EVIDENCE REPORT
No 127

Reducing Hunger and Undernutrition

Promoting Biofortified Crops for Nutrition: Lessons from Orange-fleshed Sweet Potato (OFSP) in Tanzania

Betty Waized, Daniel Ndyetabula, Anna Temu, Ewan Robinson and Spencer Henson

April 2015

The IDS programme on Strengthening Evidence-based Policy works across seven key themes. Each theme works with partner institutions to co-construct policy-relevant knowledge and engage in policy-influencing processes. This material has been developed under the Reducing Hunger and Undernutrition theme.

The material has been funded by UK aid from the UK Government, however the views expressed do not necessarily reflect the UK Government's official policies.

AG Level 2 Output ID: 11

PROMOTING BIOFORTIFIED CROPS FOR NUTRITION: LESSONS FROM ORANGE-FLESHED SWEET POTATO (OFSP) IN TANZANIA

Betty Waized,[a] Daniel Ndyetabula,[a] Anna Temu,[a] Ewan Robinson[b] and Spencer Henson[b]
[a] Sokoine University of Agriculture, Tanzania
[b] Institute of Development Studies, UK

April 2015

First published by the Institute of Development Studies in April 2015

Contents

Boxes

Figures

Tables

Acronyms

AGRA	Alliance for a Green Revolution in Africa
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CGIAR	Collaborative Global Initiative Agricultural Research
CIP	International Potato Center
COSTECH	Commission for Science and Technology
DFID	Department for International Development
DONATA	Dissemination of New Agricultural Technologies for Africa
FAOSTAT	Statistics division of the Food and Agriculture Organization
GAIN	Global Alliance for Improved Nutrition
HKI	Helen Keller International
KIMKUMAKA	Kituo cha Mafunzo ya Kuboresha Mazingira na Kilimo Adilifu
LANSA	Leveraging Agriculture for Nutrition in South Asia
LZARDI	Lake Zone Agricultural Research and Development Institute
MT	metric tonne
NARS	National Agricultural Research System
NGO	non-governmental organisation
OFSP	orange-fleshed sweet potato
RAC	Reaching Agents of Change
SASHA	Sweetpotato Action for Security and Health in Africa
SPHI	Sweetpotato for Profit and Health Initiative
SUGECO	Sokoine University Graduate Entrepreneurs Cooperative
TAHEA	Tanzania Home Economics Association
ToT	training of trainers
WFSP	white-fleshed sweet potato

Executive summary

This case study examines the outcomes of interventions in Tanzania that have promoted the production and consumption of orange-fleshed sweet potato (OFSP) – a biofortified crop – with the objective of reducing vitamin A deficiencies. The report contributes to policy efforts to promote nutrition-sensitive agriculture by providing lessons for the introduction of biofortified crops in Tanzania and elsewhere. The case study is particularly instructive because OFSP has been a flagship of biofortification efforts, and because Tanzania appeared to have high potential for uptake of the crop. The country is a major producer of sweet potato, although the vast majority of production is of the nutrient-poor white-fleshed varieties (WFSP). Sweet potato is an important food security crop for small farming households, particularly in Tanzania's Lake Zone. The crop has the advantage of requiring little land and few inputs, and can be stored on-farm for several months. The crop also has commercial value, and white-fleshed varieties are available in urban markets throughout the year.

Donor-funded initiatives have played a central role in developing all stages of the OFSP value chain, with a particular focus on breeding new varieties that appeal to the preferences of both producers and consumers. Development projects have also supported the dissemination of planting materials and funded public awareness campaigns. However, information collected for this case study suggests that, so far, interventions have not achieved widespread uptake of OFSP. Only a small minority of farming households in intervention districts grow OFSP. Commercial farmers who supplied OFSP planting materials to project distribution systems have found that, after project funding ended, the local market was not viable, and have ceased production. Meanwhile, awareness of and demand for the crop among consumers have been very limited; one survey conducted in an intervention district found that only 2 per cent of households consumed OFSP. Traders and food processors report that there is little demand, and dealing with the crop is not profitable. This state is perhaps unsurprising given that the introduction of OFSP is still relatively recent, that project efforts have been relatively scattered and uncoordinated, and that there has been little focus on commercially viable value chains. Yet the challenges encountered in Tanzania provide important lessons for other agriculture-nutrition initiatives.

A first lesson is that the successful introduction of a biofortified crop requires the development of support systems at different stages of the value chain, including seed, marketing and quality assurance systems. In the case of OFSP, interventions should design publicly funded distribution of planting materials in order to foster parallel commercial systems at the same time. Whether commercial systems will provide access for vulnerable rural households requires further assessment; there may be a need for ongoing targeted subsidy. A second lesson is that achieving uptake of a nutrient-rich crop may depend on building viable value chains and demand, even if the aim is to encourage consumption by vulnerable households. One reason farmers have not invested in OFSP is that – faced with food insecurity and capital constraints – they prefer crops that can both be used as food or sold for cash. Agriculture-nutrition interventions should develop a more nuanced analysis of the decision-making context facing farming households. Third, the absence of demand is perhaps the key barrier preventing value chain development for OFSP. Yet, without rigorous research on consumer preferences and willingness-to-pay, it is unclear how this situation can be addressed. Funding more detailed consumer studies is therefore an immediate priority. Finally, the case of OFSP highlights the importance of mechanisms that signal nutritional quality to consumers. The distinctive colour of OFSP tubers is a major advantage; it enables the consumer to identify nutritional benefits and aids efforts to market the crop. In contrast, processed products that incorporate OFSP, such as 'golden bread', lack this advantage; the orange colour can be easily faked using food additives. This can undermine consumer confidence. If market-based interventions are to generate consumer trust, they must either

concentrate on crops and foods with a clear signalling advantage, or put in place specific mechanisms to ensure the nutritional quality of end-products.

This report concludes that publicly funded programmes need to build commercial opportunities for OFSP if the crop is to achieve widespread uptake and contribute to reductions in vitamin A deficiencies. This will require more strategic and better-coordinated support from donor agencies, government and their partners. Private sector actors will play a key role, but are unlikely to invest until supportive conditions are put in place. Future interventions should aim to create this supportive environment, including by incentivising production of planting materials, developing commercially viable products and funding large-scale public awareness campaigns. Public sector actors need to assess whether commercial planting materials and processed products can be made affordable and accessible to poor and vulnerable populations; delivering nutrient-rich foods to these groups is likely to require some form of public subsidy. This case study suggests that two intervention pathways should be explored simultaneously: (1) public distribution/purchasing and purchasing programmes to deliver planting materials and/or OFSP tubers to the rural poor, and (2) demand creation through awareness and social marketing campaigns, along with product development. Building robust value chains for biofortified crops requires collective efforts from both public and private sector actors. Donors, national government and non-governmental organisations (NGOs) can play a key role in catalysing investment through appropriate public purchasing, increasing public awareness and addressing barriers to acceptability.

