Case study 5

The introduction of orange-fleshed sweet potato in Mozambican diets: a marginal change to make a major difference

Jan Low, Mary Arimond, Ricardo Labarta, Maria Andrade and Sam Namanda

Statement of the problem

Vitamin A is an essential micronutrient for human health. Vitamin A deficiency (VAD) can limit growth, weaken immunity, cause xeropthalmia leading to blindness, and increase mortality (Sommer and West, 1996). VAD is widespread among young children in sub-Saharan Africa (SSA), and in Mozambique the problem is severe with an estimated prevalence of 71 per cent in children 6–59 months of age (Nutrition Division in Department of Community Health, 2003). Food-based approaches to combating VAD aim to increase access to and intake of vitamin A-rich foods. They complement supplementation and food fortification approaches, particularly for reaching rural households with limited incomes for purchasing fortified products, but solid evidence for their effectiveness is limited (Ruel and Levin, 2000).

Why use orange-fleshed sweet potato (OFSP) as the key entry point?

There are two types of vitamin A available in foods: preformed retinol (vitamin A itself) typically found in animal foods such as eggs, liver, and milk; and pro-vitamin A carotenoids found in plant foods such as dark green leafy vegetables and yellow and orange vegetables and fruits (McLaren and Frigg, 2001). Poor households typically cannot afford to consume the highly bioavailable animal foods on a regular basis. β-carotene is the major pro-vitamin A carotenoid among plant sources and the bioavailability of that beta-carotene which is converted into vitamin A (retinol) varies considerably. Among plant sources, OFSP have good to excellent amounts of beta-carotene, which is highly bioavailable (Jaarsveld et al., 2005; Haskell et al., 2004). Just 100–125 g of boiled or steamed OFSP meet the daily recommended intake levels of vitamin A for children under five years of age (Low et al., 2009). Moreover, unlike many vegetables, the sweet potato has significant amounts of energy as well as vitamin A. Hence, OFSP is considered a biofortified staple food crop that can tackle the problem of inadequate caloric intake as well as VAD.

Sweet potato (*Ipomoea batatas (L.)*) exhibits a wide range of varietal diversity that results in it being grown from sea level to 2,300 m above sea level in SSA. Over 5,000 accessions are found in the germplasm bank maintained at the International Potato Center in Lima, Peru. Flesh colors cover the gamut of white, cream, yellow, orange, and purple. In SSA, the dominant landraces grown are white-fleshed, lacking in beta-carotene. The promotion of OFSP in SSA centers around asking households to make a marginal change in their sweet potato growing and consuming practices—eating orange instead of or in addition to white.

Delivery mechanism

The Towards Sustained Nutrition Improvement (TSNI) action research project was initiated in September 2002. Recognizing that the causes of VAD and undernutrition among young children are diverse, from the outset an integrated approach was adopted with three distinct pathways:

1 *Agriculture: Introduction of a new source of vitamin A and energy biofortified OFSP*
Intervention farmers receive (principally through groups) planting material of high-yielding OFSP varieties, combined with lessons on how to improve crop management and storage practices to maximize the availability of OFSP in the diet throughout the year (Figure C5.1).

Figure C5.1 The project specifically targeted women with small children to receive OFSP vines. Credit: J.Low

Figure C5.2 Women preparing sweet potato as part of porridge preparation during a group nutrition session. Credit: J.Low

2 *Nutrition: Demand creation and empowerment through knowledge*
At the village level, principal caregivers, both women and men, are encouraged and enabled to improve infant and young child feeding practices, hygiene practices, and diversify the household diet. A nutrition extensionist conducts monthly group sessions for a year (Figure C5.2). Demand creation efforts focus on building awareness among the broader community to create: 1) demand for the new OFSP cultivars and their derivatives, 2) demand for other vitamin A-rich foods, and 3) a supportive environment to accelerate behavior change at the household level. For the TSNI, these included six province-wide radio programs, three community theater performances (Figure C5.3), painted stalls and signs in local markets, t-shirts, caps and long cloths worn by women as skirts decorated with the slogan "O doce que dá saúde" (the sweet that gives health).

3 *Marketing: Market development for OFSP roots and processed products*
This component aims to link farmers to traders and to inform consumers about where they can purchase OFSP (Figure C5.4). Farmers with identified market outlets are more likely to expand the area under production. Thus, generated demand combined with market development stimulates production, enhances producer income and spreads the health benefits of OFSP to a wider population, all of which contribute to farmers' willingness to retain OFSP and expand production. Demand for OFSP is enhanced if profitable processed products using OFSP as a major ingredient are developed.

Figure C5.3 Community theater seeks to create a supportive environment for mothers to adopt improved caregiving practices. Credit: J.Low

Figure C5.4 OFSP traders standing in front of their decorated roadside sales stall. Credit: J. Low

The intervention lasted 18 months in two of the poorest districts in rural Zambézia, Mozambique. World Vision, an international NGO, posted pairs of extensionists, one for agriculture and marketing, the other for nutrition at the community level, each pair serving 14 farmers groups. In total there were 498 mother–child pairs captured in the study that were compared with 243 mother–child pairs from "control" areas where no intervention was made.

