EVIDENCE REPORT
No 76

Reducing Hunger and Undernutrition

Mapping Value Chains for Nutrient-Dense Foods in Tanzania

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June 2014

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.

Input was provided by Sokoine University of Agriculture, Tanzania.

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: 5

MAPPING VALUE CHAINS FOR NUTRIENT-DENSE FOODS IN TANZANIA

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June 2014

First published by the Institute of Development Studies in June 2014

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Acronyms

AGRA	Alliance for a Green Revolution in Africa
CIP	International Potato Center
COSTECH	Commission for Science and Technology
DFID	Department for International Development
GAIN	Global Alliance for Improved Nutrition
OFSP	orange-fleshed sweet potato
PICS	Purdue Improved Crop Storage
RAE	Retinol Activity Equivalents
SMEs	small and medium-sized enterprises
TBS	Tanzania Bureau of Standards
TDHS	Tanzania Demographic and Health Survey
TFDA	Tanzania Food and Drugs Authority
URT	United Republic of Tanzania
WFSP	white-fleshed sweet potato
USAID	United States Agency for International Development

Executive summary

This report details the findings of an analysis of value chains for several nutrient-dense foods in Tanzania. It rapidly assesses the potential of ten commodities to contribute to reducing undernutrition and identifies three with particularly high potential. It then systematically examines issues at the various stages of these value chains, in order to identify barriers that inhibit the extent to which the product is likely to mitigate micronutrient undernutrition. The report recommends options for development agencies, governments, public–private partnerships and other development actors seeking to strengthen the linkage between agricultural activities and nutrition outcomes. It is accompanied by two other reports on Tanzania: a case study of a particular food processing business and an analysis of policy options.

Chronic undernutrition is a critical problem in Tanzania, with alarmingly high rates of stunting and micronutrient deficiencies leading to cumulative losses of US$3.7bn over five years according to one estimate. Particular problems include low consumption of iron-rich foods by women, poor infant feeding practices and widespread use of inadequate complementary foods. Food-based approaches, especially those that deliver key micronutrients to the '1,000 days group', appear to have a key role in reducing rates of undernutrition in the country.

An expert stakeholders' workshop was convened to rapidly review experiences with ten commodities considered to have potential for nutrition. Of these, three were chosen for more in-depth study: cowpea, orange-fleshed sweet potato (OFSP) and complementary foods. The report provides an overview of these three value chains. Considerable numbers of businesses, especially small enterprises, are involved, particularly at the stages of food processing and retail. The report maps the value chains for these focal products, concentrating on whether they meet five key criteria necessary for foods to be able to mitigate micronutrient undernutrition: availability, affordability, acceptability, nutritional quality, and effective signalling of this quality to purchasers. The report then examines issues at each stage of the value chains for the focal products: production, storage/transport, processing and distribution/retail. It identifies key barriers facing these foods and assesses a set of potential responses to the barriers. The main findings are as follows:

Cowpeas are primarily a subsistence crop, although in some areas they are sold and eaten as a protein source or snack food. Cowpeas have the advantage of being a very low-cost source of protein, iron and folates. Further, there is potential to leverage consumers' familiarity with other types of pulses to increase consumption. Yet important barriers remain: demand is low and the crop is still not widespread in commercial markets. It has largely been neglected by public agricultural support programmes. Cowpea is also highly susceptible to post-harvest losses; traders use dangerous chemicals to prevent pest damage, but this creates health risks for consumers. To address these problems, interventions can seek to promote the use of low-cost and safe storage techniques. Social marketing campaigns can also increase awareness of the benefits of eating cowpeas and create greater consumer demand. Support can also be provided to foster business models that deliver new, nutrient-dense cowpea foods to a wide group of consumers.

Orange-fleshed sweet potato (OFSP) is exceptionally rich in vitamin A and can be produced at low cost in many regions of Tanzania. It is well suited for use as a complementary food for young children. However, at present, both producers and consumers prefer white-fleshed varieties of sweet potato – which contain few micronutrients – to the orange varieties. Furthermore, markets for OFSP are poorly developed and availability is low. Several donor-funded initiatives have aimed to increase production of improved varieties of OFSP, but they have not addressed marketing and demand issues. Future interventions should support new products in order to make OFSP appeal to consumer tastes, while social

marketing should be used to increase consumer awareness and to encourage traders to promote and market OFSP to their customers. Finally, supporting processors to scale up new products could make OFSP more acceptable to urban consumers. The orange colour of OFSP tubers is a key advantage for this crop: it allows consumers to easily distinguish it from white varieties, creating a potential for businesses to specialise in OFSP. The key to strengthening OFSP is to increase consumer demand through social marketing and by working with traders and retailers.

Complementary food products. Complementary foods made from mixes of cereals and legumes already have a positive impact on nutrition in Tanzania. There is robust demand and a large number of enterprises involved in making these products. However, many do not contain sufficient nutrients to support infant growth and development, and products can be contaminated with pathogens or aflatoxins. Meanwhile larger firms' products are not affordable for poor consumers. Interventions need to address market constraints so that businesses can sell safe and nutritionally adequate products at an affordable price. Policy actors can choose from a number of approaches; in-depth assessments will be needed to evaluate the risks and benefits of each. If policymakers aim to introduce quality controls in the complementary food market, they will need to organise the small enterprises into clusters so that it is easier to engage with and monitor them. This could be accompanied by a voluntary certification system that would distinguish nutritionally adequate products from those that are not. However, experience in Tanzania and elsewhere indicates that both of these interventions require substantial resources and long-term support, as well as entailing considerable uncertainty. Alternative options include procurement and distribution funded by donors or government, which can circumvent some of the key constraints faced by private markets while also targeting the most vulnerable groups. Public distribution, however, requires long-term funding commitments. A final option is to use behaviour change communications to promote home fortification using locally available ingredients. This strategy may be lower risk but does not address supply constraints.

Finally, the report highlights a set of overarching constraints that inhibit markets for nutrient-dense foods more broadly. These issues include low public nutrition awareness and demand, the difficulty of distributing to poor populations, the absence of mechanisms to signal nutritional quality, and the cost of working with value chains made up of small and medium enterprises (SMEs). These challenges, and policy options for addressing them, are examined in more detail in the accompanying policy report.

PART I: Background

1 Introduction and overview

This report presents the outcomes and findings of a rapid analysis of several nutrient-dense foods in Tanzania. This work was carried out by researchers at Sokoine University of Agriculture, Tanzania, and the Institute of Development Studies (IDS). It is part of a wider programme funded by the Department for International Development (DFID). This report, along with several accompanying analyses, is part of the 'Strengthening Agri-food Value Chains for Nutrition' workstream.

This report is intended to inform policy actors seeking to promote nutrient-dense foods in Tanzania, and in particular those related to cowpea, orange-fleshed sweet potato (OFSP) and complementary food products for young children. The report is particularly concerned with the potential for developing agriculture–nutrition linkages that take foods rich in micronutrients from the farm through to consumers. It examines whether incentives exist for private sector actors to develop, produce and distribute foods that contribute to reducing undernutrition. The report systematically outlines evidence on the three selected value chains and identifies market barriers that inhibit them at the point of specific activities and stages, as well as options for addressing these problems.

The report proceeds as follows: the introduction provides a summary of the project and the value chain approach; it presents the objectives of the report and the framework used to analyse the evidence, as well as the research methods used. Section 2 briefly reviews the undernutrition situation in Tanzania, highlighting key micronutrient deficiencies and the role of food-based approaches for addressing these problems. Sections 4–6 are a systematic mapping of value chains for the three focus product types: cowpea, OFSP and complementary foods. These sections provide a rationale for why these products were selected and present evidence to allow assessment of their potential. Each section concludes by identifying options that could increase the nutritional impact of these particular products. These responses will be built upon in the forthcoming report on policy guidelines.