1 Introduction

There is a growing consensus that reducing undernutrition, and micronutrient deficiencies in particular, represents an urgent development priority. Affecting more than one-third of the global population (Allen *et al.* 2006), micronutrient deficiencies have staggering consequences for human health and wellbeing, while also hampering economic productivity (Haddad 2013). As part of efforts to accelerate undernutrition reduction across a range of sectors, there is particular interest in ways to reshape agricultural and food systems, recognising that, in many countries, agricultural growth has failed to drive greater dietary diversity among the poor (Headey 2012: 41). In response, a body of evidence is emerging on 'linking agriculture and nutrition' through a range of strategies, including introducing new crop varieties, improving conditions for agricultural workers and increasing public nutrition awareness (Ruel and Alderman 2013). Prominent among these strategies is biofortification: the breeding of new crop varieties with enhanced micronutrient profiles, along with efforts to increase their production and consumption. Prominent biofortification programmes such as the Collaborative Global Initiative Agricultural Research (CGIAR) HarvestPlus have attracted substantial support from development and research funders (Bouis *et al.* 2013).

This report contributes to policy efforts to promote nutrition-sensitive agricultural and food systems by providing a case study from Tanzania of the introduction and promotion of biofortified orange-fleshed sweet potato (OFSP) (see Box 1.1). This case study is relevant to broader agriculture-nutrition efforts for several reasons. Firstly, Tanzania faces a particularly severe burden from undernutrition (Box 1.2). Agriculture is likely to be particularly important to improving overall nutrition in the country: approximately 70 per cent of the population live in rural areas, and more than 70 per cent are directly employed in agriculture (World Bank 2014). Secondly, the Tanzania case is instructive because OFSP is a central crop for biofortification programmes such as HarvestPlus. At present, the Sweetpotato Profit and Health Partnership is disseminating OFSP across 17 African countries with the aim of reaching 10 million households and reducing undernutrition (International Potato Center (CIP) 2011). Tanzania was an early site for OFSP promotion, and a case where conditions appeared favourable to rapid uptake (see below); experience in the country can therefore offer valuable lessons for the promotion of OFSP, as well as other biofortified crops.

Before examining the case study, it is important to define what is meant by agriculture-nutrition interventions to promote crops such as OFSP. There are two broad strategies for promoting foods such as OFSP,[1] defined by the populations they target and the channels they use to deliver food. The first approach targets members of farming households themselves, and aims to enable them to grow more nutrient-rich foods aimed primarily for household consumption (this is known as the 'pre-farmgate' strategy). The second approach targets a wider range of populations, both farmers and non-farmers, and aims to promote value chains that distribute nutrient-rich crops (or processed foods) from producers to consumer populations (this is the 'post-farmgate' strategy). These strategies are described in detail elsewhere (Henson, Humphrey and McClafferty 2013; Robinson *et al.* 2014). They are mentioned here in order to distinguish the two pathways through which various OFSP programmes in Tanzania have sought to impact nutrition. Both in Tanzania and elsewhere, the majority of interventions and research has focused on the pre-farmgate strategy; few programmes have invested substantially in reaching post-farmgate populations (Bouis *et al.* 2013; Le Cuziat and Mattinen 2011; Henson and Humphrey 2014).

[1] Other nutrient-rich agricultural products include fresh vegetables and fruit, animal foods and biofortified cereals and legumes.

Box 1.1 What is orange-fleshed sweet potato?

'Orange-fleshed sweet potato' (OFSP) in fact refers to several varieties of sweet potato (*Ipomoea batatas*) that are rich in beta-carotene, a vitamin A precursor. This beta-carotene content gives the tubers their orange colour. OFSP tubers are good sources of bio-available vitamin A; 125g of most OFSP varieties can supply the recommended daily allowance of vitamin A for children and non-lactating mothers. As well as vitamin A, OFSP also contains vitamins C, E, K and B. Major biofortification programmes such as the CGIAR HarvestPlus initiative have sought to breed OFSP varieties with enhanced vitamin A content, and to improve sensory and cooking qualities of these varieties. On the whole, OFSP has been more widely studied, compared to more recently developed biofortified crops.

OFSP has potential for reducing vitamin A deficiencies in Tanzania, particularly in young children. It is estimated to be the most affordable source of this micronutrient, and can be incorporated into a number of popular foods. The crop can be grown across a range of climatic conditions and requires little land. Helen Keller International (HKI) estimates that the crop has potential to benefit 50 million children under six in the country.

Consumer preferences have posed an important challenge for increasing consumption of OFSP in African countries, including Tanzania. Adults tend to prefer white-fleshed sweet potatoes due to their higher dry matter content compared to OFSP. OFSP is, however, commonly used as a complementary food for infants. Studies of OFSP varieties with higher dry matter content have confirmed that they can be acceptable to consumers.

Sources: Low *et al.* (2007b); Hotz *et al.* (2012); Helen Keller International (2012); Van Jaarsveld *et al.* (2005).

Box 1.2 Undernutrition in Tanzania

Tanzania has among the world's highest rates of undernutrition, with around 2.4 million children malnourished and 42 per cent of children suffering from stunting. Deficiencies in micronutrients – which are required in small amounts but are crucial to children's health and development – are especially widespread. About one-third of children in Tanzania are deficient in iron and vitamin A. It is estimated that vitamin A deficiency will contribute to one out of ten child deaths between 2006 and 2015, while anaemia (in part caused by a lack of iron in diets) will contribute to one in five deaths of mothers during pregnancy. This report examines interventions to increase consumption of vitamin A.

Source: National Bureau of Statistics and ICF Macro (2011); Tanzania Food and Nutrition Centre (2012).

2 Methods

This case study provides a qualitative review of the experiences of programmes and interventions in Tanzania aiming to promote OFSP with the objective of reducing vitamin A deficiencies. It builds upon an earlier scoping exercise assessing the potential of several foods, including OFSP, for reducing undernutrition in Tanzania (Temu *et al.* 2014). This case study examines the extent to which interventions targeting OFSP have generated sustained activities at various stages in the value chain, including production by farmers, sale in various markets, processing activities and availability of products. The study is based on a desk review of project documents, research studies and publicly available databases. This was complemented by interviews with 23 key stakeholders including processors (one interviewee), developers of new products (one), project staff (five), secondary multipliers (two) and sweet potato traders (14). In addition, scoping was undertaken of marketplaces in the regions where OFSP is produced: Mwanza (four markets: Soko Kuu, Liberty, Buhongwa, Milongo), Geita (two markets) and Morogoro (two markets).