Evidence of impact

The effectiveness of the intervention was evaluated after two agricultural cycles and findings published (Low et al., 2007). In the second year, 90 per cent of intervention households produced OFSP. Vitamin A intakes among intervention children ($n = 498$) were much higher than those of control children ($n = 243$) (median 426 vs. 56 μg retinol activity equivalents, $P < 0.001$). OFSP contributed 35 per cent of the total vitamin A intake of all children in the intervention area and 90 per cent among those who had consumed it the previous day. Serum retinol data were obtained as a proxy for vitamin A status. Controlling for infection/inflammation and other confounders, a 15 per cent decline in the prevalence of VAD was attributable to the integrated intervention. OFSP was well accepted and liked by both adults and children.

Scaling-up effort

The TSNI case study used an intensive package of activities that enabled us to demonstrate the potential for success in a community setting. The cost per beneficiary, however, was high (US$79 per direct plus indirect beneficiaries) (Labarta and Low, 2007) and hence the follow-up action research project, known as the Reaching End Users (REU) project (led by HarvestPlus), sought to lower the cost by introducing the use of village promoters and using existing church or farmers groups instead of engaging in new group formation. The integrated approach was retained, although the marketing component was restricted to areas with better market access. By working through promoters, extension personnel could reach a larger number of beneficiaries per extensionist and substantially reduce costs. Positive results were found, confirming that vitamin A intakes can be doubled in key target groups for a reasonable cost using the integrated approach with promoters (Hotz et al., 2011; HarvestPlus, 2010). In addition to the REU study, OFSP dissemination has been taking place on a broader scale in Mozambique but without the resources to measure the household-level consumption impact. Seminars and workshops have been held to disseminate findings and promote adoption. The monitoring of OFSP adoption is captured as part of the national agriculture survey, which is conducted periodically. As of 2008, 138,000 households were growing OFSP (Departamento de Estatística (Direcção de Economia), 2008).

Relevant stakeholders

From the outset of the OFSP effort, there was strong buy-in from the nutrition division of the Ministry of Health, because nutritionists doubted the financial sustainability of twice-yearly vitamin A supplement distribution and felt strongly that the underlying causes of vitamin A deficiency (inadequate intakes and disease) should be addressed. A nurse from the Ministry of Health was seconded to the project to lead the blood sampling and assist in the implementation of the nutrition component. The NGO, World Vision, collaborated with public sector agriculture extension in the establishment of maintenance of key vine multiplication sites. Another NGO, Helen Keller International, was contracted to develop the behavior change strategy and produce the radio programs. The Institute of Agronomic Research for Mozambique (INIA) was a full partner, providing the initial cuttings of the eight OFSP varieties used in the project. INIA, now reorganized and known as IIAM (Institute for Agrarian Research in Mozambique), is backstopped by a resident sweet potato breeder from the International Potato Center.

Policy impact

A stakeholder's workshop was held at the onset of the OFSP promotion effort and a six-page policy brief was disseminated on the potential for OFSP in Mozambique (Low et al., 2000). The use of food-based approaches and OFSP is recognized as an excellent source of vitamin A in the government's current nutrition strategy. The sweet potato is recognized in agriculture policy documents for its role as a crop to mitigate drought and to recover from floods. The Food and Nutritional Security Strategy II 2008–2015 (ESAN) has incorporated the basic human right to adequate food and recognizes the need to increase local production of adequate food to cover nutritional needs in terms of quantity (energy) and quality (which ensures all essential nutrients) (Bulletin of the Republic, 2007). Mozambique has a Technical Secretariat for Food Security and Nutrition (SETSAN) that coordinates, promotes, monitors and evaluates the activities carried out by line organizations of the Government and others involved in food and nutrition security. A SETSAN representative is a member of the Sweetpotato Support Platform (SSP) for Southern Africa, created in 2010 for sharing experiences and backstopping varietal development and seed systems. The SSP for Southern Africa is based in Maputo due to Mozambique's decade-long experience in developing and promoting OFSP.

The Mozambican experience, combined with findings from other studies in Uganda and Kenya, has provided vital evidence that is being used by members of the Vitamin A for Africa (VITAA) platform and others to attract funding for the development and use of locally adapted OFSP varieties and their promotions. Currently, 15 countries are actively engaged in OFSP-related activities (Kenya, Ethiopia, Uganda, Tanzania, Rwanda, Malawi, Zambia, Mozambique, Madagascar, DR Congo, Angola, South Africa, Burkina Faso, Ghana, Nigeria)

and are exchanging information through the Sweet potato for Profit and Health Initiative (launched in October 2009) and the Sweet potato Knowledge Portal (www.sweetpotatoknowledge.org, accessed July 2012). The extent of activities within a given country varies, driven by available human and financial resources.

