduction and evaluation, and capacity building. Since 2007, Irish Aid has supported the expansion of this work in partnership with Universal Industries and CU.

1.4.2 The National Agricultural Research Services of the Malawian Ministry of Agriculture

NARS has a mission to conduct research and development activities in order to contribute to the improvement of agricultural production in Malawi. NARS possesses sweetpotato research unit at the Bvumbwe Research Station, and has one PhD-level breeder responsible for on-station and on-farm varietal development. Some facilities (such as a modest tissue culture lab, screen/glass houses, land, and a pathology lab space with scientists) exist in Bvumbwe to support sweetpotato research and development, and funding from the Alliance for a Green Revolution has been recently received to support the sweetpotato breeding program and pre-basic seed production for three years. Chitedze Research Station has capacity to undertake ICM research.

1.4.3 Ministry of Agriculture Extension Services

The Malawi Poverty Reduction Strategy has a clear commitment to rebuilding the effectiveness of agricultural extension services. Creating capacity within the national extension service is an essential component of the exit strategy to ensure that sweetpotato technologies continue to be promoted beyond the life of the project. The extension services can draw on mobile vans and prior experience with community mobilization to support promotion campaigns in addition to crop production and marketing advice.

1.4.4 Department of Nutrition, HIV, and AIDS (Office of the President and Cabinet)

This department plays a key role in advocacy for interventions that improve and monitor the nutritional status of women and young children and households affected by AIDS. They are involved in producing and disseminating training materials concerning nutrition and encouraging public sector extension and NGOs to integrate nutritional concerns into their existing programs.

1.4.5 Collaboration with NGO extension services

The project is to be executed in collaboration with CU, Chikwawa-CADECOM, and the MVPs in Southern Malawi in the first year, potentially expanding to other NGOs. NGOs will co-share costs of implementation. Their experience in technology dissemination and in farmers' organization will be very useful for a successful implementation of the project at farmers' level. NGOs linked to value chains will facilitate fora between traders and farmers, and emphasize farming as a business. A brief description of each NGO partner in Phase I is provided below:

- **CU** has been implementing various development projects in Malawi since the early 1980s. Priority areas are (1) food security and sustainable livelihoods; (2) water and environmental sanitation; (3) emergency, relief, and rehabilitation; and (4) microfinance. Currently it operates in Dedza, Ntcheu, Balaka, and Phalombe districts. A major focus of their food security strategy is crop diversification in terms of production, utilization, and consumption. Sweetpotato is already being promoted, and diversified products with both roots and leaves developed with farmers, especially women, for their nutritional benefits. Because CU is currently involved in the development of smallholder irrigation schemes, it can be a valuable partner in year-round vine multiplication and root production.
- **MVPs**. This is an integrated project working with existing government structures and all development partners in Zomba (South) and Mchinji (Central) districts. In Zomba, the area proposed for this project, they currently work with 7,000 households clustered into 7 MVPs (approximately 35,000 people). In each cluster, there is a research village where every concept is tested for adoption before being scaled up in remaining villages. After learning of the OFSP project in neighboring Mozambique, MVP management arranged for a team of 20 farmers to go on an exchange visit. This resulted in initiating demonstration trials and processing of OFSP activities in one MVP research village in 2008. The initial work has been well received, and plans are now in place to scale into the other clusters. Demand for planting material is extremely high, and the one MVP multiplication site was unable to meet that demand. The MVP has much to contribute to other partners on nutrition promotion and sweetpotato product development and will benefit from backstopping and further training on vine multiplication and crop management.
- **Chikwawa-CADECOM**. CADECOM focuses on organizing farmers initially into clubs, then facilitating their evolution into cooperatives. Their ultimate objective is to empower the cooperative members to be able to conduct market surveys and develop profitable value chains. The organization is currently implementing four projects in the areas of food security, access to markets, and relief programs to mitigate the negative effects of the floods. Their access to irrigation during the dry season means that they can significantly contribute as root suppliers to the surrounding community, the Blantyre market, and to Universal Industries during the "off-season." This is particularly profitable to farmers as sweetpotato prices are highest during this time. They will also contribute in dry season vine multiplication.

1.5 Goal and Objectives

The overall objective of the 4.5-year project was to improve vitamin A and energy intake for at least 115,000 rural households with women and young children using OFSP-based approaches, ensured that at least 20% of households growing OFSP earned at least US $40 per year from OFSP sales, and increased average sweetpotato yields 50%.

Specific objectives by the end of the project include:

1. Improved vitamin A intake for rural vulnerable groups in Central and Southern Malawi through effective establishment of DVMs and a media-based demand creation campaign.
2. Increased effective demand by changing the perception of sweetpotato and developed fresh root marketing chains for OFSP in the Blantyre market and reduced the fluctuations in overall sweetpotato supply to the fresh market.
3. Increased the productivity and quality of sweetpotato in intensifying farming systems to ensure surplus production for sale and decreased the length of the hunger season.
4. Increased the capacity of DARS to produce clean tissue culture sweetpotato plantlets, maintained primary multiplication sites, and designed and conducted seed systems and integrated crop management research.

In Year 1, specific objectives included:

1. Established in-vitro tissue culture capacity at Bvumbwe Research Station and successful production of at least 1.5 ha of clean primary material of Zondeni, an OFSP variety.
2. Evaluated which OFSP varieties perform and taste best to local producers and consumers in Dedza, Zomba, Phalombe, and Chikwawa districts.
3. Identified and established at least 10 decentralized vine producers and tested the use of vouchers as a distribution mechanism, reaching 1,000 households.
4. Results from formative research to design the demand creation campaign to accompany OFSP dissemination in subsequent years and understanding the existing sweetpotato fresh root marketing chains in Central and Southern Malawi.

1.6 Target Groups

The principal target groups were poor, rural women and their young children (6 months–5 years of age) in sweetpotato-producing areas. However, attention was also paid to working with men to ensure that they understood the importance of investing in nutritionally rich foods and good care-giving practices as they influence what decisions were made and how well decisions were implemented. A secondary target group was urban consumers, many of whom relied on purchased foods. Slums in major Malawian cities and their associated peri-urban areas were expanding and poor urban women and children would particularly benefit from a nutrient-rich root. Understanding the breadth of preferences among high- and low-income consumers concerning fresh roots would enable farmers to better target their variety selection and marketing strategies to specific areas and target groups and, by doing so, obtained more revenue from sweetpotato sales.

Figure 3. The principal target groups of the project comprised poor, rural women and their young children in sweetpotato-producing areas.

1.7 Financial and Technical Contribution from Partners

1.7.1 Contribution from CIP

CIP provided the technical backstopping, overall coordination, and financial management on all aspects of the project, including:

- Coordination of partners, accounting services, and capacity strengthening
- Services of scientists: sweetpotato specialist (full-time), backstopping in impact assessment (behavioral change/nutrition/partnership)
- Research to improve OFSP impact, sweetpotato productivity and utilization, market feasibility studies, and training of trainers in collaboration with DARS
- Provided sweetpotato populations for national breeding program
- Test kits for virus detection
- Preparation of technical and financial reports.

1.7.2 Contribution from DARS

The Government of Malawi will provide through its national research program:

- A sweetpotato breeder, Felistus Chipungu, who was the principal counterpart of CIP's scientist
- Access to tissue culture facilities for maintaining clean germplasm
- Land for primary multiplication of material
- An ICM specialist, Moses Munthali, who conducted research to improve root productivity and sustainability of vine multiplication systems
- At least two research officers who contributed in ensuring quality of primary and secondary and monitoring
- At least two technicians to assist in field trials
- At least two technicians to be trained in tissue culture and germplasm maintenance.

1.7.3 Contribution from the public sector and NGO extension services

The Ministry of Agriculture permitted public sector extension agents in sweetpotato-growing sites to be trained in improved agronomic practices and helped identify and train seed multipliers. NGOs already involved in or intending to engage in sweetpotato production, nutrition education, and/or marketing activities provided extension personnel to be trained by project personnel, and provided

subsequent logistical support to enable agents to implement what they were taught. The Department of Nutrition, HIV, and AIDS helped the behavior change expert design the nutrition component and organized seminars and other media events to promote food-based approaches utilizing OFSP.

1.8 Timeline for Implementing Year 1 Project Activities

Table 1 presents the timeline for implementing the project activities of Year 1. The achievement for Year 1 is also discussed in this report.