The remainder of the report is structured as follows: Section 3 introduces the status of sweet potato production in Tanzania, which is dominated by white-fleshed varieties. Section 4 reviews the activities of a number of interventions in the country that have sought to promote OFSP at various points along the value chain, and explores evidence on the extent to which they have been successful. Section 5 draws lessons from the interventions, examining the challenges facing OFSP and their relevance to efforts to promote other biofortified crops; and Section 6 makes recommendations for key stakeholders in Tanzania.

3 Sweet potato production in Tanzania

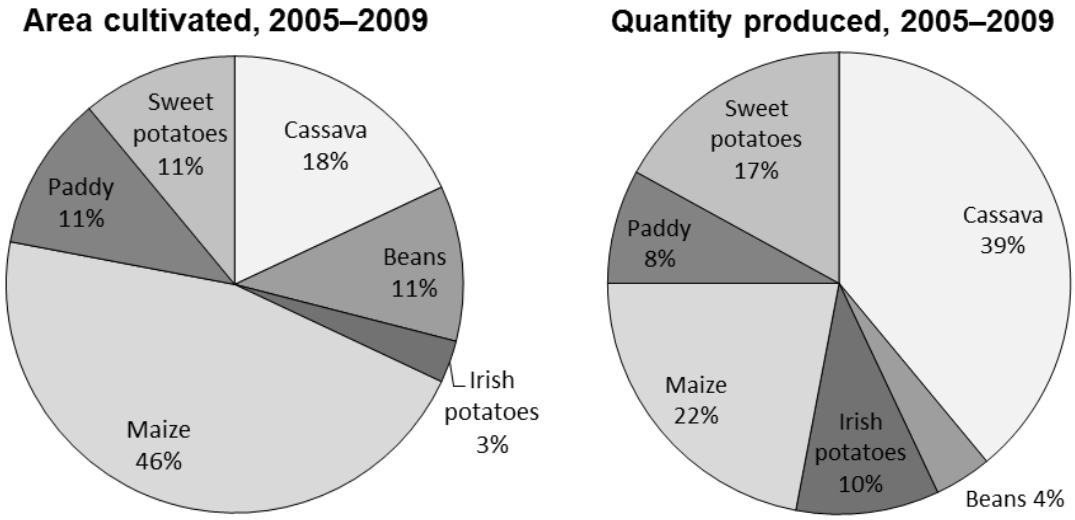
In Tanzania, the vast majority of sweet potato production is of white-fleshed varieties[2] (WFSP). WFSP, although a good source of calories, is not a good source of vitamin A or other micronutrients.[3] Sweet potato is among the five most important food crops in Tanzania in terms of area planted (acreage) and harvested volumes (tonnage) (Figure 3.1), with only maize and cassava produced in greater quantities. Tanzania produced an average of 2.4 metric tonnes (MT) of sweet potatoes annually between 2008 and 2012[4] (FAOSTAT 2013), making it the third largest producer in Africa.[5] The crop is produced, however, primarily for consumption by farming households themselves; maize, rice and beans are all more important cash crops than sweet potato. Sweet potato is regionally very important in the Lake Zone, where it is a primary staple food and produced by 99 per cent of farming households (Sindi and Wambugu 2012). It has advantages as a food security crop for vulnerable households, requiring little land and able to be stored in the ground for several months. In contrast, the crop's bulkiness and perishability increase transport costs. These factors notwithstanding, commercial markets exist for WFSP, and tubers are available in urban markets throughout the year.

Improved OFSP varieties first arrived in Tanzania in the Lake Zone, apparently brought from neighbouring regions in Rwanda and Uganda where agricultural initiatives had introduced them. Common varieties include Simama, Mataya, Kiegea, Kabode, Jewel, Carrot Dar and Carrot C.[6] After its introduction in the Lake Zone, OFSP gradually spread to other regions of the country. Nonetheless, uptake has been limited. Only a small number of farmers cultivate OFSP and, unlike WFSP, tubers are available in markets only in the areas of production and only during the production season. Even in the Lake Zone, only approximately 4 per cent of farmers produce OFSP (Sindi and Wambugu *op.cit.*).

OFSP in Tanzania is handled by the same value chain actors as WFSP. Value chains are 'short' and non-diversified. They are composed primarily of micro- and small-scale enterprises, which are particularly active in processing and retailing. A small number of small-to-medium-sized businesses make packaged OFSP products, while a growing number of kiosks sell products in urban areas. National supply chains for OFSP have only recently come into being, and are dominated by large traders who deal in various agri-food commodities. There are no specialised linkages such as contract farming schemes.

[2] The colour of tubers varies, including white- and cream-coloured varieties. For the purposes of this report, these varieties are grouped together as WFSP since none have substantial levels of pro-vitamin A.
[3] Most sources of agricultural data do not distinguish between OFSP and WFSP varieties; hence the data reported in this study are largely for sweet potatoes as a whole, encompassing all varieties.
[4] The findings in this section refer to combined white and orange-fleshed sweet potato, because production data are not disaggregated among the two varieties. However, anecdotal reports indicate that the majority of sweet potato produced and consumed in Tanzania is WFSP.
[5] The top-producing countries are Nigeria (3.3MT) and Uganda (2.7MT) (FAOSTAT 2013).
[6] Only Simama, Ukerewe, Kiegea and Mataya have been officially released in the country.

Figure 3.1 Production levels of major crops in Tanzania



4 Interventions to promote OFSP

Donor-funded research and interventions have played a central role in developing all stages of the OFSP value chain in Tanzania (from seed production to product retail) (Table 4.1). Most effort has been devoted to breeding new OFSP varieties, in order to improve dry matter content and pest resistance. Several projects have also supported the production and dissemination of planting materials[7] for improved varieties. In this way, the predominant approach used by projects has been the pre-farmgate strategy described in Section 1, focusing on increasing production and consumption by small farming households. In comparison, consumer-demand creation, processing, distribution and marketing of products have received much less attention. Projects have tended to assume that OFSP would seamlessly fit into the pre-existing value chains for WFSP and that consumers would readily take up the new food (Temu *et al.* 2014). This section reviews the outcomes of interventions at each stage of the OFSP value chain.