1.1 Project goal and context

This report forms part of the 'Strengthening Agri-food Value Chains for Nutrition' project, which aims to help reduce undernutrition by informing evidence-based policy to make food and agricultural systems more 'nutrition-sensitive'. The project identifies opportunities for improving the private sector's involvement in linking agricultural production to the consumption of nutrient-dense foods, and also analyses policy strategies that can address the gaps in private sector involvement. The project contributes to these outcomes through work in three countries: Ghana, Nigeria and Tanzania.

Key outputs from this project include:

- *Value chain mapping* (this report) to assess the potential of particular products for addressing undernutrition for poor and vulnerable population groups.
- *Case studies of businesses* that have invested in nutritious foods (Maestre *et al.* 2014).
- *Policy options* to allow donors, governments, private sector organisations and non-profit organisations to overcome the constraints that inhibit food markets from reducing undernutrition (forthcoming).

1.2 The need for food-based strategies to reduce undernutrition

Reducing chronic undernutrition is a global priority in order to address the massive burden it imposes on human health, wellbeing and economic productivity. There have been major policy efforts over the past several decades to increase the coverage of a set of health interventions in the populations most vulnerable to the health consequences of undernutrition ('1,000 days group', consisting of pregnant women, children under the age of two and adolescent girls).[1] A set of direct interventions – including micronutrient supplementation and therapeutic feeding – has been proven to reduce chronic and acute undernutrition (Bhutta *et al.* 2013; Horton *et al.* 2010). In parallel to direct interventions, development agencies and governments are increasingly looking to improve the role of sectors including food and agriculture in helping to reduce undernutrition (Herforth 2012; Department for International Development 2011a). The logic is that 'nutrition-sensitive development' might be able to deliver sustained nutritional improvements at less long-term cost than health-based interventions alone.

Food-based approaches are one part of a strategy for reducing undernutrition in Tanzania. Chronic undernutrition is incredibly widespread in the country and damages human health and productivity on a massive scale (see Section 2). Evidence shows that increasing consumption of key micronutrients (especially vitamin A and iron) by the 1,000 days group is crucial. Yet reducing undernutrition through food pathways requires a stronger base of evidence – both in Tanzania and globally. Food-based strategies are extremely diverse in their scope, the problems they seek to address, and the value chains they target. One aspect of this difference is the kinds of food targeted, which can include micronutrient-rich fruits and vegetables, cereal or legume products or foods fortified with micronutrient premix. These different foods will have different prospects for delivering nutrients to the most vulnerable groups and will face different constraints in their value chains. Evidence and analysis are needed to inform decision makers about how and where to intervene in specific food value chains in order to enhance their nutritional impacts. This is the gap addressed by this report.

1.3 Objectives of the report

The purpose of this report is to contribute evidence on how to strengthen the link between agriculture and nutrition in Tanzania by focusing on several specific commodities and food products. It pays special attention to foods and delivery mechanisms that could reach the 1,000 days group, but also considers foods that can contribute to nutritional outcomes for children above two years and adults. The report assesses whether there is a case for donors, governments and public–private partnerships to intervene in these value chains to enhance the consumption of nutrient-rich foods that will provide much-needed nutritional benefits. The report therefore recommends which foods and crops have strong potential as well as where interventions are most needed in the value chains. To complete the analysis, the report focuses on how well the selected value chains meet a set of criteria necessary for nutrition impact. These criteria derive from a value chain framework.

1.4 Value chain approach to food and nutrition

A value chain approach is useful for identifying the challenges involved in delivering safe, nutrient-rich foods to target populations through market mechanisms. The approach identifies weaknesses in value chains that undermine their capacity to deliver the desired outcome (in this case an enhanced supply of nutrient-rich foods for the undernourished). Value chains are simply the sets of actors and activities involved in producing products and delivering them to end consumers. However, the value chain approach adds value by focusing on the

[1] Global nutrition research has demonstrated that the most crucial groups for nutrition outcomes are pregnant women and children under the age of two. If children do not receive adequate nutrition during this so-called 1,000 days period, they will suffer irreversible and lifelong negative consequences. Adolescent girls are also a key group, as their health prior to becoming pregnant is also a determinant of future child development (Bhutta *et al.* 2013).

specific actors and relationships that shape the performance and outcomes of the entire chain (see Box 1.1).

Box 1.1 Why use a value chain approach?

The value chain approach highlights the fact that food products are produced by a series of linked activities and actors. The approach has a number of advantages:

- It identifies the different activities and agents required to bring products to market.
- It pays attention to the capacity of the chain to deliver desired outputs, including the qualities delivered and the populations reached.
- It emphasises that incentives have to be established for different actors along the chain because performance at one point in the chain has consequences for activities and agents at other points.
- It helps to identify at which point in the chain, and with which actors, policy interventions can be most effective at improving the functioning of markets.

But what are the criteria that food value chains need to fulfil in order to help reduce micronutrient deficiencies? Research has highlighted four issues[2] (adapted from Hawkes and Ruel 2011):

- *Food must contain sufficient nutrients***:** businesses and other food producers need to provide products that are safe and contain key nutrients, especially the vitamins and minerals crucial to maternal and child health such as vitamin A, zinc, iron and folic acid.
- *Food must be acceptable***:** food must appeal to consumers' tastes and requirements, including taste, kind of meal, preparation and special requirements for infants.
- *Food must be affordable***:** in order to improve nutrition for the most vulnerable, products need to be sold at a price that is affordable to the poor. This requires minimising costs throughout the value chain.
- *Food must be accessible***:** food must be present in regions where poor and undernourished populations live, and it must also be sold in locations that they can access.

To these issues, we add one further criterion, which is effective signalling of nutritional quality to consumers. This criterion is particularly important because for a market-based strategy for delivering food to the undernourished to work, businesses have to be able to sell food that meets the four criteria above and also make commercially viable returns in doing so. The signalling of nutritional quality is critical for businesses trying to sell foods rich in micronutrients. If it is not possible for businesses to establish the nutritional benefits of the foods they are selling in the minds of consumers, they will be unable to appropriate the benefits of their investments in the production of such foods. This latter challenge is particularly difficult in the case of foods rich in micronutrients because the nutrient value of such foods is not immediately apparent at the point of sale. As a result, businesses that make nutritionally enhanced products may find it difficult to earn commercial returns – they will be undercut by competitors making nutrient-poor alternatives. It follows that the success of nutrition businesses depends considerably on the market environment in which they operate. Gradl and Jenkins (2011) referred to this as the business ecosystem. Relevant issues include consumer awareness, the availability of distribution systems, securing supplies, and consumer protection arrangements.

[2] These conditions are discussed in greater detail in *Policy Guidelines: Enhancing Markets for Nutrient-Dense Foods in Ghana* (Anim-Somuah *et al.* 2013a).

The body of this report combines assessment of the four criteria set out above with an analysis of the value chain issues that determine whether business involvement at each stage is commercially viable. To do so, the relevant sections (4–6) describe for each of the three commodities examined the main products and value chain actors involved in Tanzania. They then outline the products' nutrient content, acceptability to consumers and affordability. Finally, they assess key issues that affect business viability at each step along the value chain: production, storage/transport, processing and distribution/retail. The conclusion to each section summarises the barriers facing the commodity and options for development actors to intervene.

1.5 Methods

The framework used in this report builds on an existing tool designed to facilitate private sector involvement in nutrition-sensitive agriculture (Henson, Humphrey and McClafferty 2013). The tool was restructured and expanded to systematically assess challenges and opportunities for private sector involvement in specific value chains, as well as to contribute to the development of broader policy options.