Table 1. Timeline for Implementing Year 1 Project Activities and Achievements

Objective	2009				2010								Achievement
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
1.1 Rehabilitate the tissue culture lab at Bvumbwe	■	■											Lab is functional
1.2 Clean-up 10 Malawian sweetpotato varieties (viruses eliminated) at the Plant Quarantine Center in Kenya	■	■											Done
1.3 Train 2 DARS technicians and 1 project technician in in-vitro multiplication and virus testing		■	■										Done
1.4 Obtain 3,000 in-vitro plantlets of Zondeni from GTIL (private sector tissue culture lab in Kenya)							■						Obtained in phases: 23 plantlets in July and 1,000 by end of Sep., etc.
1.5 Build screen house at Bvumbwe Research Station		■	■										Almost ready
1.6 Train 2 DARS technicians and 1 project technician in how to harden plantlets and rapidly multiply sweetpotato						■	■						As soon as the screen house is functioning
1.7 Establish at least 1.5 ha under irrigation with primary multiplication by the end of Year 1 (Zondeni and other)							■	■	■	■	■	■	2 ha have been established and another 2 ha of land have been established
2.1 Train extension personnel in sweetpotato in site selection, conducting demonstration trials and conducting consumer assessments		■											Done in Jan 10 and consumer assessment in July 10
2.2 Conduct at least 30 demonstration trials in Year 1: 10 in Chikwawa, 10 in Phalombe, 5 in Dedza, 5 in Zomba			■	■	■	■	■	■	■	■	■		Done

Objective	2009				2010								Achievement
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
2.3 Evaluate data and select material for each intervention area										■			Data collected
3.1 Agree on criteria for selecting DVMs and appropriate type of water supply	■												Done-Irrigation system
3.2 Identify and establish at least 10 DVMs (secondary multiplication sites) in partnership with NGOs and public sector extension			■	■									Done in Dedza, Phalombe, Chikwawa, and Zomba districts
3.3 Design vouchers and conduct rapid assessment of existing vine prices and demand to establish voucher value	■	■	■										Done
3.4 Train vine multipliers in quality vine multiplication and use of vouchers				■	■								Done and using voucher in Oct.
3.5 Coordinate distribution of materials by partners to 1,000, ensuring quality control and accurate recording of recipient							■	■					In progress, beneficiaries have been selected
3.6 Assess Year 1 distribution using vouchers and decide on strategy for Year 2 (number of DVMs; continued use of vouchers)										■	■		Will be done in Nov. after disseminating the vine cuttings
4.1 Conduct formative research to understand current child feeding and dietary practices and develop demand creation messages					■	■	■	■					In progress
4.2 Conduct diagnostic market survey, including an assessment of the fresh root supply chain							■	■	■	■			In progress
4.3 Conduct baseline survey in selected pilot areas to understand demographic characteristics of household, current role of sweetpotato, and dietary practices					■	■	■						In progress

2. OUTPUT AND PERFORMANCE INDICATORS OF THE INTERVENTION: PROJECT IMPLEMENTATION IN YEAR 1 (1 OCTOBER 2009–30 SEPTEMBER 2010)

2.1 Building-up Sweetpotato Seed Systems: a "1–2–3" Scheme

2.1.1 In-vitro culture at Bvumbwe Research Station

In-vitro capacity for sweetpotato plantlet production and virus-testing facilities was established so that a sustainable system of clean, disease-free planting material could be developed. Multiplication in vitro of virus-free material was initiated at the Plant Quarantine Center in Kenya while the tissue culture lab at the station at Bvumbwe was rehabilitated. Ten varieties were sent to Nairobi for virus indexing. Four disease-free in-vitro OFSP plantlets have been brought back to Malawi on 9 July 2010: Resisto, Jewel, Cordiner, and Zondeni (Table 2). Over time, we were able to multiply these clean planting materials at Bvumbwe Research Station to provide farmers and research activities with clean planting materials.

Table 2. Number of Clean OFSP Plantlets Received from Nairobi on 9 July 2010 and Maintained at Bvumbwe Research Station

Variety	No. of Plantlets Received	No. of Plantlets Started Shooting	No. of Plantlets Ready to Be Transplanted	Total of Plantlets to Date at Bvumbwe Research Station
Resisto	120	365	224	589
Jewel	120	0	120	120
Cordiner	120	0	82	82
Zondeni	58	0	58	58
Total	**418**	**365**	**484**	**849**

We planned to have 5,000 plantlets of the virus-free planting materials of Zondeni OFSP from Nairobi in July 2010. However, the private and public sector in Nairobi helping us multiply this variety had a problem during culturing the Zondeni explants in vitro. The roots of Zondeni plantlets did not develop well in their medium, and research was done to find a proper medium for Zondeni. The work was in progress, and we expect to receive 1,000 Zondeni plantlets by end of September (Fig. 4).

(A) ***(B)***

*Figure 4. Clean Zondeni plantlets in vitro culture **(A)** and the chambers for screening the sweetpotato virus diseases at the private sector in Nairobi **(B)** (March 2010).*

Resisto, Jewel, and Cordiner will be used by DARS (Dr. Chipungu, sweetpotato breeder) for plant population in the breeding program. Zondeni was used as sweetpotato planting materials in the "1–2–3" multiplication scheme and for storage root production by selected beneficiaries. The vine cuttings would be planted in the onset of rainy season, in November 2010.

The overgrown plantlets of Resisto were received from Nairobi. Nevertheless, we succeeded multiplying them in vitro. The number of this variety was increased (Table 2). Others were very small when we received them—they just started to shoot up. However, we maintained them in vitro and they remained healthy. One container with 24 plantlets of Cordiner was discarded because of contamination with fungi when we received it from Nairobi. Two days later, another container with 24 plantlets was also contaminated with fungi; however, we kept 20 plantlets out of it healthy. Together with 72 other clean Cordiner plantlets, a total of 82 plantlets were available at the lab.

Plantlets were conserved and stored at lower incubation temperature, 5°–20˚C. They were periodically checked and we maintained them in vitro. The new-growth plantlets were incubated at 25°–30˚C (Ng and Ng 1991) (Fig. 5). In this way, we needed at least two rooms for sweetpotato in-vitro culture. Hardening process was needed by plantlets cultured in vitro before planting them in the field, for multiplication and storage production. This activity should be done in the new screen house at Bvumbwe Research Station (Fig. 6).

Beginning in Year 2, this clean material would be multiplied in the screen house in Bvumbwe. By Year 3, we expect that cuttings from this disease-free material will be the core material serving the entire program. Implementation strategies will include the coordination of the provision and testing of new varieties, the cleaning up (through thermotherapy) of popular farmers' and improved varieties, the development of vine supply systems, improvement in home preparation of sweetpotatoes, and provision of nutritional information on child feeding.

Figure 5. Tissue culture at Bvumbwe Laboratory, Malawi.

Figure 6. Screen house at Bvumbwe Research Station is in a progress and will be ready soon for hardening the tissue culture plantlets from the laboratory at Bvumbwe Station.

2.1.2 Primary Multiplication

Figure 7. Primary multiplication at Bvumbwe Research Station.

At Bvumbwe Research Station, 2 ha of land were used for a primary multiplication of OFSP Zondeni (Fig. 7). A rapid multiplication method with irrigation was practiced. This primary multiplication provided clean planting materials needed by the secondary or tertiary multipliers. For instance, in August, Bvumbwe Research Station has supplied the healthy vine cuttings to tertiary multipliers as many as 400 50-kg bags. These were 288,000 vine cuttings 30 cm long. The tertiary multipliers were in Dedza District managed by CU. Moreover, we also extended the multiplication area for another 2 ha of land. They were already planted in this new field. In total, 4 ha of Zondeni are ready for Year 2 project activities (1 October 2010–30 September 2011).

Other accomplishments and planned activities:

- CIP has backstopped the activities of DARS to strengthen and build the capacity of Bvumbwe Research Station in producing clean OFSP planting materials as primary multiplication.
- Training and transferring knowledge and technology to Malawian partners in tissue culture activities both at the laboratory and screen house.
- Serving enough clean planting materials for farmers in the onset of rainy season in November, and also providing planting materials for research activities.

2.2 Decentralized Vine Multiplication Scheme

The seed system strategy identified and trained *decentralized vine producers*. These are sweetpotato producers interested in engaging in both vine and root production and who have the conditions (access to water for irrigation) for sustaining vine production during dry periods. Each decentralized vine producer could serve a 12–15-km radius. The focus in Malawi on irrigation had particular advantages in ensuring timely production of vines and in extending the supply of roots to the market throughout the year. For example, efforts in irrigated sweetpotato production by

Chikwawa-CADECOM and public sector extension in the Shire Valley means that an "off-season" crop is produced, reducing hunger during the dry season.

During the dry season, additional tertiary multipliers were identified that had access to irrigation. These multipliers were trained by the already established secondary multipliers. Approximately 40% of the trained secondary multipliers were women, and 46% of the tertiary multipliers. This addition enabled at least 7,097 direct beneficiary households to each receive 4 kg of vines (300 cuttings 30 cm long) during the next major rainy season, due to begin in November 2010 (Fig. 8). The criteria of selecting the secondary and tertiary DVMs can be read in Appendix 1.