4.1 Planting materials and OFSP production

Projects including Dissemination of New Agricultural Technologies for Africa (DONATA), Marando Bora, *Reaching Agents of Change* (RAC), Tanzania Home Economics Association (TAHEA) and Kituo cha Mafunzo ya Kuboresha Mazingira na Kilimo Adilifu (KIMKUMAKA) have promoted production of planting materials, usually by contracting commercially oriented private farmers to multiply vines,[8] which are then distributed for free to poor, smallholder farmers. Project reports indicate that this approach reached large numbers of farmers. For example, the Marando Bora project claimed to have reached 100,000 families in 2012. Project-sponsored vine distribution systems have provided attractive opportunities for better equipped, commercial farmers who have supplied vines while demand from projects persisted. However, they have not translated into viable commercial value chains. A survey of secondary multipliers indicated that, in the absence of the assured markets provided by projects, some multipliers withdrew from the programme due to the low willingness and ability to pay of farmers in the area.

Data are scarce, but those that are available indicate that, despite projects' efforts, only a small minority of households in intervention districts grow OFSP. In 2012, a survey in the Lake Zone by Marando Bora found that, of more than 600 households surveyed, while 99 per cent grew WFSP, only 7 per cent grew OFSP. However, lack of data makes it difficult to assess the true extent of production. While reports by DONATA, Marando Bora, TAHEA and RAC indicate the number of vines distributed and the number of households reached, they provide no information on the area or quantity of OFSP produced. One project reported having distributed 99,000 vines during one year. However, this translates to a production area of only three acres at recommended planting densities. These reports suggest that OFSP production remains very limited.

[7] OFSP is propagated through fresh vegetative cuttings, rather than through seed.
[8] These contracted farmers are known as secondary multipliers.

Table 4.1 Programmes promoting OFSP in Tanzania

Programme	Implementing institute	Time frame; areas; funding	Major activity and focus	Outcome
DFID[9] – Crop protection	Kagera Agricultural and Environmental Management Project	2002–05 Kagera and Zanzibar Funding: DFID	● Focus on smallholder farmers ● Main crop sweet potato including OFSP ● Capacity building – training through farmer field schools and dissemination materials	A number of training sessions and farmer field schools during the project timeline in Kagera and Zanzibar
DONATA	LZARDI,[10] local governments, NGOs (Kolping Society of Tanzania and TAHEA), SIDO,[11] managed by ASARECA	2008–12 Mainly the Lake Zone of Tanzania Funding: African Development Bank	● Focus on the poor rural farmers ● Seed multiplication and distribution of vines with main ● Training – extension officers and farmers ● Processing and technology dissemination through farmer groups	At the time of project completion about 2,800 home-based processors were trained and were processing[12] in their small groups Varieties promoted in Tanzania: Carrot C, Carrot Dar, Ejumula and Jewel 2.2 hectares under OFSP multiplication in Tanzania ToT – 169 extension agents; 1,378 farmers trained
SPHI[13] SASHA[14] Marando Bora	CIP	2009–14 Mainly the Lake Zone of Tanzania Funding: Bill and Melinda Gates Foundation	● Focus on small holder producers in rural areas ● Breeding improved quality and pest-resistant varieties from primary countries and disseminate the same in Tanzania ● Scale up production of improved variety vines ● Form groups for distribution and processing	Introduction of new OFSP varieties Had reached 10,000 households in 2011 through improved vines distribution, planned to reach 150,000 households through decentralised vine multipliers and mass distribution strategies

(Cont'd.)

[9] Department for International Development
[10] Lake Zone Agricultural Research and Development Institute.
[11] Small Industries Development Organisation, Tanzania
[12] Our survey indicated no evidence of their processing, their products are not available in the markets; they could be processing for home consumption.
[13] Sweetpotato for Profit and Health Initiative.
[14] Sweetpotato Action for Security and Health in Africa.

Table 4.1 (cont'd.)

Programme	Implementing institute	Time frame; areas; funding	Major activity and focus	Outcome
Eat Orange Tanzania	HKI[15]	2009 – Two districts in Mwanza region – Ukerewe and Sengerema Funding: Monsanto Fund	Their main focus is reducing vitamin A deficiency among children under five, pregnant and lactating women through: ● Nutrition education ● Formation of internal savings groups to improve access to credit ● Supplying OFSP planting materials ● Linking producers to market opportunities e.g. projects buying clean OFSP vines	The project claims to have reached 6,000 community members in 1,200 households living in the Sengerema and Ukerewe districts of Mwanza through nutritional education and/or vines distribution/internal savings groups
Reaching Agents of Change	HKI, CIP	2011–14 Throughout Tanzania Funding: Bill and Melinda Gates Foundation	● Focus on local government and extension workers that will eventually train smallholder farmers in rural producing areas ● Advocate for investment in OFSP ● Train agricultural extension workers ● Distribute clean OFSP vines	Increased investment on OFSP development projects (RAC 2003)
Sweet potato Improvement	NARS,[16] Ukiliguru	2009–12 Lake Zone Funding: AGRA[17]	Breeding	
Promotion of OFSP	NARS, Kibaha	2012–14 Eastern and Central Zone COSTECH[18]	Sweet potato value chain development	

Source: Authors' own.[19]

[15] Helen Keller International.
[16] National Agricultural Research System.
[17] Alliance for a Green Revolution in Africa.
[18] Commission for Science and Technology, Tanzania.
[19] Most of the interventions were part of different projects with differing objectives; none of them aimed to promote commercialisation of the crop in particular.

4.2 Storage, transport and wholesaling

As discussed, storage and transport of OFSP are expensive due to tubers' perishability. Several projects have promoted improved storage technologies, primarily limited to simple, low-cost techniques, including pit storage, drying and processing into chips. These technologies are geared towards micro-scale operations for subsistence rather than commercialisation. Field survey findings indicate that traders and middlemen prefer WFSP and generally do not purchase OFSP, due to low demand and short shelf life. The market for OFSP is thin, with demand coming from small numbers of consumers. In the four markets visited in Mwanza, the margins for WFSP were higher than those for OFSP (the selling prices were more or less the same). Low demand by traders and middlemen appears to severely hamper the commercialisation of OFSP value chains.