Evidence-gathering occurred in two stages: first, an expert workshop was held to identify and assess ten potential commodities. Of these, three were selected for in-depth mapping (Section 3 describes the selection methodology). Research methods included reviews of scholarly and grey literature, stakeholder interviews and market visits. The team met with informants including researchers in universities, staff in NGOs and implementing agencies, civil servants, managers in small food processing businesses, and commodity traders.

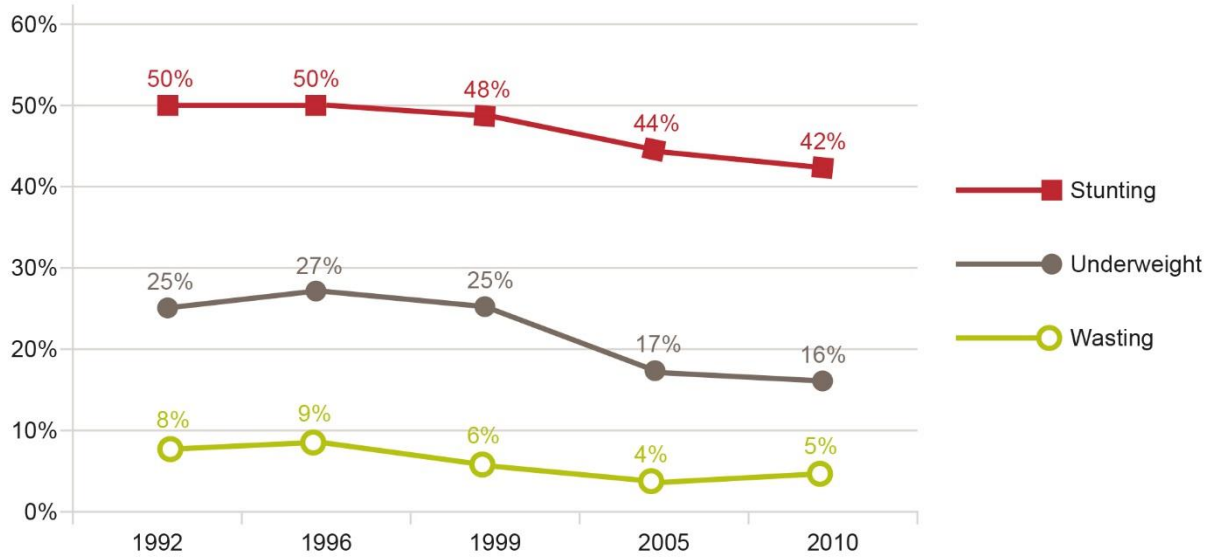
2 Undernutrition in Tanzania

This section briefly introduces the evidence on the rates and drivers of undernutrition in Tanzania,[3] especially for the 1,000 days population. It aims to inform the remainder of the report by identifying the most important population groups and micronutrient deficiencies that can be addressed through food.

2.1 Indicators of nutrition status

Chronic undernutrition (as indicated by stunting) has decreased since 1999, but remains alarmingly high, affecting 42 per cent of children under five (Figure 2.1). This is the third highest rate in Africa. Micronutrient deficiencies are a key contributor: 30 per cent of women are deficient in iron and 50 per cent are anaemic. The impact of undernutrition is staggering: it is estimated that vitamin A deficiency will contribute to one in ten child deaths between 2006 and 2015, while anaemia will contribute to one in five deaths during pregnancy (Tanzania Food and Nutrition Centre 2006). The cumulative losses of undernutrition[4] between 2006 and 2015 have been estimated to be nearly TSh6tn (US$3.7bn) (*ibid*.). Available evidence suggests that increasing consumption of nutrient-rich foods – particularly iron-rich foods for women and infants under two years – could play a role in reducing undernutrition in Tanzania.

Figure 2.1 Trends in anthropometric indicators of nutrition status, 1991–2010



Source: modified from National Bureau of Statistics and IFC Macro 2011.

As in other countries, there are large disparities in rates of chronic undernutrition between and within regions and between rural and urban settings (National Bureau of Statistics and ICF Macro 2011; Simler 2006). Average stunting rates are much higher in rural areas than in urban settings (45 per cent, compared to 32 per cent). Of particular relevance for the issue of micronutrient undernutrition, the evidence suggests that stunting rates are highest in the southern regions with the largest surplus production of cereals (Comprehensive Africa

[3] The Tanzania Demographic and Health Survey (TDHS) is the main source of nutrition status data in this section (National Bureau of Statistics and ICF Macro 2011).
[4] This estimate includes the impacts of stunting, low birth weight, anaemia and mental impairment (Tanzania Food and Nutrition Centre 2006).

Agriculture Development Programme 2013). This suggests that strong agricultural production is not translated into food consumption that addresses the key drivers of undernutrition in these regions. Overall, rates of stunting and underweight among children are also strongly associated with household wealth. Children born in poor families are more likely to suffer from stunting (Table 2.1). Stunting rates are above 40 per cent in the bottom three wealth quintiles, compared to only 26 per cent in the richest quintile. Differences in underweight are even more pronounced, with the bottom two wealth quintiles suffering more than double the rate of the wealthiest group.

Table 2.1 Disparities in undernutrition indicators across social groups for children

	Residence		**Wealth quintile (poorest to richest)**				
Indicator	Urban	Rural	1	2	3	4	5
Stunting	32	45	48	45	44	39	26
Underweight	11	17	22	18	14	13	9

Source: modified from National Bureau of Statistics and IFC Macro 2011.

2.2 Micronutrient intake

Lack of sufficient sources of key micronutrients in diets is one driver of undernutrition. Available information indicates that dietary diversity is not adequate among low-income households in both urban and rural settings in Tanzania, with most diets – particularly those of the poor – based on starchy cereals and tubers (Food and Agriculture Organization 2008). Studies of dietary intake in Dar es Salaam show that the population group in the lowest wealth quintile rarely consumes fruit, vegetables, milk and meat products (Kinabo *et al.* 2004, cited in Food and Agriculture Organization 2008; Rikimaru 2000; Mazengo *et al.* 1997) while local surveys have indicated that only 3 per cent of the rural population eats fruit, vegetables or foods from animal sources on a daily basis.[5] In some areas, people eat almost no animal source foods (Food and Agriculture Organization 2008). Most women do not consume enough foods rich in iron (Table 2.2) while infants, once they begin to eat solid foods, do not receive adequate foods in terms of energy, protein, vitamin A and especially iron (Muhimbula and Issa-Zacharia 2010).[6]

Table 2.2 Consumption of micronutrient-dense foods and micronutrient deficiencies in women and young children*

Population group	**Residence**	**Percentage consuming foods rich in…**		**Percentage with deficiency in…**	
		Iron	**Vitamin A**	**Iron**	**Vitamin A†**
Women	Urban	46	73	31	40
	Rural	32	72	29	36
Children‡	Urban	38	61	41	32
	Rural	28	62	34	33

*Based on 24-hour recall data reported in the TDHS.
†Adjusted to account for infection/inflammation.
‡Dietary intake data are for children aged six months to three years; vitamin deficiency data are for children aged six months to five years.
Source: adapted from National Bureau of Statistics and ICF Macro 2011.

[5] Information provided by local informants.
[6] Zinc is also an essential micronutrient for child development; however, national data on consumption of zinc-rich foods are not available.

2.3 Other drivers of undernutrition

Diet is not the only factor influencing nutrition status for children; infant breastfeeding, care and complementary feeding practices are also crucial. The majority of Tanzanian infants are not fed in an optimal way, with only 23 per cent of infants still exclusively breastfeeding by 4–5 months. Complementary feeding is usually introduced too early: by 4–5 months 64 per cent are given food other than breastmilk. In comparison, more children – although still an insufficient number – are fed appropriate foods; 67 per cent of children receive at least some vitamin A-rich foods. These practices may contribute to the growth setbacks suffered by children after six months (Muhimbula and Issa-Zacharia 2010). Behavioural factors in infant feeding and care are thus crucial, alongside availability of appropriate foods.