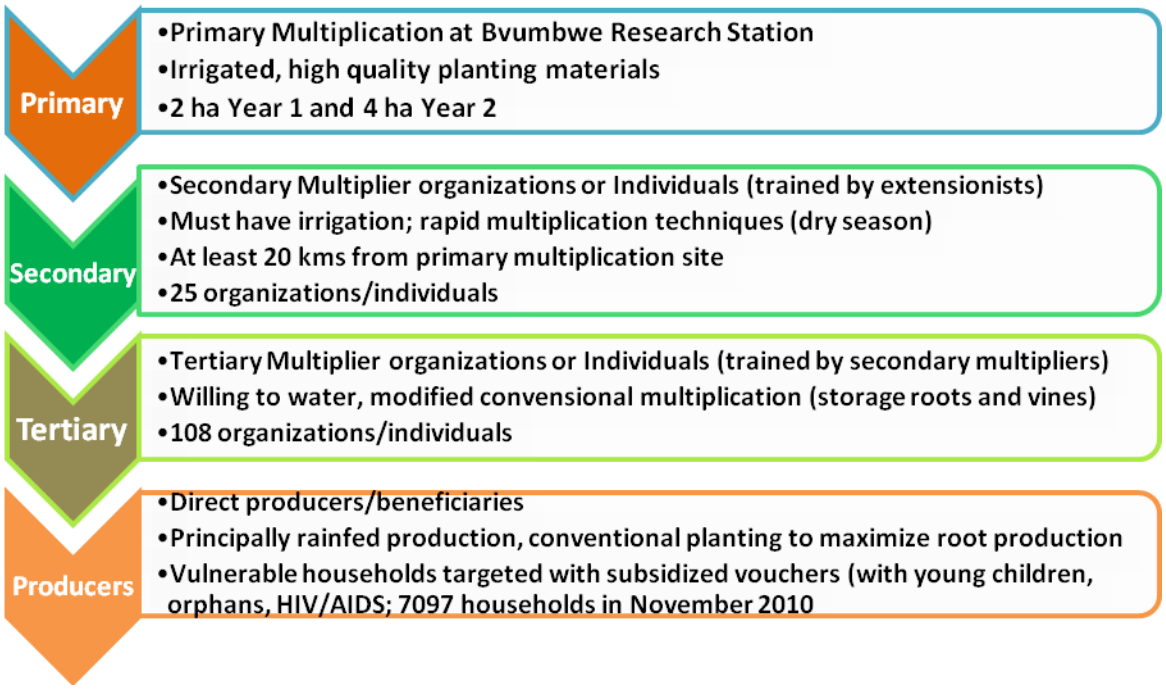

Figure 8. Sweetpotato multiplication scheme: learnt from Year 1.

In the secondary multiplication, farmers applied the rapid multiplication method, 2 or 3 nodes vine cuttings were planted in a plot with planting distance of 10 x 20 cm apart (Fig. 9). In the tertiary multiplication, a modified conventional multiplication method was used, 30 cm length of vine cuttings were planted in ridges, planting distance within plants was 15 cm and between ridges 75 or 90 cm (Fig. 10). The criteria of selecting the vine multipliers at each district managed by the NGOs can be read in Appendix 1.

Figure 9. Secondary multiplication in Zomba and Chikwawa.

Figure 10. Tertiary multiplication in Chikwawa and Dedza.

Table 3 provides detailed information on each DVM and number of beneficiaries. Table 4 shows the number of multiplier organizations/groups involved and the number of beneficiaries based on their gender. Gender issue was very important in this project. When they selected the vine multipliers, all partners (CU, MVPs, and CADECOM) tried to balance the gender numbers. Not all partners reported detailed numbers on the membership of each multiplier organization.

Table 3. Availability of Land and Planting Materials Ready at the Onset of Rainy Season in November 2010 at the DVMs

Partner	Primary Multiplication		Secondary Multiplication		Tertiary Multiplication		Total			Beneficiaries	
	Area (m^2)	No. Plant	Area (m^2)	No. Plant	Area (m^2)	No. Plant	Area (m^2)	No. Plant	No. Vine Cutting Expected†	Potential No.	No. Registered
Bvumbwe Station*	20,000	2,000,000	—	—	—	—	20,000	2,000,000	4,000,000	13,300	backstop
CU-Dedza	—	—	940	47,000	33,100	294,222	34,040	341,222	682,444	2,274	2,000
MVPs-Zomba	—	—	1,144	57,200	7,400	370,000	8,544	427,200	854,400	2,848	2,450
CU-Phalombe	—	—	1,090	54,500	7,000	350,000	8,090	404,500	809,000	2,696	620
CADECOM-Chikwawa	—	—	875	43,750	5,600	280,000	6,475	323,750	647,500	2,158	2,027
TOTAL	20,000	2,000,000	4,049	202,450	53,100	1,294,222	77,149	3,496,672	6,993,344	23,311	7,097

*Another 2 ha of land has been established, so currently there are 4 ha of land for Zondeni rapid multiplication.

† More vine cuttings could be expected because each multiplication scheme could provide at least twice of the number of vine cuttings 30 cm long. The length of one stem of Zondeni was more than 60 cm.

Table 4. DVM and Number of Beneficiaries at Each District and Managed by CU, MVPs, and CADECOM in Year 1 (1 October 2009–30 September 2010)

District	Secondary Multiplication*	Tertiary Multiplication†	Beneficiaries		
			Female	Male	Total
CU-Dedza	9	8	1,420	580	2,000
MVPs-Zomba	7	37	1,395	1,055	2,450
CU-Phalombe	4	35	197	423	620
Cadecom-Chikwawa	5	28	752	1,275	2,027
TOTAL	**25**	**108**	**3,562**	**2,508**	**7,097**

*Dedza: 90 females and 98 males; Zomba: 66 females and 58 males.

†Dedza: 576 females and 616 males; Phalombe: 13 females and 4 males; Zomba: 19 females and 37 males.

Number of beneficiaries will receive the voucher from the project is 7,097 households. Each household will receive 4 kg (300 cuttings) of OFSP planting materials in November 2010. These beneficiaries will be subsidized by the project. After a number of informal trainings on the OFSP were done, the demand for the OFSP planting materials was high. The vine multipliers who had more planting materials could sell them in a free market (see market assessment, also in this paper).

2.3 Training for Vine Multipliers

In January 2010, extension staff members of partner organizations were trained by CIP and 10 secondary vine multiplication sites were established for Zondeni from positively selected material at Bvumbwe Research Station. These were expanded to 25 trained secondary multipliers and 108 tertiary multipliers by the dry season of 2010. All of the partner organization (CADECOM, CU, MVP) opted to work with farmer organizations as the unit of multiplication instead of single individuals in large part because these organizations had access to irrigated land, a major selection criterion for being considered for training as skilled multipliers (Figure 11).

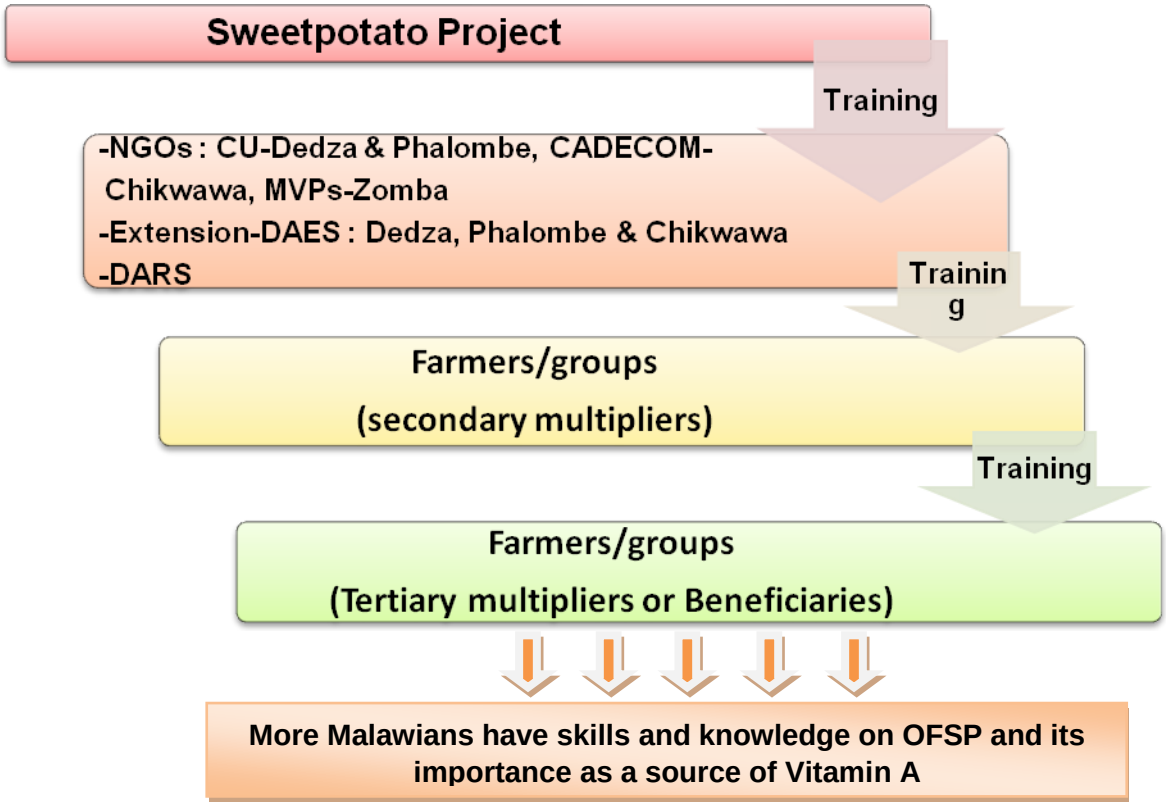

Figure 11. Training of the trainers involved in the Zondeni multiplication scheme.