4.3 Processing and product development

Processing has the potential to help address OFSP tubers' perishability, and to make OFSP products more acceptable to urban consumers. However, OFSP processing remains in its infancy; most OFSP in Tanzania is sold in the form of raw tubers. A number of projects have aimed to promote OFSP processing, primarily through training farmers to undertake simple, micro-scale processing techniques. The DONATA project trained 2,800 farmers (primarily women) and organised them into groups to begin making products. Beyond micro-operations, most interventions have not sought to foster larger-scale processing efforts; only one or two examples of mechanised OFSP processing were identified in the survey. As part of the DONATA project, TAHEA linked OFSP farmers to Nurti Products Co. Ltd, a small-scale processing enterprise making OFSP flour and chips. The company has been purchasing fresh OFSP roots from farmers in Misungwi and Sengerema Districts. However, demand for these products remains extremely low and the company has very small capacity (Box 4.1). Helen Keller International, through the Reaching Agents of Change project, has introduced a number of OFSP products including juices, flour and pastries. Interest in OFSP has come from the private Sokoine University Graduate Entrepreneurs Cooperative (SUGECO), which has developed formulations for OFSP whole breads, cookies and biscuits. Initial trials have indicated that these products can be acceptable to consumers, although they have yet to be marketed at scale. However, for the most part, current efforts have not led to products that are available commercially. No processed OFSP products were found in shops or stands during the survey of Mwanza's main market (Soko Kuu); products manufactured by SUGECO are available in Morogoro City, but thus far at a very limited scale.

Box 4.1 Mechanised processing: Nurti Products Co. Ltd

Nurti Products Co. Ltd is a private firm involved in OFSP vine multiplication and processing of tubers. The company works with donor-funded projects TAHEA, RAC and KIMKUMAKA. Their main products are OFSP flour and chips, which the enterprise sells to retailers and individual consumers. Despite the firm's small scale of operations, it is not operating at full capacity due to low demand. According to a company representative, 'currently we are supplying to only one "big" retailer that buys 25kg per month, the rest is sold to individual consumers'. Nurti Products sees its main challenges as low awareness among consumers, low dry matter content of available OFSP varieties and lack of public support.

Source: Interviews.

4.4 Marketing and awareness building

Over the past decade, a number of projects have aimed to increase sensitisation and awareness about OFSP as a source of vitamin A. These include local government initiatives to link maternal health clinics with OFSP education, awareness campaigns on radio and in newspapers variously sponsored by SASHA, the Eat Orange campaign and the Reaching Agents of Change project. Available evidence, however, suggests that the impact of these activities may be limited. One study conducted by Marando Bora in 2012 found that more than 60 per cent of households in the Lake District either did not know that OFSP was healthier than WFSP, or believed that WFSP was healthier. Similar trends are seen in consumption behaviour; a seven-day recall survey found that 51 per cent of households reported eating WFSP, compared to just 2 per cent for OFSP (Sindi and Wambugu 2012). Low awareness and even lower consumption indicate serious challenges for projects aiming to promote OFSP and generate demand. These challenges are reflected in widespread retailing practices: OFSP and WFSP tubers are generally displayed side-by-side and sold at the same price, making it more difficult for consumers to differentiate between the two varieties.

As mentioned above, the obvious colour difference between OFSP and WFSP provides a major advantage for marketing and raising public awareness. Unlike many other nutrient-rich foods (such as zinc-biofortified rice or fortified wheat flour[20]) consumers and retailers alike can easily distinguish OFSP from the nutrient-poor alternative (WFSP). Indeed, interventions targeting OFSP in other countries have used the orange colour to substantial advantage (Box 4.2). Market surveys in Mwanza revealed that, despite awareness-raising campaigns, the orange colour was not being used by retailers to market the nutritional advantages of OFSP. Market research also revealed a challenge with OFSP processed products (such as breads): the 'golden' colour of OFSP bread is easily mimicked by processors who add food colouring to their products. As mentioned, in this respect processed-OFSP products are similar to many other product types: it is difficult to signal to consumers which products are nutrient-rich (Anim-Somuah *et al.* 2013; Temu *et al.* 2014). This poses a challenge for ensuring nutritional quality and building consumer trust; potential solutions are discussed in Section 5.

Box 4.2 OFSP interventions in other countries

Although a number of programmes have promoted OFSP in Tanzania, more intensive investments have been made in neighbouring countries. Much of the evidence on the impacts of OFSP comes from work in Uganda (Coote *et al.* 2011) and Mozambique (HarvestPlus 2010; Low *et al.* 2007a; Westby *et al.* 2011). The primary focus of these projects has been breeding, disseminating new varieties and awareness campaigns to encourage consumption. A sub-set have also supported local value chain development for OFSP products in intervention districts, including a branding campaign and training for market sellers (Coote *et al.* 2011; Westby *et al.* 2011). Study results showed that more consumers purchased OFSP in Ugandan markets where it had been promoted than in those where it had not (Coote *et al.* 2011). In Mozambique, the proportion of OFSP compared to WFSP increased 'from virtually 0 per cent in 2006 to 18 per cent in 2008 and to 50 per cent in 2009.' (Westby *et al.* 2011: 23). Price differentials arose in four out of five urban markets in Mozambique, but did not emerge in Uganda. These differentials were not the result of nutrition awareness alone, but also the limited supply of OFSP and faster turnover time.

[20] Where there is no clear visual distinction between products (such as fortified flours, sprinkles, etc.), there is a risk that fraudulent, unfortified products will be 'passed off' as fortified ones. This undermines consumer confidence. Various regulatory and certification options exist to deal with this problem (see Robinson *et al.* 2014).

5 Lessons from case study

Overall, efforts to promote OFSP production and consumption in Tanzania have made very slow progress. Despite investments in training farmers and distributing improved planting materials, only a small fraction of farmers produce OFSP, even in the Lake Zone where the crop was heavily promoted. This is accompanied by very low demand for OFSP products in local and national markets, providing few incentives for commercial involvement in production or processing. Value chains are fragmented, poorly coordinated and characterised by sporadic micro-scale activities. This state is perhaps unsurprising given that there was not a previously established value chain for the crop, and that project interventions have been largely localised and uncoordinated. It is notable that no major OFSP project in Tanzania has focused on commercialising the crop or developing the broader value chain. The challenges encountered in Tanzania point to a number of important lessons for agriculture and value chain initiatives that seek to reduce micronutrient deficiencies.