Other factors such as lack of access to clean water, sanitation and health care also play a role in undernutrition. This report did not identify studies assessing the relative contributions of the various drivers of undernutrition in Tanzania, although a World Bank study (Alderman, Hoogeveen and Rossi 2005) found that both higher income and access to medical services were necessary to improve nutrition outcomes in several districts in the north-west of the country.

In summary, the evidence – although incomplete – highlights the extent of undernutrition, particularly among children, and points to dietary deficiencies. It is well established that consumption of foods rich in micronutrients can offset these deficiencies. Especially important are increasing women's consumption of iron-rich foods and feeding infants over six months with foods rich in vitamin A and iron, along with adequate levels of energy and protein. Foods can be delivered to those that most need them through a variety of mechanisms, including mandatory fortification (Department for International Development 2011a). Nevertheless, it is also possible to promote the production and consumption of specific foods that are rich in the relevant micronutrients.

PART II: Mapping value chains for selected nutrient-dense food products

3 Scoping exercise: selecting high-potential product types

In order to identify products with a good potential for reducing micronutrient deficiencies, a scoping workshop was held with experts from the fields of agriculture, nutrition and food processing; participants included professionals from research institutions, development projects and the private sector. Participants collectively identified ten food commodities[7] which they saw as having relatively good potential for contributing to nutrition in Tanzania. The workshop used a two-stage process to select two of these commodities for in-depth value chain mapping. First, the group discussed all of the commodities, and participants individually scored each one[8] according to how well they believed it performed against the criteria outlined in Section 1.4 for nutrition impact. The average scores for the commodities are shown in Annex 1. The commodities were then ordered according to their average score across all criteria and all participants.

In the second stage, participants discussed the commodities with the highest average scores in order to assess their potential in a more nuanced, qualitative way. The top three ranking commodities were local amaranth, mango and local chicken. After discussing these commodities, the group decided that none of them was an ideal candidate for addressing undernutrition. Amaranth and mango were used almost exclusively for household consumption and had little distribution through markets; local chicken scored highly on six of seven criteria but was ranked very low on affordability, which the group deemed to be an overriding factor. For these reasons, the top three commodities were dropped, and the group discussed the next three highest scoring: cassava leaves, cowpea and orange-fleshed sweet potato (OFSP). The group concluded that both cowpea and OFSP had strong potential across the criteria, particularly on their affordability and capacity to reach large numbers of vulnerable households. Cassava leaves were excluded from consideration because they were almost exclusively used for household consumption, and because they were only eaten in certain parts of the country, due to risks of poisoning under certain agro-ecological and soil conditions. In addition, complementary foods were selected in advance of the scoring process because they specifically target children aged 6–24 months, one of the most crucial age groups for nutrition. During the scoping exercise, it was noted that complementary food mixes have also attracted substantial business interest, and that both cowpea and OFSP can serve as ingredients in these products.

Cowpea, OFSP and complementary foods were selected for detailed value chain mapping. As will be shown in the sections that follow, particular products in these value chains have the potential to address key micronutrient deficiencies and to be available, acceptable and affordable to the populations who need them. Business interest exists – in the formal and informal sectors – in all three products. Furthermore, key development actors are interested in these product types, creating demand for evidence.

[7] The commodities reviewed were amaranth, cassava leaves, cowpea, green gram, local chicken, mango, orange-fleshed sweet potato, sesame, soya bean and tamarind.

[8] Using a scoring approach allows the products to be ranked according to their average scores and also assessed on individual criteria. While the scoring does not constitute a systematic evaluation, it helps organise the input collected from stakeholder interviews and desk research and provides clarity on the reasoning that underlies selection.

4 Cowpea

Cowpea is an important food crop in many African countries, although in Tanzania it is not an indigenous crop, having been introduced in the 1960s. Production has increased dramatically since then, but cowpeas remain a supplementary food type, and not as popular as other varieties of pulses.[9] The most widely eaten pulse is the common dry bean (*Phaseolus vulgaris* L.),[10] which is a popular side dish. Although consumption of cowpea remains moderate, the crop's potential for nutrient-dense foods is high, since it is cheaper than other pulses and contains higher levels of folates. Cowpea leaves are an especially rich source of micronutrients. The fact that consumers already eat pulses and that value chains exist to provide them represents an opportunity to scale up the production and distribution of cowpea. It also has potential to be incorporated in snacks and convenience foods that could make it appeal to urban populations. Indeed, micro-scale processors are beginning to sell cowpea foods in several urban areas.

4.1 Products

Cowpeas can be used in a variety of foods (see Table 4.1). The most common preparation is simply boiled beans, which are eaten as a side dish alongside rice or *ugali* (stiff porridge). Cowpeas (or other beans) are also used in *kande*, in which they are mixed with de-hulled maize. *Kande* is especially eaten by lower-income groups and is prepared in school feeding programmes. More recently, new products have been introduced, especially snacks made from cowpea flour, such as *bagia* (a kind of bun). Cowpea leaves are also widely eaten and can be preserved through sun drying; fresh leaves are eaten as a side dish, while dried leaves are sometimes used to fortify infant complementary foods (Burgess and Glasauer 2004).

Table 4.1 Cowpea products consumed in Tanzania

Product type		Used as …	Target groups
Dry beans			
	Boiled (accompanying *ugali* or rice)	Side dish	Middle- and low-income households
	Kande (maize and cowpea)	Main dish	Middle- and low-income households
Bean flour			
	Bagia (buns)	Snack	Middle- and high-income consumers, majority of school children and students
	Instant soups (not yet commercialised)	Snack	The whole family, middle- and high-income households
	Mixed cereal flours (with cowpea flour as an ingredient)	Complementary food	Children over six months for households across all income categories
Cowpea leaves			
	Fresh or dried leaves	Side dish	The whole family, middle- and low-income households
	Ground, dried leaves (added to fortify complementary foods)	Complementary food	Children over 6 months, middle- and low-income households

Source: Authors' own.

[9] Data are unavailable for Tanzania; for the East African region as a whole, cowpeas reportedly constitute less than 10 per cent of pulse consumption (Akibode 2011: 47).
[10] Tanzania is the largest producer of common beans in Africa, with average annual production of approximately 850,000 tonnes in 2006–08 (Akibode 2011: 25).

4.2 Value chain actors

The cowpea value chain involves large numbers of actors and is highly fragmented. Most activities are dominated by actors in the informal sector. Cowpeas are produced by smallholder farmers, while processing and retail are also undertaken by micro-enterprises. In between these actors the market is dominated by a small number of large traders who specialise in aggregating grains and legumes and reselling to consumer markets. Since cowpea remains a recent introduction, most value chain actors are not specialised and deal in a variety of crops and foods.