The way forward

A total of 2,186 individuals and/or organizations have been trained. The topics included were OFSP multiplication techniques, crop management, and the importance of vitamin A in the OFSP varieties. Next, another group to be trained in October would be the beneficiaries, bringing the total number to 7,097.

2.3.1 The impact of the training

A significant impact from the first training in January 2010 was the diffusion of technology on sweetpotato management. After the training, all partners (CU, CADECOM, MVPs, DARS, and DAES) immediately took some action by conducting a series of trainings, first training the extension and field staff who worked directly with farmers/vine multipliers. Furthermore, these trained farmers also trained another group of farmers and so on. They could be a tertiary multiplier and/or producers/beneficiaries (Fig. 10). This type of training was mostly informal and took place in a farmers' field, during harvests, at demonstration sites and field days. It is notably effective. The OFSP crop management, vine multiplication integrated with the irrigation scheme (Fig. 12), selecting the healthy vines, data collection, nutrition—the importance of vitamin A in their meals, and food diversification in daily diets were included in the trainings (Figs. 13 and 14). Hence this knowledge was transferred to Malawians both farmers and sweetpotato producers (Fig. 11).

Figure 12. Irrigation scheme and OFSP multiplication, the Zondeni planting materials just planted at tertiary multipliers, Dedza District, August 3, 2010 (visit of Irish press officer and Irish Aid team).

Figure 13. Food diversification training of various sweetpotato recipes, Zomba District.

Figure 14. Trainings on various local recipes and income-generating program, Dedza District.

From a number of field visits, we observed that the trained farmers had good knowledge of OFSP and were willing and able to teach other farmers/producers. This experience could be serve as a strategy in the sweetpotato seed systems. Another significant impact from the trainings was people's awareness of existing OFSP varieties (e.g., Zondeni). The dissemination of OFSP at the onset of the November rainy season could then be easily done. We can expect that farmers might inform other farmers (farmers-to-farmers) and would encourage them to grow the OFSP at their homes. Moreover, they consciously included the OFSP in their daily meals for food diversification. Farmers were eager to get the vine cuttings of OFSP and plant them at home, every time when visiting the open fields (Figure 18a). Another indicator was the demand for OFSP planting materials. It was significantly high, so the sweetpotato increasingly became a cash crop in Malawi. As a result, for example, one of the secondary multipliers in Dedza District wanted to sell the vine cuttings for as much as Mk 1,500 (US $10) per 50-kg bag (equal to ± 9 kg of Zondeni vine cuttings 30 cm long). It was reported in Phalombe and Chikwawa districts that farmers could sell the vine cuttings for Mk 400–600 per bag.

2.3.2 Training and supervision by CIP and partners

A number of trainings organized and backstopped by CIP were also done. A sweetpotato virologist from Lima, Peru, was invited to Malawi to train Malawian scientists and technical staff on sweetpotato virus detection course at Bvumbwe Research Station. The topics covered were (1) general introduction to sweetpotato viruses, their detection, and control (theory); (2) symptoms induced by viruses in sweetpotato (theory); and (3) testing sweet potato viruses using NCM-ELISA test (practical). Twenty-one people participated in the training in May 2010.

In June 2010, CIP has backstopped training for the Malawian technical staff on sweetpotato data collection. This training was organized by DARS and held at Bvumbwe Research Station. Number of participants was 30 (Fig. 16).

Figure 15. Training for NGOs and extension for sweetpotato multiplication and crop management at Bvumbwe Research Station in January 2010.

Supervision and monitoring were done by CIP staff as their routine work (Fig. 17). Also, the CIP-Malawi accountant recently visited the offices of CU (Dedza and Phalombe), CADECOM, and MVPs. He oversaw the partners' accountants in financial management, accountability, and the handling of receipts before their submittal to project management for liquidation. Recordkeeping would be

introduced to farmers/vine multipliers before disseminating the OFSP to beneficiaries in November. This action should be done in October 2010.

Figure 16. Malawian field assistant training on data collection and analysis organized by DARS and backstopped by CIP.

Figure 17. Supervision by CIP at Chikwawa-CADECOM and DAES/CU-Dedza in July 10.

2.4 Demonstration Sites, On-farm trials and Field Days

Concurrently, demonstration sites and on-farm trials established in four districts in Malawi (Dedza, Zomba, Phalombe, and Chikwawa) were enabling consumers and producers at the community level to assess Zondeni and other OFSP materials for performance and taste against their own predominant local varieties. At the harvest days on each demonstration and on-farm trials, a field day was also set up. On the field day, research and extension services addressed farmers on sweetpotato issues, such as OFSP crop husbandry/management, vine multiplication, nutrition information on OFSP related to combating VAD for children, vulnerable women, and Malawian men and women in general (Table 5).

Table 5. Field Days

Date	Site	Organized by	No. of Attendants		
			Female	Male	Total
27 Mar 10	Bvumbwe Station	DARS	70	50	120
29 & 30 June 10	Dedza	CU and DAES	117	67	184
1 Jul 10	Phalombe	CU and DAES	14	26	40
9 Jul 10	Zomba	MVPs and DAES	37	21	58
3 Aug 10	Chikwawa	Cadecom	73	80	153
Total			311	244	555

Thirty demonstration plots have been conducted in Chikwawa District. Six sweetpotato varieties were planted and already familiar to farmers. We included a recently disseminated OFSP Zondeni. The demonstration plots were managed by five FGs (Table 6).

Table 6. Demonstration Plots of 6 Sweetpotato Varieties in Chikwawa District

Name of Farmers/FGs	Location		No. Plots
	EPA*	Village	
Osten Mwanyenga	Livunzu	Masenjere	6
Margret Sobilika	Livunzu	Masenjere	6
GVH Kapasula	Livunzu	Masenjere	6
Anderson Tchesa	Livunzu	Masenjere	6
Elias Peter	Livunzu	Masenjere	6

Variety planted by all 5 FGs at all sites were Kenya, Semusa, Mugamba, Salera, Mwalwanda, and Zondeni. *Extension Planning Area

Figure 18 shows that farmers were eager to have some varieties to be grown at their homesteads. After the field days, farmers were allowed to carry some vines of a number of varieties that have been released, mostly OFSP.

(A) ***(B)***

*Figure 18. Farmers attending the harvests and field days **(A)** in Chikwawa and **(B)** in Dedza districts.*

On-farm trials were conducted (Fig. 19; Table 7), concluding a series of varietal trials. Besides assessing the yield performance of the varieties by researchers, farmer-participatory approach is an important tool in a sweetpotato breeding program (Abidin 2004, Witcombe et al. 1996, Franzel and Coe, 2001). The two activities mentioned above were organized by DARS and backstopped by CIP.

(A) ***(B)***

*Figure 19. Shortly before harvesting on-farm trials in Dedza **(A)** and Chikwawa **(B)** districts.*

Table 7. Sweetpotato On-Farm Trials with 9 Varieties* Conducted in Chikwawa, Phalombe, and Zomba Districts and 6 Varieties in Dedza District (Planted in February 2010)

District	Number of participants	Total area (ha)
Chickwawa	4	0.056
Phalombe	10	0.113
Zomba	3	0.09
Dedza	5	0.048
Total	22	0.307

*Cordiner, Kenya, Semusa, Zondeni, LU06/0043, LU06/0046, LU06/0050, LU06/0252 and LU06/527

Harvesting the on-farm trials was organized during the field days (Fig. 20). Farmers involved in selecting the best OFSP varieties ranked them according to their preferences. The final results of these sweetpotato variety trials, including the on-station trials, will be separately reported by the sweetpotato breeder of DARS (i.e., Dr. Felistus Chipungu).

Figure 20. Field day and harvest of the on-farm trials in Phalombe.

From Tables 8a–d, the percentage of dry matter (DM) was relatively high in three districts—Dedza, Zomba, and Phalombe—but not in Chikwawa. However, the average yield was relatively low. This is one of the challenges for DARS to carry out further investigation on the integrated sweetpotato production and pest and disease management. Yield data shown in the tables were analyzed with Genstat version 8 program (Genstat 2005).

In Dedza (Table 8a), the tested variety LU06/0527 looked promising, but farmers ranked it 3. Zondeni yielded below average, but its DM is moderately high. However, farmers still preferred Zondeni OFSPP.

Table 8a. Yield (Mt/ha) and DM (%) of Sweetpotato On-Farm Trials, Dedza

Variety	Yield (mt/ha)	DM (%)
Kenya	7.6	38.85
LU06/0043	2.6	31.40
LU06/0046	1.8	30.00
LU06/0050	2.9	26.20
LU06/0252	3.3	29.70
LU06/0527	8.9	31.70
Semusa	5.1	37.35
Zondeni	3.1	32.25
Grand mean	3.8	32.25
p value	*	(*)
LSD	3.065	(6.596)
cv%	33.1	10.5

*Significant at $p < .05$; (*): significant at $p < .1$; LSD (least significant differences) inside parentheses at 10% and without parentheses at 5%.

In Zomba (Table 8b), OFSP Zondeni and tested variety LU06/0257 yielded best and significantly above local check Semusa. Their DM was also moderately high.