5.1 Biofortification strategy requires developing support systems

Biofortification initiatives have been successful in developing new crop varieties rich in key micronutrients; nutrition studies of several crops have shown that, when consumed regularly, they can increase micronutrient intake and potentially reduce micronutrient deficiencies. The Tanzania OFSP case suggests that biofortification efforts face barriers to achieving widespread uptake among farmers and consumers. Doing so is likely to require developing support systems at different stages of the value chain. The first and most obvious of these are seed systems. In Tanzania, projects supplied large numbers of farmers with planting materials, but they did not create the conditions for seed systems to continue after interventions ceased. Although this was not an explicit aim of these projects, future efforts to introduce biofortified crops could have a greater impact if they sought to help develop viable commercial seed systems. Whether commercial seed systems will provide access to the households most vulnerable to undernutrition requires further research. Ongoing public subsidy may be necessary to ensure that biofortified crops such as OFSP reach the most vulnerable households, at least in the short- and medium-terms. Public systems can be designed to complement, rather than crowd out, private seed systems.

In addition to seed, other support systems are needed at the stages of marketing and retail. In Tanzania, OFSP public awareness campaigns have not connected with marketing systems for agri-products; as a result, traders have found it continues to be more profitable to deal in WFSP than OFSP. Lessons can be learned from programmes in Mozambique, which worked with local traders and retailers to promote OFSP, and witnessed increasing uptake (see Box 4.2). Finally, the Tanzania case highlights the importance of quality assurance systems at the processing and retail stages. Since, once OFSP has been processed into breads and other foods, its orange-colour can no longer be relied upon to distinguish it from less nutritious products, strategies are needed to ensure products' nutritional quality. These include branding, certification or regulatory systems, and can be implemented by various combinations of public and private actors (for examples, see Robinson *et al.* 2014). Regardless of the specific options pursued, the broader lesson is that introducing and sustaining biofortified crop production – whether for home consumption or market distribution – requires analysis of and investments in strengthening a range of support systems across the value chain.

5.2 Commercial opportunities are important for crop adoption

Most efforts to introduce nutrient-rich crops and agri-products have focused on increasing consumption within farming households themselves, focusing on the most vulnerable households. The Tanzania OFSP case, however, provides an important lesson: in some cases, home consumption alone does not provide sufficient incentive for farming households

to adopt a new crop. The case showed that the lack of market demand for OFSP tubers appeared to have discouraged small farmers from growing the crop. Addressing this requires attention to the wider decision-making context facing farming households. Given their vulnerability to food insecurity and extreme capital constraints, small farmers can have strong preference for crops that can be used both for food and for sale. This flexibility can help them to maximise food security and meet critical cash needs (Berger 2001; Marra, Pannell and Ghadim 2003; Eugenio *et al*. 2012). While previous research has noted that establishing markets post-farmgate can distribute nutrient-rich crops to a wider population (Hawkes and Ruel 2011; Henson and Humphrey 2014), it has not highlighted how commercial opportunities may be important for crop uptake, even when the aim is to improve nutrition pre-farmgate. Assessing whether this trend is generalised requires further, case-specific and comparative research. The problem is complex since, in some cases, commercialisation can direct nutrient-rich products away from poor households and towards more lucrative urban or export markets.[21]

5.3 Dual strategies to reach the vulnerable and develop value chains

Interventions promoting OFSP have faced a tension between targeting the poorest farmers who are most vulnerable to undernutrition and catalysing commercial production. The Tanzania case suggests that poor farming households are unlikely to rapidly adopt a new crop such as OFSP. The challenge then is to create demand for OFSP and catalyse the development of viable value chains that incentivise production by both asset-poor and commercial-scale farmers. Given that past efforts in Tanzania have not had a commercial orientation, there is a dearth of evidence about how this might be achieved, and about the potential nutrition impacts. There have not thus far been assessments to consider whether poor households can afford commercially produced OFSP vines, or whether processed foods derived from OFSP can be sold at affordable prices to the urban poor. One option for interventions is to pursue a dual strategy. In order to increase consumption of OFSP among the rural poor, donor- and government-funded initiatives may want to subsidise the supply of vines for these households (through voucher systems, etc.). This would also create a reliable source of demand for planting materials, stimulating private involvement in commercial seed production. In parallel, support for nutrition awareness campaigns and innovative product development could help to build demand for processed OFSP products in urban areas – likely to be among wealthier households. These efforts could create incentives for farmers to adopt OFSP and catalyse the emergence of more coordinated value chains. There is a need for in-depth assessment of this potential, drawing on lessons from market promotion in places such as Mozambique.

5.4 Better information on consumer preferences and demand

In order for there to be substantial demand for OFSP, it must serve as an 'improved substitution product', being either lower cost or higher quality than alternative foods. At present, the crop does not meet either of these criteria. Although nutritionally superior to WFSP, OFSP performs more poorly on dry matter content, shelf life, storability and handling qualities. Furthermore, it offers lower profit margins to traders and intermediaries. These are fundamental barriers to OFSP entering the established value chains used for WFSP, and appear to be reflected in the small number of households (2 per cent) that reported eating OFSP in the dietary recall survey. Yet available data are insufficient for drawing firm conclusions about how to make OFSP more appealing to consumers. No robust consumer studies have been conducted in East Africa to establish consumer preferences and trade-offs between attributes of sweet potato varieties, and small-scale surveys funded by projects

[21] At present, this is not a problem for OFSP in Tanzania, since urban markets are in their nascent stages and OFSP does not command a high price.

have tended to collect stated preference information, which may be biased by what respondents aspire to, rather than their actual behaviours (Alphonce, Alfnes and Sharma 2014). Funding rigorous consumer research is therefore an immediate priority to inform future interventions targeting OFSP and other nutrient-rich crops.

5.5 Signalling value where regulation is poor

One of the principle advantages of OFSP as a nutrient-rich food is the orange colour which distinguishes tubers from WFSP. This provides a 'signal' to consumers and value chain actors that confirms the product's nutritional quality. As documented in a number of other cases (Nwuneli *et al.* 2014; Robinson *et al.* 2014), foods that lack clear signalling mechanisms face major problems from fraudulent 'pass-off' products and difficulty building consumer trust, particularly in contexts where regulatory capacity is poor. Yet OFSP initiatives in Tanzania have not taken full advantage of this trait. Although awareness campaigns have targeted small farmers and some consumers, they have not used the colour advantage to promote OFSP with traders, wholesalers and retailers. The Mozambique case suggests that these efforts can be fruitful in promoting OFSP value chain development (Box 4.2). A second implication of the colour advantage is that the promotion value-added products derived from OFSP should be approached with caution. It is clear that certain products, such as OFSP bread, do not have the colour signalling advantage, since their orange/yellow colour can be easily faked using colouring agents.[22] Given that the industry is dominated by informal businesses selling unlabelled products, and that regulating bodies such as the Tanzania Food and Drugs Authority have difficulty enforcing quality standards even for the smaller range of products covered by the National Fortification Programme (Robinson *et al.* 2014), it is unrealistic to expect that effective quality assurance will be established for OFSP in the short term. Interventions seeking to promote value-added OFSP products will need to put strategies in place for ensuring the nutritional quality of end-products to consumers. They might, for example, investigate the feasibility of local certification schemes e.g. Masters, Kuwornu and Sarpong (2011).