The value chain involves the following actors (and see Figure 4.1):

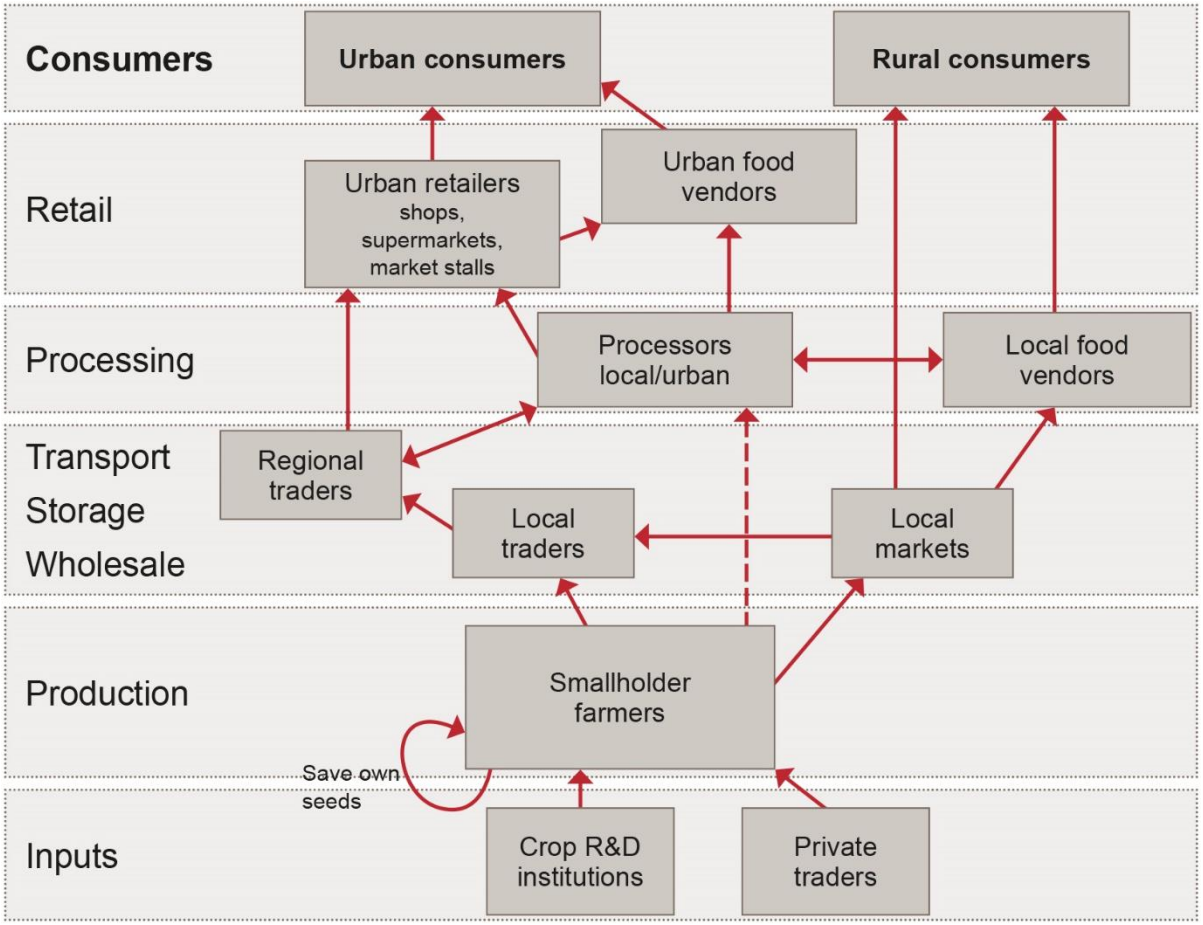
- *Research and input suppliers*: research, development and supplies of improved seeds and other inputs for cowpea are at an embryonic stage. Actors at this stage include a small number of publicly funded research institutions and a small number of private input providers.
- *Smallholder farmers*: large numbers of farmers produce cowpea, predominantly for consumption in their own households.
- *Local traders*: relatively large numbers of traders purchase cowpeas from farmers and transport them to urban and regional markets. They work for and are financed by large wholesalers.
- *Wholesalers*: a small number of very large traders aggregate cowpeas and resell them whole (they also sometimes process them into flour). Wholesalers are the dominant actors in the value chain, having the largest revenues and controlling storage facilities, which enable them to profit from price fluctuations.
- *Processors*: small-scale millers process cowpea alongside a range of cereals and pulses. They do not purchase ingredients; instead they process on demand from retailers.
- *Urban retailers*: large numbers of micro- and small-scale retailers buy whole cowpeas and resell them in small quantities.
- *Food vendors*: large numbers of micro-scale enterprises make and sell various cowpea foods, especially in urban areas.

4.3 Nutrient content

Cowpeas are rich in protein, containing an average of 24 per cent protein by weight. They are also one of the lowest cost sources of protein in Tanzania (see Section 4.5). In addition, they are rich in thiamine, folates and iron, and also contain zinc, potassium, magnesium, riboflavin, vitamin B6 and calcium, lysine and tryptophan. Although cowpea grains are not as rich in iron as common beans,[11] cowpea leaves are exceptionally nutrient-dense, with fresh leaves containing 17 times as much iron as cowpea grains (Table 4.2). Analysis of local cowpea recipes indicates that the way foods are processed has an important impact on the minerals retained. Some recipes retain high levels of micronutrients after processing, although when processed into flour, cowpeas can lose up to 33 per cent of iron content (Mamiro and Mbwaga 2011). These analyses indicate that substituting cowpea grains for common beans in diets will not increase nutrient intake for Tanzanians. Instead, cowpea needs to be consumed in addition to current bean content. The fact that beans tend to be eaten in small quantities is a barrier to nutritional impact. However, cowpea leaves have particular nutrition potential, since they are extremely rich in iron and zinc, and can be incorporated in complementary foods for infants.

[11] Levels of iron and zinc for common beans in East Africa have been reported at 70 and 33 mg/kg, respectively, with biofortified varieties achieving much higher levels of iron (Ugen *et al.* 2012).

Figure 4.1 Actors and flows of activities in the cowpea value chain



Source: Authors' own.

Table 4.2 Average micronutrient content in cowpea grains in Tanzania

Micronutrient	Content* (mg/kg)				
	Whole cowpea	Cowpea flour	Bagia†	Fresh leaves	Dried leaves
Protein	22–26%	23%	19%	22%	N/A
Calcium	975	307	463	1805	539
Zinc	32	28	9	36	32
Iron	28	18	11	498	237

*Nutrient content varies widely depending on variety.
†Variation between sites where products were tested was especially wide for *bagia*, with ranges of 33–893 mg/kg for calcium, 5–14 for zinc, and 5–16 for iron.
Source: Adapted from Mamiro and Mbwaga (2011); Weinberger, Msuya and Mamiro (2004).

4.4 Consumers and acceptability

Cowpea is relatively familiar food in most parts of Tanzania although not as widely consumed as other pulses. One survey in two rural districts known for producing cowpeas found that nearly all residents consumed cowpea foods at some point, with between 38 and 47 per cent of respondents eating cowpeas at least three times a week (Mamiro and Mbwaga 2011). The majority of cowpea consumers are rural residents; in urban areas, cowpeas are increasingly used in convenience foods.

There are some acceptability problems with cowpea. The association of eating cowpea with poverty may discourage some consumers, especially those in urban areas. In addition, the grains are poorly digestible and can cause flatulence and indigestion for some adults and for

many infants. For this reason, although they are a good source of nutrients and protein, cowpea grains are rarely used in complementary food mixes. The long cooking time of dried cowpeas is also an important barrier, especially for urban households with little time.

4.5 Affordability and availability

It is estimated that cowpeas are one of the cheapest sources of protein available in Tanzania. A rapid survey at markets in Morogoro municipality revealed that cowpeas are cheaper than other pulses including common beans and soya (Table 4.3). However, availability of cowpea is a problem in many parts of the country. In Morogoro, the price fluctuates from TSh1,200 (US$0.75) per kg after harvest to TSh2,000 (US$1.25) per kg, and there is a period of two to three months every year during which cowpeas are not available at all. No evidence was identified on the availability of cowpea in rural areas. Lack of availability is related to low production and commercialisation and storage problems, as discussed below in sections 4.6 and 4.7.

Table 4.3 Price of common legumes and pulses at Morogoro market

Legume/pulse	Price (TSh per kg)
Cowpeas	1,200
Pigeon peas	1,300
Common beans	1,800–2,300 (depending on variety)
Soya beans	2,500

Exchange rate: US$1 =TSh1,600.
Source: Market visits to Morogoro municipality, 10 March 2014.