Table 8b. Yield (Mt/ha) and DM (%) of Sweetpotato On-Farm Trials, Zomba

Variety	Yield (mt/ha)	DM (%)
Kenya	2.7	36.47
LU06/0146	1.0	33.55
LU06/0257	2.5	32.28
LU06/0428	1.9	32.40
Semusa	1.3	37.70
Zondeni	2.6	37.52
Grand mean	2.1	34.44
p value	**	**
LSD	0.821	2.468
cv%	20.4	3.8

**Highly significant at $p < .01$; LSD at 5%.

In Phalombe (Table 8c), most of the tested OFSP yielded better than others, and were all above the average, except the check variety Semusa.

Table 8c. Yield (Mt/ha) and DM (%) of Sweetpotato On-Farm Trials, Phalombe

Variety	Yield (mt/ha)	DM (%)
KENYA	4.1	37.64
LU06/0043	2.5	33.40
LU06/0046	1.9	24.34
LU06/0050	5.0	28.06
LU06/0252	5.8	32.17
LU06/0527	6.0	31.59
Semusa	6.3	36.90
Zondeni	5.2	33.98
Grand mean	4.6	32.26
p value	**	**
LSD	2.3	6.333
cv%	38.6	15.2

**Highly significant at $p < .01$; LSD at 5%.

Interestingly, Zondeni did not do well in Chikwawa (Table 8d). However, the other two tested varieties, namely, LU06/0046 and LU06/0252, performed well. They were better than the local checks, Kenya and Cordiner. All tested varieties in the trials were OFSP ones.

Table 8d. Yield (Mt/ha) and DM (%) of Sweetpotato On-Farm Trials, Chikwawa

Variety	Yield (mt/ha)	DM (%)
Cordiner	3.0	26.60
Kenya	1.8	29.20
LU06/0043	2.0	28.10
LU06/0046	5.9	24.10
LU06/0050	3.9	26.00
LU06/0252	5.4	29.70
LU06/0527	4.8	27.00
Semusa	8.4	20.10
Zondeni	2.5	28.40
Grand mean	4.2	25.70
p value	**	Nonsignificant
LSD	3.6	-
cv%	58.5	-

**Highly significant at $p < .01$; LSD at 5%.

2.5 Methods of Selecting the Best Performance of Varieties by Farmers

Farmers were divided into groups and each chose a chairperson and a secretary. Before the selection took place, farmers harvested a few storage roots of each variety from the guard rows. Then they boiled/steamed them separately for the taste test. The procedure consisted of the following: (1) every group inspected the sweetpotato field, discussed what they observed, and made some notes on the aboveground performance of every variety; (2) after harvesting them, farmers observed the storage roots performance, bit the fresh roots, and made some notes; (3) each group discussed their findings; (4) the taste test was conducted; and (5) general group discussion

took place. They ranked the varieties that they preferred most. In Dedza, prior to the general group discussion, each group had already ranked the varieties and given a name to each variety that had not been named.

For the taste test, farmers boiled/steamed them in a separate pan covered by banana leaves with little water for 10–15 minutes on a charcoal stove.

2.5.1 Dedza District (responsible partner: CU)

A total of 156 farmers attended the field day on 30 July; there were 69 male and 87 female farmers. Farmers were grouped into threes: chiefs, farmer clubs/organization leaders, and farmers (men and women).

Each group has come out with a result as follows:

1. Chiefs: Semusa was ranked 1, Zondeni 2, and LU06/0527 3; name given: Thandizo (means ”Help”).
2. Farmer clubs/organization leaders: Semusa was ranked 1, Zondeni 2, Kenya 3, and LU06/0527 4; name given: Mthanjala (“Fight Hunger”).
3. Farmers: Semusa was ranked 1, LU06/0527 2; name given: Msungabanja (“Wash Hands”). Kenya 3, LU06/0050 4; name given: Nyasi m’maso (“The Viewer”). Zondeni 5, LU06/0043 6; name given: Namaluza (“The Loser”).

The overall ranking resulted from group discussion was Semusa (1), Zondeni (2), LU06/0527 (3), Kenya (4), LU06/0050 (5), and LU06/0043 (6). Unfortunately, Semusa and Kenya are a white- and yellow-fleshed variety, respectively, but the other four were orange-fleshed varieties.

Figure 21 shows that farmers enjoyed their time tasting a number of varieties and judging the varieties directly in the field together with other farmers. In this way, we suspected that the farmers were telling other farmers about the availability of OFSP and its importance as a source of vitamin A. The information would be effectively diffused.

Figure 21. Farmer-participatory varietal selection at harvest, Dedza District in July 2010.

2.5.2 Zomba District (responsible partner: MVPs)

The compiled results are shown in Table 9.

Table 9. Ranking of Varieties by Farmers (Total, 20) in Zomba District

Variety	Ranking	Number of Farmers		
		Female	Male	Total
ZONDENI	1	14	6	20
LU06/0428	2	11	5	16
KENYA	3	9	3	12
SEMUSA	4	5	3	8
LU06/0146	5	4	4	8
LU06/0257	6	5	2	7

2.5.3 Phalombe District (responsible partner: CU)

Another field day was conducted to harvest on-farm trials and select the best varieties by farmers in Phalombe District. Forty farmers were involved: 26 males and 14 females. A taste test was done before ranking them. The result is as follows: LU06/0252 was ranked 1; name given: Kadyaubwerere ("You Eat and Eat Again"), LU06/0050 2, LU06/0043 3, Kenya 4, Zondeni 5,

Semusa 6, LU06/0046 7, and LU06/0527 8. Farmers made a note that the variety LU06/0527 was ranked the least because it was overcooked, thus spoiling the flavor and taste.

2.5.4 Chikwawa District (responsible partner: CADECOM)

Table 10 shows the result from the harvest at on-farm trials in Chikwawa District.

Table 10. Ranking of varieties by farmers (Total, 20) in Chikwawa District

Variety	Ranking	Number of Farmers		
		Female	Male	Total
Kenya	1	13	7	20
LU06/0252	2	7	6	13
Semusa	3	7	5	12
Zondeni	4	7	2	9
Cordiner	5	4	4	8
LU06/257	6	3	4	7
LU06/0043	7	2	4	6
LU06/0050	8	3	2	5
LU06/0046	9	1	3	4

2.6 Baseline Survey for Calculating the Break-even Prices for Sweetpotato Vines

During the month of May 2010, a survey to find out the break-even prices for sweetpotato vines was conducted in four districts: CU–Dedza, MVPs–Zomba, CU–Phalombe, and CADECOM–Chikwawa. This survey was done by the CIP marketing officer and the CIP field technician, Bvumbwe Research Station.

Objectives of the survey were to find out (1) from DVMs how much they would like to sell sweetpotato vines; (2) the marketing system of sweetpotato vines in each district; (3) how farmers keep vines locally; (4) the challenges farmer face when growing sweetpotato; and (5) the farmer's knowledge of OFSP. The CIP marketing officer interviewed farmers (DVMs) and extension officers (district and development officers).

2.6.1 Questions

Some questions were prepared and were addressed to:

Farmers

- What types of crops are grown in your area?
- What varieties of sweetpotato are grown in your area?
- How are sweetpotato vines accessed by farmers in your area?
- Do people sell vines? If yes, at what price per 50 kg bag by volume?
- Where do farmers sell the sweetpotato vines—is it within the village or at the market?
- Do you have records on activities carried out at your nursery?
- How long did it take to accomplish the following activities: land preparation, planting, weeding?
- When did you plant vines?

- How many times were you watering/irrigating your vines per week?
- For farmers using motorized pumps, we asked them how much fuel was used during each watering time.
- What methods do farmers use to keep vines locally?
- What challenges do farmers face pertaining to sweetpotato production in this area?
- What do farmers know about Zondeni variety?

Extension Staff-Crops Officer

- How many extension planning areas (EPAs) grow sweetpotato in the district?
- Which EPA grows a lot of sweetpotato in the district? (The sheets for sweetpotato production estimate figures were provided by crop officers from each district.)
- What varieties of sweetpotato are commonly grown by farmers in the district?
- Are there trained vine multipliers in the district?
- What about staff who were trained in sweetpotato vine multiplication?
- How do farmers access vines in this district?
- Do farmers sell vines? If yes, at what price?
- Is there an organized market system sweetpotato roots or vines?
- What challenges do farmers face pertaining to sweetpotato production?

After asking above-mentioned questions to farmers and extension staff, responses were recorded in a note pad for analysis.

Appendix 2 is showing the result from this survey. The cost of vine multiplication was calculated by the CIP marketing officer.

2.6.2 Significant remarks from this baseline vine price survey

Marketing system of sweetpotato storage roots and vines

Currently, there is no organized market system for both roots and vines in all districts. Farmers share sweetpotato vines in Chikwawa, Phalombe, and Zomba. Some farmers sold vines in local markets at low prices. For sweetpotato storage roots, middlemen bought from farmers and sold to towns and trading centers. Some farmers sold the roots on local markets in their respective villages.