[22] It should be noted that fraudulent products would only become a problem if (a) there was substantial demand for these products, and (b) OFSP commanded a higher price than alternative ingredients. If these conditions were met, food processors would have an incentive to substitute other flours in place of OFSP in order to reduce costs while achieving the higher price point for OFSP products. At present, these conditions are not present in Tanzania.

6 Implications for intervention and policy

Thus far, OFSP value chains in Tanzania have been led by donor-funded initiatives, NGOs and government institutions. There has been no clear policy support from government that could have helped coordinate various project activities, build demand or generate support from private businesses. Given low levels of demand at present, developing OFSP value chains will continue to require substantial and strategic public support. This does not mean that private sector actors will not play a key role. Past interventions have shown that publicly funded distribution systems created opportunities for commercial farmers to produce OFSP planting materials at scale. However, they have had less success in catalysing private involvement in marketing and distributing OFSP. Future interventions could incentivise private sector involvement at other stages of the value chain, including production, distribution, processing and retail. These efforts should be designed to create the conditions that make private sector involvement commercially viable in the long term. A proof of concept study conducted in Rwanda by CIP (2010) shows that involvement of government in establishing contract farming of OFSP to supply to a processing business can lead to ongoing production. In Tanzania, there is potential for value chains to develop that market value-added OFSP products to wealthier urban consumers, who demand alternative meal preparation options and convenience. Interventions need to assess whether such products can be made affordable and accessible to the urban poor.[23] Given the importance of commercial opportunities for uptake even among small-scale farmers, stimulating demand for OFSP appears to be the key for triggering value chain development. As a starting point, this requires better information about consumer preferences in Tanzania.

Based on the findings presented in this case study, two intervention pathways are recommended in order to address the needs of rural farming households, while also building demand necessary for wider uptake. Other recommendations are listed in Box 6.1.

Public distribution/purchasing will continue to be essential to reaching vulnerable farming households, and incentivising production of planting materials by commercial farmers. Public purchasing of OFSP tubers for use in programmes such as school feeding could provide a further source of demand.

Value chain development to link farmers to new sources of demand. The key is to increase demand through awareness raising campaigns, while supporting the development of new products that appeal to urban consumer preferences. Demand will trigger involvement by private sector actors across the value chain.

[23] Given that stunting rates are above 35 per cent for the bottom three wealth quintiles in Tanzania (National Bureau of Statistics and ICF Macro 2011), there is a role for the market mechanisms to play in order to reach the middle 20 per cent, even though they are unlikely to provide products that are affordable to the bottom 40 per cent.

Box 6.1 Recommendations for promoting OFSP in Tanzania

Government, donor agencies and NGOs should:

- Continue to fund distribution of OFSP vines, school feeding programmes, etc. in order to incentivise uptake by farmers and reach the rural poor.
- Analyse the 'ecosystem' for crop introduction and value chain development. Make strategic investments to support the development of support systems for seed, marketing and quality assurance.
- Improve coordination between programmes in order to improve coverage and maximise impact.
- Fund large-scale behaviour change campaigns to increase awareness of the nutritional benefits of OFSP and the importance of its orange colour and to stimulate demand.
- Fund research on consumer preferences and willingness-to-pay under real-world conditions.
- Support new product development by research institutions and private companies to make products appeal to consumer preferences. Encourage bakeries, manufacturers, restaurants, hotels, etc. to use OFSP products.
- Continue to fund breeding efforts to improve dry matter content, shelf life and disease resistance.

Private businesses involved in OFSP value chains should:

- Explore new business models for producing improved OFSP planting material at low cost.
- Develop OFSP products that maintain pro-vitamin A content and appeal to consumer preferences.
- Partner with NGOs and public agencies to provide public nutrition awareness about OFSP.
- Use OFSP's colour to communicate its advantages to consumers. Differentiate OFSP and WFSP through marketing activities.

References

Allen, L.; De Benoist, B.; Dary, O. and Hurrell, R. (eds) (2006) *Guidelines on Food Fortification with Micronutrients,* Geneva: World Health Organization (WHO); Rome: Food and Agriculture Organization (FAO)

Alphonce, R.; Alfnes, F. and Sharma, A. (2014) 'Consumer vs Citizen Willingness to Pay for Restaurant Food Safety', *Food Policy* 49.1: 160–6

Anim-Somuah, H.; Henson, S.; Humphrey, J. and Robinson, E. (2013) *Strengthening Agri-Food Value Chains for Nutrition: Mapping Value Chains for Nutrient-Dense Foods in Ghana*, IDS Evidence Report 2, Brighton: IDS

Berger, T. (2001) 'Agent-based Spatial Models Applied to Agriculture: a Simulation Tool for Technology Diffusion, Resource Use Changes and Policy Analysis', *Agricultural Economics* 25.2–3: 245–60

Bouis, H.; Low, J.; Mcewan, M. and Tanumihardjo, S. (2013) *Biofortification: Evidence and Lessons Learned Linking Agriculture and Nutrition*, Rome: FAO and WHO

Bouis, H.E. and Haddad, L.J. (1990) *Agricultural Commercialization, Nutrition, and the Rural Poor: a Study of Philippine Farm Households*, Boulder: Lynne Rienner Publishers, Inc

CIP (2011) *Sweetpotato for Profit and Health Initiative*, http://sweetpotatoknowledge.org/sweetpotato-introduction/overview/sweetpotato-for-profit-and-health-initiative (accessed 20 January 2015)

CIP (2010) *Sweetpotato Value Chains that Work for Women and the Poor: a Proof of Concept Action Research Project in Rwanda,* CIP, http://sweetpotatoknowledge.org/ (accessed 21 January 2015)

Coote, C.; Tomlins, K.; Massingue, J.; Okwadi, J. and Westby, A. (2011) 'Farmer, Trader, and Consumer Decisionmaking: Toward Sustainable Marketing of Orange-Fleshed Sweet Potato in Mozambique and Uganda', *Leveraging Agriculture for Improving Nutrition and Health Note*, New Delhi: International Food Policy Research Institute

Eugenio, C.; Ferrari, E.; Bollani, L. and Coccia, M. (2012) 'Attitudes and Behaviour of Adopters of Technological Innovations in Agricultural Tractors: a Case Study in Italian Agricultural System', *Agricultural Systems* 130: 44–54