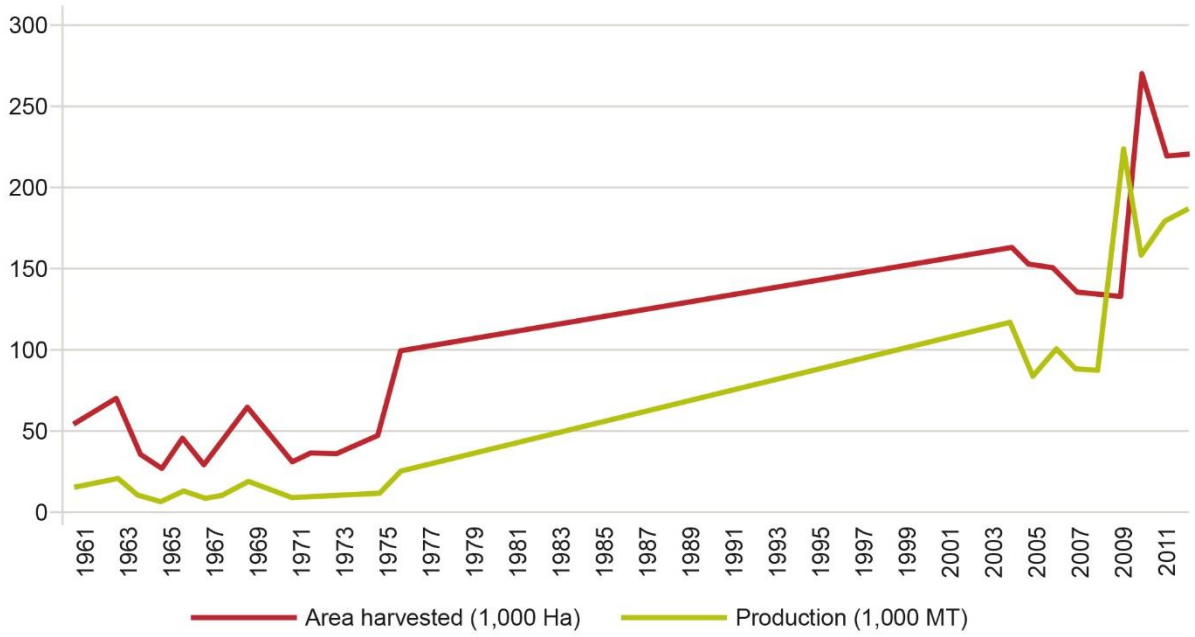
4.6 Production and supply

Tanzania produces substantial quantities of cowpea, and the crop has expanded steadily since the 1970s (Figure 4.2). In 2011, Tanzania was the fifth largest cowpea producing country in Africa and tenth in the world.[12] Yields of cowpea have been low, although on a par with other large producing countries.[13] Cowpeas are primarily cultivated in the Southern Highlands, Central Zone and Lake Zone, and have potential to be produced in most climatic conditions in the country (Hallensleben *et al.* 2009).

Despite growing production, cowpea remains a subsistence crop, and there is relatively little commercialisation. Cowpeas are overwhelmingly produced by resource-poor smallholder farmers, while within households women are generally responsible for cultivation (Hallensleben *et al.* 2009). The production system uses few inputs or improved seeds.[14] Cowpeas are particularly attractive to poor farming households, because they provide a protein-rich food and a leafy vegetable for household consumption, as well as forage and hay for animals (Hallensleben *et al.* 2009). For these reasons, cowpeas remain a subsistence crop, and only one-quarter of producing households sell cowpea grains or leaves (Stahley *et al.* 2012). The result is that relatively few cowpeas are sold into markets and made available for consumption outside producing areas. This contributes to low availability and price fluctuations, as discussed above. Commercialising cowpea will require examining incentives for farmers to grow and sell the crop, compared to alternatives.

[12] FAO FAOSTAT data, http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor, accessed 2013.
[13] FAO FAOSTAT data for 2006–2008, http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor, accessed 2013.
[14] One regional survey found that as many as 73 per cent of farmers self-provision with seeds (Coulibaly *et al.* 2010).

Figure 4.2 Cowpea production volumes and area harvested in Tanzania, 1961–2011



Source: adapted from FAO FAOSTAT data.[15]

4.7 Storage

Storage is a crucial problem for cowpeas, since the grains are highly subject to pests, particularly bruchid weevils (*Callosobruchus maculatus*). One study found that, when stored using traditional methods, over 80 per cent of cowpea grains were damaged after eight months of storage (Caswell 1984, cited in Murdock *et al*. 1997). This rapid deterioration contributes to large seasonal price fluctuations noted above. There are a variety of approaches to reduce post-harvest losses, including breeding pest-resistant varieties and using improved storage technologies. However, at present there is little use of these approaches in Tanzania. Despite some donor-funded breeding programmes, pest-resistant varieties are not widely used. Simple and effective storage sacks have recently been introduced to the country (Box 4.1). However, it is unclear whether there will be sufficient incentives for farmers and traders to use this technology, especially since cowpeas are not widely commercialised.

At present, the main means to prevent pest damage in cowpea appear to be additives and pesticides. Some farmers use diatomaceous earth to protect cowpeas during storage on farm. During wholesale and transport, traders add various chemical pesticides to storage containers to protect the grains from damage. However, these chemicals can be harmful to human health. In order to promote wider consumption of cowpea, storage solutions are critical both to increase availability and affordability, and to avoid food safety hazards associated with the use of pesticides.

[15] http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor, accessed 31 March 2014.

Box 4.1 Low-cost cowpea storage technologies

The well-known Purdue Improved Crop Storage (PICS) bags, originally developed in West Africa, have recently been introduced to Tanzania. These bags have three layers of plastic, which once sealed prevent oxygen from entering, killing off the weevil; this is highly effective at preventing pest damage. Reports indicate that the bags are used by some traders and farmers in Mbeya, Songea, Arusha, Kigoma and Dar es Salaam (Jones, Alexander and Lowenberg-DeBoer 2011). However, there is limited experience with the use of these bags under commercial conditions. Evidence from Nigeria (where the technology was first introduced) shows that, despite a domestic value chain that supplies the bags at low cost, uptake has been slow. One reason is that traders have been unwilling to offer farmers a higher price for cowpeas stored in the bags (Robinson *et al.* 2014). In order to anticipate this challenge in Tanzania, efforts are needed to establish markets for pest-free cowpea and generate incentives for traders and farmers to use the bags.

4.8 Processing

The vast majority of cowpeas are eaten without processing. Some cowpeas are processed into flour using small mechanical mills. Cereal mills are widely available in rural and urban areas because they are the principal means for processing maize and other cereals for household consumption. Thus, most processing is simple and done at the household level, and there are almost no specialised cowpea processors.

There are technologies that can help overcome problems with acceptability of cowpeas, but they are not widely used in commercial products. Grains can be germinated, roasted and de-hulled to enhance digestibility and the bioavailability of certain nutrients (Martin, Laswai and Kulwa 2010; Muhimbula, Issa-Zacharia and Kinabo 2010). These may be used by rural households in cowpea-producing areas. Further research is needed to understand why these practices are not used in commercial products; in particular, they could enable cowpea flour to be more widely used in complementary foods.

4.9 Distribution and retail

There is no detailed evidence on the structure of cowpea distribution channels, but they appear to follow those of other common food commodities. There do not appear to be specialised cowpea traders or distributors.

At the retail stage, the home appears to be the most common place where cowpeas are prepared and eaten in both rural and urban areas. Once in urban areas, there are dense distribution and retail networks, with cowpeas sold in open markets, shops and some supermarkets. Cowpea snack foods are sold by vendors along roadsides. This means that these products are freely available in many areas where undernourished people are likely to live. This is the main advantage of distribution through informal channels. The primary challenge appears to be with the available supply of cowpea, rather than its distribution.