System of keeping vines by farmers

Farmers generally kept very few sweetpotato vines where there was water; for example, at the bathroom water outlets. Others planted very few sweetpotato vines at a place where women threw water after washing their kitchen utensils. Some farmers planted very few sweetpotato vines in their gardens near river banks without following the recommended spacing (referred to the two methods, rapid multiplication and adjusted conventional multiplication also written in this report). This has led to shortage of sweetpotato vines at the onset of rainy season and hence a delay in planting and consequently low yields. The coming in of the sweetpotato rapid vine multiplication is yet another milestone for sweetpotato production. Farmers liked the method and were willing to adopt this technology so that they could have more vines at the onset of rainy season.

2.6.3 Challenges

Three notable challenges have emerged: (1) unreliable ways of keeping sweetpotato vines, (2) lack of organized market system for sweetpotato vines, and (3) a few nursery beds were affected by viruses in Dedza. However, rouging of all diseased plants was done.

2.6.4 Knowledge of OFSP

In all districts, the interviewed farmers were able to explain that OFSP like Zondeni can provide vitamin A when eaten.

The in-depth baseline survey and market assessment on the storage roots are in progress. The report will be prepared separately.

2.7 Voucher Systems

In the onset of rainy season 2010 (i.e., November) 7,097 households have been registered as our target group. They will receive subsidized voucher of 4 kg of Zondeni OFSP for the storage root production. The criteria for selecting the target group are written in this report. Partners have also added some criteria based on the relevant situation at each locality (Appendix 1).

In Year 1, we will test the intervention of two voucher systems—subsidized voucher and non-subsidized. The subsidized voucher is paid by the sweetpotato project (Irish Aid project) from Year 1 activity. An example of the subsidized vouchers can be seen in the Appendix 3. The number of beneficiaries getting vouchers is mentioned in this report as well (Table 4). A slogan in Chichewa is written on every voucher, it means "Eat OFSP for Energy and Health."

Surprisingly, the amount of vine cuttings ready in November is beyond of our expectation. In the meantime, the information about the OFSP variety being healthy because it contains vitamin A has been diffused very well. This indicates that the demand for the planting materials was significantly increasing. It also means the multipliers have good opportunity to obtain more revenue. The government's price was 300 Malawian Kwacha (US $2) per 50-kg bag. As mentioned elsewhere in this report, multipliers in Dedza could sell it for as much as Mk 1,500 per bag. Considering the break-even prices (Appendix 2), the prices in the free markets, and also the government's price, we agreed with the price of Mk 350 ($2.33) per bag, as for the subsidized vouchers. In this case, 1 bag has 9-kg vine cuttings of Zondeni. Each household will receive one voucher of 4 kg (300 cuttings) of OFSP planting materials for Mk 155 ($1.03). The beneficiaries will pick up the planting materials from a multiplier and give him/her the voucher. The multipliers will ask the respective partner to cash the voucher in Malawian kwacha. A form for recording the beneficiaries was prepared as well (Appendix 4).

To boost the morale of the vine multipliers, we agreed to test two types of vouchers as mentioned above. We also need to monitor where all planting materials go. So, we will make two different vouchers, each of them to be printed on different colored paper. To make it easy to monitor, each partner has its own serial number: CADECOM, a serial number of 10000 to 19999; CU, 40000 to 49999; and MVPs, 80000 to 89999. The non-subsidized vouchers will be blank. The multipliers should write down the price and amount of cuttings they are going to sell. Multipliers can already find the growers early and sell the vouchers to the storage root producers.

Good recordkeeping should play a role in this method—the name, number of cuttings and payment should be recorded in the record book. In this way, they can estimate the number of planting materials available for the next buyers. Training is needed on the recordkeeping, preferably in October. The CIP field officer and marketing officer together with partners will monitor the activities until the period of selling the planting materials is over. When the growers are ready with their fields, they can collect the planting materials by showing their vouchers. Together with their payment, the voucher will be returned back to the multipliers. The growers will then receive the number of planting materials as written on the voucher. The validity of practicing the vouchers should be clearly defined—we suggest November–December 2010.

2.8 Formative Research

The objective of formative research was to understand better how to promote OFSP as a foundation for a broader intervention. This would include research on how to incorporate OFSP into improved infant and young child-feeding practices and also how to best to promote OFSP awareness and consumption among different target groups (e.g., urban consumers, men, market traders, decision-makers, etc.).

Formative research is required to develop and test the demand creation and behavioral change strategy to be used to promote improved dietary patterns for vulnerable women and child-feeding practices incorporating OFSP and other vitamin A rich foods. It is recognized that increased nutritional awareness does not necessarily lead to behavioral change in child-feeding practices, and that behavioral change and communication interventions need to be culturally specific and appropriate. Malawi has specific characteristics, including high population density, small land holdings, land scarcity, soil infertility, reasonably good transport and communication infrastructure, and high female literacy levels, which may influence the type of intervention.

We intended to use the trial improve practices (TIPs) approach as well as doing some research to understand the most effective communication channels to achieve wide coverage in a cost-effective way (e.g., the zoom-in, zoom out approach using video/radio developed by Food for the Hungry) for different target groups and develop and implement a communication and behavior change strategy. A number of studies have been done in Malawi using the TIPs approach on infant and young child-feeding practices. Thus, we did not want to duplicate this work, but tried to incorporate some TIPs focusing on OFSP, and would test how mothers were able to sustain improved practices over time. A preliminary approach has been done. We approached a number of important Malawian stakeholders who worked with nutrition and food security: Bunda College, nutritionists at the office of president, and policy-makers.

We planned to conduct this work as part of an MSc student thesis project. However, the project time scale for 2010 and the current academic year did not make this possible for this year. Alternatively, we identified a number of potential Malawian candidates who could do this work and be involved for a short period this year that is between October and November. Then the result would help us build the monitoring and evaluation of the interventions into a potential MSc thesis project for next academic year. This work is in progress and the report will be written separately.

For the first learning on the OFSP dissemination in November, a good community theater group would be used for our strategy on sending messages to our target audience. The strategy should

explain how each message would support a specific behavior change by explaining the behavior, including effective motivations, resolving resistance points, and presenting essential information clearly. It would explain messages' broad motivational elements, such as use of authority figures or mothers' aspirations for their children. Messages should suggest what foods, how much, how often, (possibly) how they can be prepared, and perhaps most importantly who within the family needs food. The messages also included a piece that talked about the benefits of OFSP, how they need to prepare the field properly before looking for the vines, how to plant, maximizing use of planting material, and showing someone going to redeem his/her voucher. Documentation would be included in this campaign action, such as video camera and record book to estimate the number of audience. The results could be used for the next project implementation.

3. DEVELOPMENT COOPERATION IRELAND INPUT AND ITS IMPACT

The Development Corporation Ireland of Year 1 (1 October 2009–30 September 2010) has assisted in advocating policy-makers to focus on solving the hunger and undernutrition problems in the country and promote the value of OFSP in international hunger fora. It is clear that this project has contributed to the Agriculture Sector Wide Approach (ASWAp) Malawi's prioritized and harmonized agricultural agenda (Table 11).

Table 11. Project Objectives Corresponding to ASWAp Strategic Objectives

Project Objectives	Corresponding ASWAp Strategic Objectives
Overall objectives	
1.1 To improve vitamin A and energy intake for at least 115,000 rural households with women and young children using OFSP-based approaches. **1.2** To ensure that at least 20% of households growing OFSP earn at least $ 40 USD per year from OFSP sales and increase average sweetpotato yields 50%.	**1.2.1.c:** Increase productivity of cassava, sweet and yellow potato, and Irish potato in relevant areas **1.2.2.a:** Promote dietary adequacy **1.2.2.b:** Improve quality of diets for the most vulnerable groups **1.2.2.c:** Intensify nutrition education **Key support service 1a:** Institutional strengthening and development **Key support service 1b:** Capacity building **Key support service 2a:** Conducting results and market-oriented research on priority technology needs and provision of technical and regulatory services **Focus area 3.1:** Sustainable agricultural land management
Specific project objectives	
2.1 To improve vitamin A intake for rural vulnerable groups in Central and Southern Malawi through effective establishment of DVMs and a media-based demand creation campaign. **2.2** Increase effective demand by changing the perception of sweetpotato and develop fresh root marketing chains for OFSP in the Blantyre market and reduce fluctuations in overall sweetpotato supply to the fresh market.	**1.2.1.c:** Increase productivity of cassava, sweet and yellow potato, and Irish potato in relevant areas. **1.2.2.a:** Promote dietary adequacy **1.2.2.b:** Improve quality of diets for the most vulnerable groups **1.2.2.c:** Intensify nutrition education **Key support service 1a:** Institutional strengthening and development **Key support service 1b:** Capacity building **Key support service 2a:** Conducting results and market oriented research on priority technology needs and provision of technical and regulatory services **Focus area 2.3.a:** Improve the public/private partnerships for broader growth of the agriculture sector **Focus area 3.1:** Sustainable agricultural land management

2.3 Increase the productivity and quality of sweetpotato in intensifying farming systems to ensure surplus production for sale and decrease the length of the hunger season. **2.4** Increase the capacity of DARS to produce clean, tissue culture sweetpotato plantlets, maintain primary multiplication sites, and design and conduct seed systems and integrated crop management research.	**1.2.1.c:** Increase productivity of cassava, sweet and yellow Potato, and Irish potato in relevant areas **Key support service 1a:** Institutional strengthening and development **Key support service 1b:** Capacity building **Focus area 2.3.a:** Improve the public/private partnerships for broader growth of the agriculture sector **Focus area 3.1:** Sustainable agricultural land management

4. INCREASING RETURNS AND EFFICIENCY IN FRESH ROOT MARKETING

Although sweetpotato production has been rising in Malawi, this has primarily been motivated by its increasing role as a food security crop. There has been some penetration of urban markets, but this has been haphazard and limited in relation to its potential. A range of factors contribute to this situation: (1) the seasonality of the crop (linked to lack of timely access to vines and appropriate varieties), (2) lack of knowledge about how to store fresh roots, (3) its image as a food of the poor, (4) high transport costs, and (5) lack of processing knowledge and enhanced utilization in the diet.