Key lessons learned

There have been four major lessons growing out of the OFSP promotion experience to date in Mozambique. First, all age groups enjoy consuming OFSP and it can make significant impacts on vitamin A intakes and status when it is available. The orange color proved to be an advantage, not a disadvantage, for an agriculture intervention with a clear nutritional message. Second, adults and children can differ in their varietal preferences. Adults in general prefer more floury textures (higher dry matter content) than young children do. This is relevant because introduced OFSP germplasm from the Americas tends to have lower dry matter content than existing African varieties, including the limited number of OFSP African varieties that have been collected and used in promotion programs in SSA. Third, the most important constraint to expanded and sustained sweet potato production is the timely availability of quality planting material at the beginning of the rains. We tested various distribution methods and found that for drought-prone areas establishing trained farmer multipliers with water access to serve their local communities is preferable to periodic mass distribution efforts. In addition, a new method (the Triple S method) of storing small but healthy roots in a bucket of sand during the dry season and re-sprouting in protected seed beds prior to the rains is a promising solution for rural farmers with limited dry season water access. Fourth, for sustained adoption, it is necessary to invest in actual breeding efforts in Africa to have materials that are sufficiently adapted to local conditions. It has been discovered that the most preferred variety found in the TSNI project for its taste, yield, and excellent shape for marketing, Resisto, did not have vines sufficiently vigorous as the local varieties to withstand the dry season or alternatively, re-sprout in adequate amounts at the beginning of the rains. This led to the seeking and obtaining of funds to launch an accelerated breeding effort to produce more drought-tolerant OFSP for Mozambique. In early 2011, 15 new improved OFSP varieties were released and will form the foundation for a major dissemination effort to reach 120,000 households beginning in December 2011.

References

Bulletin of the Republic (2007) Resolution Nr. 56/2007 Food and Nutrition Security Strategy, Maputo: Government of Mozambique.

Departamento de Estatistica (Direcção de Economia) (2008) T*rabalho do Inquérito Agrícola 2008* [*National Agricultural Survey for Mozambique 2008*], Maputo: Ministério da Agricultura.

Harvestplus (2010) *Disseminating Orange-Fleshed Sweet Potato: Findings From a HarvestPlus project in Mozambique and Uganda*, Washington DC: HarvestPlus.

Haskell, M.J., Jamil, K.M., Hassan, F., Peerson, J.M., Hossain, M.I., Fuchs, G.J. and Brown, K.H. (2004) "Daily consumption of Indian spinach (*Basella alba*) or sweet potatoes has a positive effect on total body vitamin A stores in Bangadeshi men" *American Journal of Clinical Nutrition*, vol 80, pp.705–714.

Hotz, C., Loechl, C., Braum, A.D., Eozenou, P., Gillagan, D., Moursi, M., Munhaua, B., Van Jaarsveld, P., Carriquiry, A. and Meenakshi, J.V. (2011) "A large-scale intervention to introduce orange sweet potato in rural Mozambique increases vitamin A intakes among children and women" *British Journal of Nutrition*, pp.1–14, doi: 10.1017/S0007114511005174.

Jaarsveld, P.V., Faber, M., Tanumihardjo, S.A., Nestel, P., Lombard, C.J. and Benade, A.J. (2005) "Beta-carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test" *American Journal of Clinical Nutrition*, vol 81, pp.1080–1087.

Labarta, R. and Low, J.W. (2007) "Can integrated agriculture-nutrition extension programs deliver cost-effectively? Evidence from the dissemination of vitamin A rich orange-fleshed sweet potato in Mozambique", Working Paper, International Potato Center.

Low, J., Uaiene, R., Andrade, M.I. and Howard, J. (2000) Orange-flesh Sweet Potato: Promising Partnerships for Assuring the Integration of Nutritional Concerns into Agricultural Research and Extension in Mozambique [Online]. Maputo: Ministry of Agriculture and Rural Development (Mozambique), Directorate of Economics, Flash No. 20E, http://ageconsearch.umn.edu/bitstream/55215/2/flash20e.pdf, accessed August 2012.

Low, J.W., Arimond, M., Osman, N., Cunguara, B., Zano, F. and Tschirley, D. (2007) "A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique" *J Nutr*, vol 137, pp.1320–1327.

Low, J.W., Lynam, J., Lemaga, B., Crissman, C., Barker, I., Thiele, G., Namanda, S., Wheatley, C. and Andrade, M. (2009) "Sweetpotato in Sub-Saharan Africa", In: G. Loebenstein and G. Thottappilly (eds) *The Sweet potato*, Dordrecht: Springer Science + Business Media BV.

McLaren, D.S. and Frigg, M. (2001) *Sight and Life guidebook on vitamin A in health and disease*, Basel, Switzerland, Task Force Sight and Life.

Nutrition Division in Department of Community Health (2003) National survey about vitamin A deficiency, anaemia prevalence, and malaria in children 6–59 months of age and their respective mothers, Maputo: Ministry of Health (Mozambique).

Ruel, M.T. and Levin, C.E. (2000) "Assessing the potential for food-based strategies to reduce vitamin A and iron deficiencies: a review of recent evidence", FCND Discussion Paper No. 92. Washington DC: Food Consumption and Nutrition Division, International Food Policy Institute.

Sommer, A. and West, K.P. (1996) *Vitamin A deficiency: health, survival, and vision*, Oxford University Press, UK.