4.10 Involvement of development actors

For the most part, cowpea has been neglected by both government and donor-funded agricultural investment programmes in Tanzania. Although there have been efforts aimed at breeding new varieties, little has been done to promote its production and commercialisation. In efforts to improve yields, new varieties of cowpea have been introduced[16] and adapted to local conditions (Mbwaga *et al.* 2010). Research institutions, including the government Agricultural Research Institutes at Ilonga, Ukiriguru and Naliendele, are seeking to improve

[16] Including the project 'Development and promotion of *Alectra* resistant cowpea cultivars for smallholder farmers in Tanzania and Malawi', funded by the McKnight Foundation.

pest resistance. Currently, there is no evidence on the extent of farmer adoption of the improved varieties.

4.11 Barriers, responses and assessment

Cowpeas have a number of advantages that make the crop a good candidate for improving nutrition in Tanzania. They can be a highly affordable source of protein, folates and iron. Further, various kinds of pulses are already an accepted part of the diet for many Tanzanians and appeal especially to poor populations. The challenge is to encourage people to eat cowpea in larger quantities and to incorporate cowpea leaves into dishes and complementary foods. In order to create this demand, more research is needed to understand the barriers to acceptability for various populations. Finally, new product types may help to increase cowpea consumption and make them appeal to urban populations. Cowpeas also have potential to be used in complementary foods, which are discussed in Section 6. The performance of cowpea as a source of nutrient-dense foods is summarised in Table 4.4.

Creating a wider base of demand nationwide will increase the incentives for cowpea production and processing. At the same time, production must be scaled up drastically if cowpeas are to be available in markets across Tanzania. New technologies and practices need to be introduced to reduce post-harvest losses, which currently contribute to large price and availability fluctuations. Mainstreaming these practices will require value chain changes to create incentives for actors to adopt them.

However, cowpea also faces substantial barriers, and interventions by public and private institutions are needed to strengthen the potential of this crop. Barriers and potential responses are discussed below.

Cowpea remains a niche and neglected crop. Although production has increased consistently since the 1970s, cowpea remains a specialised crop grown mostly in small quantities and in a few districts. Yields are low and most production is used for home consumption. With only 80,000 tonnes available in commercial markets, there is limited opportunity for downstream actors to use cowpea at large scale. Government and donor-funded agricultural programmes have neglected cowpea, with support limited to only a handful of breeding efforts. Greater investment in research, dissemination and extension programmes will be needed to increase the status of cowpea as a food and cash crop and incentivise more farmers to produce the crop. In the short term, the primary producers of cowpea will probably continue to be small-scale, resource-poor farmers. If consumer demand increases in the medium term, this might also motivate medium-scale farmers to produce cowpea commercially.

Promote the use of safe, improved storage technologies. There are large fluctuations in price throughout the year and cowpeas are unavailable during some periods, even in major markets. Supporting production for the market is one solution, but efforts will also need to address very high post-harvest losses. Although there are low-cost technologies such as improved storage sacks that are highly effective, they are not widely adopted. Increasing the use of these technologies will require creating viable chains to supply them to farmers while also creating incentives for farmers to use them. Experience from Nigeria shows that traders may not be willing to pay a higher price for cowpea stored in this way. Supporting linkages between food processors and organised farmer groups could help create a premium for farmers who use this technology. Mainstreaming this technology would also attenuate the food safety risks associated with the use of dangerous chemical insecticides to preserve cowpea.

Increase demand with awareness campaigns. Ultimately, increasing demand for cowpeas among consumers in Tanzania is key to addressing the production and storage issues. Although consumers are generally aware that cowpeas are a nutritious food (a meat substitute), they are not aware of their health benefits, particularly for infants and pregnant women. Furthermore, cowpeas are regarded as a low-status subsistence food, which may mean that consumers prefer not to eat them when given a choice, particularly those in urban areas. To address this, government, NGOs and other partners should promote the benefits of cowpea as an affordable source of proteins and micronutrients and a contributor to good health. Incorporating cowpea into school feeding programmes could help to increase acceptance of the food among children.

Provide support to develop products that appeal to consumers' tastes. Awareness campaigns alone are unlikely to address the acceptability problems. Introducing new products, recipes and technologies could make cowpea more appealing to urban and middle-class consumers. Donors, government agencies and private foundations can support food processing businesses that are developing cowpea products. Programmes can provide incentives not only to appeal to consumer tastes, but also to create products and retailing chains that maintain and enhance nutrient content. Creating value-added cowpea products may help increase awareness and address some consumers' reluctance to eat cowpea.

In conclusion, cowpea's affordability, along with the potential of existing consumption of pulses, mean the crop has solid potential to help address undernutrition. However, policy interventions are needed to increase demand, incentivise the use of storage technologies and scale up production in order to achieve full potential.

Table 4.4 Performance of cowpea against criteria for addressing undernutrition

Criteria	Extent to which criterion is met	Comment
Nutritional content	Satisfied	Cowpea varieties grown in Tanzania are very rich in protein and micronutrients compared to many other common legumes.
Availability	Partially met	High seasonal price fluctuations. Products are not readily accessible in most urban areas; availability in rural areas is seasonal.
Affordability	Fully met	Cowpea beans are affordable to poor consumers.
Acceptability	Partially met	Most consumers especially from poor households accept cowpea products and recipes. However, consumers do not have a preference for cowpeas based on their nutrient content.
Awareness and signalling of nutritional value	Partially met	Consumers consider cowpeas to be a low-cost protein source. Other nutritional contents of cowpeas are less well-known. Unprocessed cowpeas are distinguishable from alternative foods; this is not necessarily the case when cowpea flour is incorporated into other foods.

Source: Authors' own.

5 Orange-fleshed sweet potato

Orange-fleshed sweet potato (OFSP) includes a group of several varieties of sweet potato (*Ipomea batatas*) that contain high levels of vitamin A and as a result have an orange colour when cut open.[17] This is in contrast to white-fleshed varieties of sweet potato (WFSP), which contain no vitamin A. Although WFSP is a staple food in some parts of Tanzania, OFSP has only recently been introduced. The development and dissemination of new OFSP varieties has been led by several donor-funded programmes[18] that cover a range of countries in sub-Saharan Africa and South Asia (Food and Agriculture Organization 2013: 35). These programmes use a biofortification strategy, where the aim is to make use of existing production systems and consumer preferences for sweet potato as a means to introduce the new vitamin A-rich crop.

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. According to one project promoting OFSP, the crop could benefit up to 50 million children under six in Tanzania (Helen Keller International 2012). OFSP has high production potential in the country, tolerates a wide variety of climates and requires little capital or land to cultivate (Mmasa, Msuya and Mlambiti 2012). However, in contrast to other countries in East Africa (particularly Uganda), production and awareness of OFSP are low in Tanzania. Although regarded as a food security crop in some parts of the country, markets for OFSP are poorly developed, and tubers are not available during much of the year. Furthermore, there are relatively few value-added products using OFSP, although in some regions increasing numbers of micro-enterprises are processing the tubers into snack foods. Several NGOs and research organisations have promoted OFSP in Tanzania, and government agencies have provided a small amount of public investment.

The key challenge for OFSP in Tanzania is to shift consumption from white to orange varieties. This requires adapting OFSP strains to make them more acceptable to adult consumers, building demand for OFSP products and developing markets for OFSP products so they are more widely available. Current programmes provide a foundation, but they have not made sufficient progress on distribution and marketing.

5.1 Products

The majority of OFSP is consumed as unprocessed tubers, cooked and eaten whole or as part of traditional porridge-based foods. Rural residents in production regions have traditionally dried sweet potatoes and processed them into *michembe* and *matoborwa,* products with a shelf-life of up to ten months (Gichuki *et al.* 2005). OFSP leaves are also a popular side dish eaten with *ugali* or rice throughout Tanzania.