There are some areas, however, where sweetpotato is grown for commercial purposes. The main areas where sweetpotatoes have a commercial orientation are Thyolo, Mulanje, and Phalombe located south of Blantyre and next to the Mozambican border. In addition to the normal rains from November–March, these areas benefit from the Chiperoni phenomenon that brings winds and moisture from the South during the May–July period. Given that the main production areas are close to the Mozambican border, it is not surprising that the main wholesale market for sweetpotatoes, Chinakanaka, is located 30 km from that border.

The Chinakanaka market is supplied with sweetpotatoes from the three aforementioned main production areas and has direct linkages to the main markets in Blantyre. Most of the sweetpotatoes are bought in small rural markets located close to the production areas. One important production area is Nsikawanjala in the Mulanje District and 12 km from Chinakanaka. The sweetpotato coming from Mozambique is mainly the variety ADMARC and an increasing amount of OFSP. As is true for most other produce, almost all of the sweetpotato coming from Mozambique crosses the border at non-official border points.

Traders from Blantyre come directly to Chinakanaka, buy sweetpotato, transport the bags, and sell them in markets around Blantyre (Chilomoni, Ndirande, Chirimba, Limbe). Some retailers sell the sweetpotato directly in these markets, but other retailers take the sweetpotatoes for selling to other small urban markets. In addition to Chinakanaka, there are medium-sized wholesale markets, but they get sweetpotatoes only from surrounding production areas. This is the case of Bvumbwe and Chikwawa—both are located around 20–40 km outside Blantyre and supply the Blantyre markets. In Lilongwe, the demand for sweetpotato is met by medium-sized wholesale markets also located around the city center between 20–40 km from Lilongwe.

Usually, sweetpotato is bought in 50-kg bags (reference of maize weight) in the production areas and then transported by small trucks to the wholesale markets. These bags actually weigh 60–70 kg. In Chinakanaka, the "small" bags of 60–70 kg are converted into large ones (equivalent of 5 small bags) and then transported to Blantyre. The main reason for this is that savings in transportation costs reach 20%. (In current figures, to transport each 60–70-kg bag to Blantyre costs 150 Kwacha, whereas transporting the big bag of 300–350 kg cost only 600 Kwacha.) However, it is important to highlight that the cost savings is not really 20% because traders have to pay people to prepare the big bags from the small ones, but in general the margin is still around 15%.

Sweetpotato farmers in Malawi, especially women, could gain substantially more profit from commercialization of sweetpotato if they bulked their product at an accessible site to transport and more efficient value chains were built. The development of an efficient urban fresh market would require a coordinated approach across the value chain. At the farm level, development of more continuous year-round supply is important in developing the crop as more than a snack food in urban markets. Improved efficiency in the marketing chain is also important in keeping sweetpotato competitive. Interventions at the production and marketing stages must be complemented by promotional strategies to change the image of the crop, develop alternative uses of the roots in urban diets, and increase effective demand. The Mozambique experience indicates the building up the "Orange Brand" can be effectively achieved using media and market-based promotions. These efforts will be designed in Year 1, and tested and initiated beginning in Year 2, to encourage the expansion of area under OFSP production.

5. DISCUSSION AND CONCLUDING REMARKS

5.1 Project Design and Implementation Plan

The project aimed to contribute towards combating hunger and VAD in Malawi. It provided backstopping services to existing extension efforts to integrate significant nutrition awareness and demand-creation components into existing programs and in designated areas with market access, a market component. It built on the Mozambique experience using the Orange Brand to promote awareness of the importance of consuming vitamin A rich foods and the Malawi experience in the potato project on building private-public partnerships. Building in sweetpotato as a component to existing programs maximizes the use of scarce resources. OFSP could serve as an effective entry point for agriculturally focused organizations to broaden the scope of their interventions to include improvement of diet quality and better nutritional practices.

Concurrently, the project aimed to increase demand among consumers of all socioeconomic brackets and expanded interest and diversified use of the crop through the promotion of fresh sweetpotato roots as a health food and as a breakfast food. On the production side, the project focuses on working with less skilled/educated rural populations, particularly women, in areas with poor to good agro-ecologies. Production risk would be mitigated by investment in decentralized vine production supplemented by small-scale irrigation.

There were two phases of the project. The first two years of the project (Phase I) focused on designing the appropriate intervention agriculture-nutrition-marketing intervention approaches for the delivery system by engaging in formative research for development two NGO partners (CU and Chikwawa-CADECOM) and the MVP in Central and Southern Malawi. Phase I built up quantities

of clean planting material of Zondeni, the newly released OFSP variety, and other promising OFSP clones identified from participatory on-farm trials and demonstrations and reaching at least 23,000 households. Phase II would involve public sector extension and might expand to include additional NGO partners (the number depending on the level of available resources). At least 70,000 households would be subsidized and will have been reached by the end of Phase II. The original project program involved 115,000 households, a figure that includes those who have bought the vines by themselves after being aware of the importance of OFSP regarding their health.

5.2 Phase I Features

The first year of the project focused on developing the content for the proposed intervention model and appropriate training materials for the Malawian context with three partners in Malawi identified during the proposal preparation phase: CU, Chikwawa-CADECOM, and the MVP. Public sector extension service agents would participate in trainings with their respective NGO colleagues. CU worked in Dedza and Phalombe. Chikwawa-CADECOM and CU in Dedza had access to irrigation and its farmers would be the main suppliers of OFSP to markets during the dry season. MVP already initiated OFSP activities a couple of years ago after visiting the Reaching End User project in Milange District, just across the border in Central Mozambique. Acceptance of the OFSP varieties has been very high.

The multiplication of clean, disease-free in-vitro plantlets will be used to build up the supply of vines in what was known as the "1–2–3" system. The major limitation in sweetpotato was the relatively low rate of multiplication: 15 cuttings from 1 cutting in 3 months using conventional multiplication methods. Rapid multiplication methods could be employed that get multiplication rates of 90:1, but these require good management skills and access to fertilizer. Hence it is usually undertaken only at primary and secondary multiplication sites with good irrigation facilities. (Contrast this to maize, where 200 seeds can be obtained from a single cob.) The primary multiplication site (Bvumbwe Research Station) provided materials to the secondary multipliers (trained farmer multipliers backstopped by NGO extension personnel) and key demonstration plots in Years 1 and 2. Secondary multipliers provided cutting to tertiary multipliers (individual farmers or farmer/community organizations). These secondary multipliers would be at least 20 km from the primary multiplication site so that a decentralized system of clean planting material is built up. Partner organizations would be encouraged to prioritize households with women and small children in their distribution efforts.

The use of vouchers would be tested during the main growing season beginning in November 2010, providing free vouchers to approximately 7,000 households with children under 5 years of age or being affected by HIV/AIDS or loss of parents. In this system, farmers received a voucher for 4 kg of planting material (equal to 300 vine cuttings 30 cm long). When they are ready to plant the sweetpotato, they travel themselves to the vine multiplier in their area, then exchange the voucher for their desired OFSP variety. The NGO reimburses the vine multiplier for the vouchers received. This approach can be adapted over time to become commercially oriented, with vouchers being sold as well as distributed for free to targeted households. Its major advantages over mass dissemination days are (1) farmers obtained the material when rainfall conditions were appropriate and their fields were prepared, (2) trained vine multipliers could evolve into community sweetpotato experts and might provide a more sustainable source of vines than public

sector maintained fields, and (3) if multiple varieties were available, farmers could choose only those that they prefer.

The beauty of a vegetatively propagated crop was that farmers could retain their vines for the next season and usually either gave or sold vines to their neighbors. Extension advice would draw on research findings to work with farmers on new techniques of vine conservation. Given Malawi's high population density, it is likely that each direct recipient would give or sell vines to at least an additional 10 households.

5.3 Tackling the Productivity (Yield and Micronutrient Content) Bottleneck in Intensifying Systems through Crop Management

Since crop production in Malawi is mostly rain-fed, there is food shortage during off seasons. This jeopardizes household food and nutrition security and income. Extending the supply period of sweetpotato would thus make a significant contribution towards alleviating these insecurities. For example, areas such as Thyolo and Phalombe provide roots to the Blantyre market during the main season of April–August. Irrigated production sites in the Shire Valley/Chikwawa area are the major off-season producers from August through January. Filling the "gap" in availability (February–March) will require combining varieties of different maturity period, expanded use of irrigation, and promotion of low-cost fresh storage technologies. Other ways that can help extend the sweetpotato supply period include integrated control of sweetpotato weevils, deployment of drought-resistant varieties, and appropriate time of and staggering of planting.