FAOSTAT (2013) *Food and Agriculture Organization of the United Nations*, http://faostat.fao.org/default.aspx (accessed 2 February 2015)

Haddad, L. (2013) *Ending Undernutrition: Our Legacy to the Post 2015 Generation*, London and Brighton: Children's Investment Fund Foundation and IDS

HarvestPlus (2010) *Disseminating Orange-fleshed Sweet Potato: Findings from a HarvestPlus Project in Mozambique and Uganda*, Washington DC: HarvestPlus

Hawkes, C. and Ruel, M.T. (2011) 'Value Chains for Nutrition', in S. Fan (ed), *Leveraging Agriculture for Improving Nutrition*, Washington DC: International Food Policy Research Institute

Headey, D. (2012) ‘Turning Economic Growth into Nutrition-sensitive Growth’, in S. Fan and R. Pandya-Lorch (eds), *Reshaping Agriculture for Nutrition and Health*, pp. 39–46, Washington DC: International Food Policy Research Institute, www.ifpri.org/sites/default/files/publications/oc69ch05.pdf (accessed 20 January 2015)

Helen Keller International (2012) *Orange-fleshed Sweet Potato: Situation Analysis and Needs Assessment: Tanzania Report*, Dar es Salaam: Helen Keller International

Henson, S. and Humphrey, J. (2014) ‘Assessing the Effectiveness of Agri-Food Value Chain Interventions Aimed at Enhancing Consumption of Nutritious Food by the Poor: Conceptual Framework’, *LANSA Review of Agri-Food Value Chain Interventions*, Brighton: LANSA

Henson, S.; Humphrey, J. and McClafferty, B. (2013) *Nutritious Agriculture by Design: a Tool for Programme Planning*, *IDS-GAIN Discussion Paper*, Washington DC: Global Alliance for Improved Nutrition

Hotz, L.; Loechl, C.; Lubowa, A.; Tumwine, J.K.; Ndeezi, G.; Nandutu Masawi, A.; Baingana, R.; Carriquiry, A.; de Brauw, A.; Meenakshi, J.V. and Gilligan, D.O. (2012) ‘Introduction of ß-Carotene-rich Orange Sweet Potato in Rural Uganda Results in Increased Vitamin A Intakes among Children and Women and Improved Vitamin A Status among Children’, *Journal of Nutrition* 142: 1871–80

Le Cuziat, G. and Mattinen, H. (2011) *Maximising the Nutritional Impact of Food Security and Livelihoods Interventions: A Manual for Field Workers*, Montreal: ACF International

Low, J.W.; Arimond, M.; Osman, N.; Cunguara, B.; Zano, F. and Tschirley, D. (2007a) ‘Ensuring the Supply of and Creating Demand for a Biofortified Crop with a Visible Trait: Lessons Learned from the Introduction of Orange-fleshed Sweet Potato in Drought-prone Areas of Mozambique’, *Food and Nutrition Bulletin* 28.2 Suppl: S258–70

Low, J.W.; Arimond, M.; Osman, N.; Cunguara, B.; Zano, F. and Tschirley, D. (2007b) ‘A Food-based Approach Introducing Orange-fleshed Sweet Potatoes Increased Vitamin A Intake and Serum Retinol Concentrations in Young Children in Rural Mozambique’, *Journal of Nutrition* 137.5: 1320–7

Marra, M.; Pannell, D.J. and Ghadim, A.A (2003) ‘The Economics of Risk, Uncertainty and Learning in the Adoption of New Agricultural Technologies: Where Are We on the Learning Curve?’, *Agricultural Systems* 75. 2–3: 215–34

Masters, W.A.; Kuwornu, J. and Sarpong, D. (2011) *Improving Child Nutrition through Quality Certification of Infant Foods: Scoping Study for a Randomized Trial in Ghana*, Working Paper, London: International Growth Centre, London School of Economics

National Bureau of Statistics and ICF Macro (2011) *Tanzania Demographic and Health Survey: Key Findings*, Calverton, Maryland: NBS and ICF Macro

Nwuneli, N.; Robinson, E.; Humphrey, J. and Henson, S. (2014) *The Role of Business in Providing Nutrient-rich Foods for the Poor: Two Case Studies in Nigeria*, IDS Evidence Report 64, Brighton: IDS

Robinson, E.; Temu, A.; Waized, B.; Ndyetabula, D.; Humphrey, J. and Henson, S. (2014) *Policy Options to Enhance Markets for Nutrient-dense Foods in Tanzania*, IDS Evidence Report 90, Brighton: IDS

Ruel, M.T. and Alderman, H. (2013) ‘Nutrition-sensitive Interventions and Programmes: How Can they Help to Accelerate Progress in Improving Maternal and Child Nutrition?’, *The Lancet* 6736.13: 1–16

Sindi, K. and Wambugu, S. (2012) *Going-to-Scale with Sweet Potato Vines Distribution in Tanzania: Marando Bora Baseline Study,* Milestone Report OB3BMS2.1C1, Nairobi: CIP

Tanzania Food and Nutrition Centre (2012) *Tanzania Assessment for Scaling Up Nutrition*, Dar es Salaam: Scaling Up Nutrition

Temu, A.; Waized, B.; Ndyetabula, D.; Robinson, E.; Humphrey, J. and Henson, S. (2014) *Mapping Value Chains for Nutrient-dense Foods in Tanzania*, IDS Evidence Report 76, Brighton: IDS

Van Jaarsveld, P.; Faber, M.; Tanumihardjo, S.A.; Nestel, P.; Lombard, C.J. and Benadé, A.J.S. (2005) 'β-Carotene-rich Orange-fleshed Sweet Potato Improves the Vitamin A Status of Primary School Children Assessed with the Modified-Relative-Dose-Response Test', *The American Journal of Clinical Nutrition* 1:1080–87

Westby, A.; Coote, C. and Tomlins, K. (2011) 'Increasing the Production, Availability, and Consumption of Vitamin A–rich Sweet Potato in Mozambique and Uganda', in C. Hawkes and M. T. Ruel (eds), *Value Chains for Nutrition*, New Delhi: International Food Policy Research Institute

World Bank (2014) *World Development Indicators,* Washington DC: World Bank, http://data.worldbank.org/data-catalog/world-development-indicators (accessed 29 January 2015)

Brighton BN1 9RE

T +44 (0)1273 606261
F +44 (0)1273 621202
E ids@ids.ac.uk
www.ids.ac.uk