More responsive varieties that have market quality can provide the incentives for the intensification of crop management. However, in an African context, the initiation of such a dynamic, especially within a smallholder farming context, must start with effective access to markets and appropriate price incentives. Market access, which is vital for impacting sweetpotato producers, will require a surplus production of quality produce beyond the household consumption in a constant manner. However, current practices of cultivating sweetpotatoes on exhausted soils or towards the end of the rainy season to feed on residual moisture and exploit the little resources left for its development will not warrant surplus production. It is believed that poor soil fertility, highly weathered soils, and nutrient depletion significantly contribute to poor crop growth, leading to lower than desired yields in Malawi (Saka et al. 2004, Makumba 2003, Mughogho 1992, Mwendemere 1979). The rampant poor soil fertility is aggravated by continuous cultivation of crops on same piece of land with little inputs (organic or inorganic) added, leading to severe nutrient mining and removal and burning of crop residues during land preparation by most of the smallholder farmers.

Understanding the components of the yield gap helps guide priority setting in investment. Commercial sweetpotato growers in South Africa who have access to irrigation, fertilizers, and credit achieve yields ranging from 40 to 60 t/ha. Under rain-fed conditions of smallholder agriculture, the yield potential would never be achieved because of many constraints (i.e., lack of good quality of seeds, pests and diseases, soil fertility, etc.). A number of studies indicated that an increase of yield from 6 to 20 t/ha could be achieved if constraints were managed properly. However, through an improved breeding program in Eastern and Southern Africa, an average of 24 t/ha were obtained (Grüneberg et al. 2004).

Potential gains in yield are obtained applying research findings in four key areas:

- Better agronomic practices (planting techniques and spacing, site selection, soil fertility management) can contribute substantially to increase yields (more than 100% increase) (Niederweiser 2004). However, facilitating farmer access to fertilizers is not an easy task, so the estimation of yield gains through better management of local sources of nutrients and other practices is conservative at 60%.
- The lack of virus-free or "clean" planting material is regarded a major constraint. Most of the local landraces and introduced materials are degenerated because of the sweetpotato virus disease. Experts and references indicate that a yield gain of 30–50% could be obtained through healthy planting material (Fuglie et al. 1999).
- Genetic gains in terms of yield are expected to be about 20% compared to healthy local landraces. Breeding is also the pathway for introducing quality traits (higher micronutrient content, DM content, etc.) that do not contribute towards improving yields but are essential for achieving other goals, such as consumer acceptance and improved nutritional status.
- Sweetpotato weevil is an important constraint to sweetpotato in Africa. However, most of the effect is when sweetpotato roots are formed already. Work in Cuba indicates, however, that about 10–20% increase in yield could be expected through a better control of sweetpotato weevil (Lagnaoui et al. 2000).

From this analysis, we can draw two "rules of thumb" to guide efforts to increase sweetpotato productivity in the region under average rain-fed conditions: (1) the introduction of new varieties adapted to local conditions, which is always based on the use of clean, improved planting materials, provides an opportunity to at least double yields; and (2) combining the introduction of new adapted varieties with a package of improved agricultural practices provides an opportunity to triple yields.

Closing the yield gap in a crop such as sweetpotato, where much of the production is directed to home consumption, in general requires a change in incentive toward investment in soil fertility and/or irrigation, more timely planting in relation to the start of the rains, and greater focus on managing root quality. Such investments in general only come when farmers have incentives like improved access to markets and better prices, and in turn provide the basis for exploiting the yield potential of improved varieties. Market-focused interventions to improve farmer incomes provide the ideal opportunity to research and implement techniques to improve productivity and quality under relevant farmer conditions. Usually farmers do not apply fertilizer to sweetpotato because they prefer to use it for more commercial or cash crops. Therefore, soil management should take into consideration crop rotation possibilities, especially those using nitrogen-fixing legumes, so that sweetpotato could take advantage of remaining fertility from the previous crop or from intercropping with legumes and/or other crops that have been fertilized.

There are no magic bullets to solving micronutrient deficiency problems in the Malawian context. Since zinc deficiency is widespread in the soils (Munthali 2008) and zinc-containing animal source foods are expensive, it is not surprising that zinc, an essential element for young child growth, is lacking in the rural diet—a probable causal factor underlying Malawi's high stunting rate. Thus, Malawi provides an excellent setting for evaluating food-based approaches within a food systems framework. The fundamental principle of nutrition (both for humans as well as plants) is that all essential nutrients must be present together in adequate amounts in the soil and food supply for

full health and vigor of the organism. No extra amount of any nutrient can compensate for the deficiency of another. Where other nutrients are also deficient, the full advantage of a biofortified crop such as OFSP is not achieved. Nutrient balance is as important as nutrient amount in both African soils and African food systems. In some cases, notably where iodine and selenium are deficient in the soil, biofortification by breeding has not proven viable (Lyons et al. 2004), but biofortification by fertilizer is very effective. In contrast, iron is a poor fertilizer and biofortification with iron is best done by genetic means. Likewise, vitamins synthesized by plants and needed by humans must be enhanced by genetic biofortification and managed agronomically. For many minerals, agronomic or fertilizer biofortification alone is practicable. Combining the strengths of genetic and agronomic biofortification to deliver adequate, balanced, or complete nutrition to subsistence populations in regions with multiple nutrient deficiencies in the soils is a strategy the University of Adelaide calls the "food systems paradigm" (Graham et al. 2007).

Based on the 4.5-project program, the initiation of a comprehensive integrated crop research was proposed to begin in Year 2 and would have been undertaken by master's candidates supervised by DARS and a CIP specialist or, in the case of agronomic biofortification, and a specialist from the University of Adelaide. However, it depended on the budget situation in Year 2.

5.4 Monitoring/Review Arrangements and Exit Strategy

Partners met and designed a common monitoring tool so that varietal dissemination was captured, nutritional and income indicators measured, and gender access could be assessed. The agricultural economist based with CIP in Malawi, Owen Sapo, facilitated these sessions and designed and implemented the monitoring and evaluation system with backstopping from a CIP impact assessment specialist. Both the motor vehicle and the motor bike bought from the project budget helped us very much to reach the fields for monitoring and evaluation.

5.5 Key Issues/Assumptions/Risks

The project assumed that the Malawian Government retained its commitment to its crop diversification strategy, which emphasized the promotion of roots and tubers as alternative energy sources to maize, the promotion of agro-processing to capture value-added, and greater cultivation of vegetables and fruits and increased livestock holdings to ensure a healthy, diversified diet.

In any agricultural project, the greatest risk is loss of production due to unpredictable weather. Malawi is subject to cyclical drought and in some areas, floods. The Malawian Government and its partners have been heavily investing in treadle pumps and other irrigation strategies to mitigate that risk. Irrigation for maintaining supplies of vines during the dry season may be key to obtaining adequate vine supply in drought-prone areas.

In this type of project, it is difficult to estimate the total benefits as many of the benefits, such as improved micronutrient intake, are difficult to put a value on as is increased capacity of research personnel to conduct research, extension personnel to deliver new technologies, and the establishment of more sustainable vine multiplication systems. In Year one, 2,186 households were trained as vine multipliers. In November 2010, at least 7,000 households with young children (the principal target for improved nutrition) will be reached as the seed system is being established. However, the 4.5-year proposed project intends to reach at least 115,000 smallholder households

as direct recipients of pro-vitamin A rich sweetpotato varieties by its end. It also intends to increase the number of families that specifically sell part of their sweetpotato harvest.

Given that sweetpotatoes are vegetatively propagated and that population density is high in Malawi, there will no doubt be a considerable number of *indirect* beneficiaries not captured by these estimates as farmer-to-farmer seed sales and sharing are a common practice in Malawi. The extent of informal distribution will be captured in the final impact assessment.

As a rough estimate, if 115,000 households receive disease free, improved OFSP varieties that on average increase yields from 5 to 9–13 t/ha, families who plant a minimum of 300 m^2 once a year would have a value of US $2.8 million based on a value of a kg of sweetpotato at 40 kwacha (27 cents) a kilogram. Many of these households would be able to cultivate larger plots or produce a second crop. In Mozambique, vitamin A intakes increased eightfold among young children participating in the intervention. Hence, it is reasonable to expect that vitamin A intakes will increase at least fivefold among young children in Malawi belonging to resource-poor participant households.

Compelling evidence is available of the potential contribution of OFSP to improved nutrition. To evaluate potential health and economic impact, economists estimate the number of VAD-related Disability-Adjusted Life Years that could potentially be saved through the use of biofortified sweetpotato. Results indicate that just by replacing white-fleshed with orange-fleshed varieties could reduce the VAD burden by 15–22% in 17 SSA countries where sweetpotato is widely grown.

6. FINANCIAL REPORT

The detailed financial report is separately reported and accompanies this technical report. The expenses made after 31 August are not included in the financial expenses. However, they are already committed to the activities that are still going on until November and December, where the ultimate implementation of this project transpired.

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