Research institutions and NGOs have developed a range of convenience foods that incorporate OFSP. These include snacks such as chips and crisps, and recipes for using OFSP in bakery products such as buns, chapattis or cake. OFSP can also be used in sweeteners, porridges and weaning food mixes. However, very few of these products are available commercially.

A small number of packaged OFSP products – including packaged flour and crisps/chips – are available in select shops in urban centres. These represent emerging product

[17] OFSP contains beta-carotene, a precursor that the body converts to vitamin A.

[18] A handful of projects have focused on OFSP in Tanzania; however, much larger interventions have been undertaken 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.* 2007; Westby, Coote and Tomlins 2011). The primary focus of these projects has been breeding, disseminating new varieties and awareness campaigns to encourage consumption. A sub-set of these projects has also included components focused on marketing OFSP (Coote *et al.* 2011; Westby *et al.* 2011).

differentiation as products are developed to appeal to urban middle- and upper-income consumers. (Table 5.1 shows the range of OFSP products.)

Table 5.1 OFSP products common in Tanzania

Product	Description
Boiled tubers	Probably the most common way to eat OFSP in Tanzania; prepared and consumed at home.
Matoborwa, michembe	To prepare these traditional products, tubers are cooked, sliced and dried to increase their shelf life. Large amounts of OFSP are eaten in this form.
Baked goods	OFSP flour can be incorporated into bakery goods and sweets popular in urban areas, including buns, chapattis, *maandazi*, *kalimati* and cakes. OFSP can substitute for 20–50 per cent of wheat flour. At present, these products are not widespread in Tanzania.
Complementary foods	Formulations have been developed for incorporating OFSP into cereal-based complementary foods. None of these have yet been commercialised.
OFSP leaves	OFSP leaves are a common side dish, using either fresh cooked or dried leaves.

Source: Authors' own.

5.2 Value chain actors

At present, OFSP in Tanzania is handled by the same value chain actors who deal in white-fleshed varieties; most actors and activities do not differentiate between the two varieties. Sweet potato 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. At the same time, there are some small/medium-scale businesses, including a handful that make packaged OFSP products and a growing number of kiosks that sell products in urban areas. National supply chains for OFSP have only recently come into being, and they are dominated by large traders who deal in various agri-food commodities. There are no specialised linkages such as contract farming schemes at present. Table 5.2 provides an overview of the structure of the sweet potato value chain in Tanzania.

5.3 Nutrient content

The orange-fleshed and white-fleshed varieties of sweet potato differ substantially in their nutritional content: WFSP is poor in micronutrients, while OFSP is rich in beta-carotene, a micronutrient that becomes vitamin A in the body. Further, the beta-carotene in OFSP is more bioavailable than alternative vegetable sources; OFSP contains between 250 and 833 RAE[19] per 100 grams. At this level, one small root (100–125 g) can supply the recommended daily allowance of vitamin A. In addition to vitamin A, OFSP contributes significant amounts of vitamins C, E and K.

5.4 Consumers and acceptability

Sweet potatoes (white and orange) are consumed by all categories of consumer in Tanzania. Sweet potato is a widely eaten food in certain regions, especially the Lake Zone, where sweet potato is regarded as a food security crop for the poor due to its low cost. This association of sweet potatoes with poverty could be a barrier to increasing consumption of OFSP in urban areas.

[19] Retinol Activity Equivalents, a measure of the density and bioavailability of vitamin A in a food.

Table 5.2 Structure of the value chain for OFSP in Tanzania

Stage in value chain	Actors	Mature or emerging industry?	Consolidation – restructuring process	Description
Inputs	Input suppliers	Somewhat mature	None	Small shops provide inputs; these already exist for WFSP.
	Vine producers	Emerging	Private entrepreneurs are emerging	There is growing interest in producing OFSP vines in the Lake Zone.
Production	Farmers	Emerging	Limited adoption of OFSP	Predominantly smallholder famers, along with a few larger ones. Farmers are also the primary consumers of OFSP.
Storage, transport, wholesale	Traders	Somewhat mature	Limited	Large traders buy sweet potato from farmers and sell to retailers, exporters and processors.
	Exporters	Emerging	None	A handful of agents export OFSP to the Middle East; volumes remain small. Source from commercial farmers.
Processing	Processors	Emerging	Limited	Mostly micro-enterprises. A few small/medium-scale processors, mostly sponsored by development projects.
Retail	Market stalls	Somewhat mature	Limited	Sell unprocessed OFSP and WFSP in consumer markets
	Street food vendors	Somewhat mature	New business models emerging, e.g. kiosks	Segment is rapidly growing, with lots of micro-enterprises.
	Urban consumers	Emerging	Small segment	Small segment of educated urban consumers purchase OFSP for health benefits.

Source: Adapted and modified from Sørensen, Ndyetabula and Temu (2012).

As has been found in many other countries, there are also problems with the acceptability of OFSP for adults; many consumers prefer WFSP varieties because of their non-sweet taste, more solid texture and use in traditional dishes (Helen Keller International 2012). In contrast, OFSP is less popular because it is sweet and has low dry matter content. Yet existing preferences for sweet potato present an opportunity for scaling up OFSP – the key is to make OFSP products that meet consumers' preferences. There is experience on how to do this; in Uganda and Mozambique, studies have confirmed that OFSP can be an acceptable replacement for WFSP (Westby *et al.* 2011; Chowdhury *et al.* 2009). In Tanzania, Senzota (2012) has indicated that newly introduced products can achieve widespread acceptability, under the right circumstances. However, a study by Tumwegamire *et al.* (2004) suggested that most consumption of OFSP in sub-Saharan Africa was by children, due to OFSP's low dry matter content, which makes it less popular for adult dishes, but easier for infants to swallow.[20] It is possible that different varieties of OFSP could be promoted for different populations: new varieties could be promoted for adults and pregnant women, while existing sweet varieties could be promoted as a complementary food for infants.

[20] Low dry matter content means that when cooked, OFSP is softer than white varieties. This makes it easier for infants to swallow. However, most adults prefer denser sweet potato. Low dry matter also means OFSP takes longer to dry and is more perishable than WFSP.

5.5 Affordability and availability

OFSP is one of the cheapest sources of Vitamin A in Tanzania. However, availability is poor, and markets do not regularly supply commercial quantities. OFSP is unavailable in some urban areas during part of the year and must be specially ordered from markets in the region of production. At times when supplies are available, sweet potatoes are widely retailed at food kiosks in urban areas. There are also processed, packaged OFSP products available in a handful of urban supermarkets; these products are sold at much higher prices and are unaffordable to lower-income consumers.

5.6 Production and supplies

Taking both white- and orange-fleshed sweet potato together, [21] Tanzania produced an average of 2.4 million tonnes of sweet potatoes annually between 2008 and 2012.[22] This makes it the third largest producer in Africa.[23] Among all crops, sweet potato represents the fourth highest in terms of value of production, and the sixth largest in terms of quantity produced.[24] After five years of near-stagnant production levels, national data show that yields and production grew dramatically between 2009 and 2012, with total production more than doubling over this period (Figure 5.1). The crop is grown in districts with high population densities, especially the Lake, Central and Northern Highlands zones.

Large numbers of small-scale farmers in Tanzania produce sweet potato (both WFSP and OFSP). Its advantages are that it requires little land and labour, as well as few inputs. Tubers can also be left in the ground for several months and harvested piecemeal. For these reasons, it is regarded as a crop for resource-poor households: it provides food and small amounts of cash at critical times of the year.[25] Women are often the primary producers. Clearly, sweet potato already contributes to the food security of resource-poor households. However, its perception as a 'poverty crop' – along with low market prices – may discourage commercial farmers from growing it.

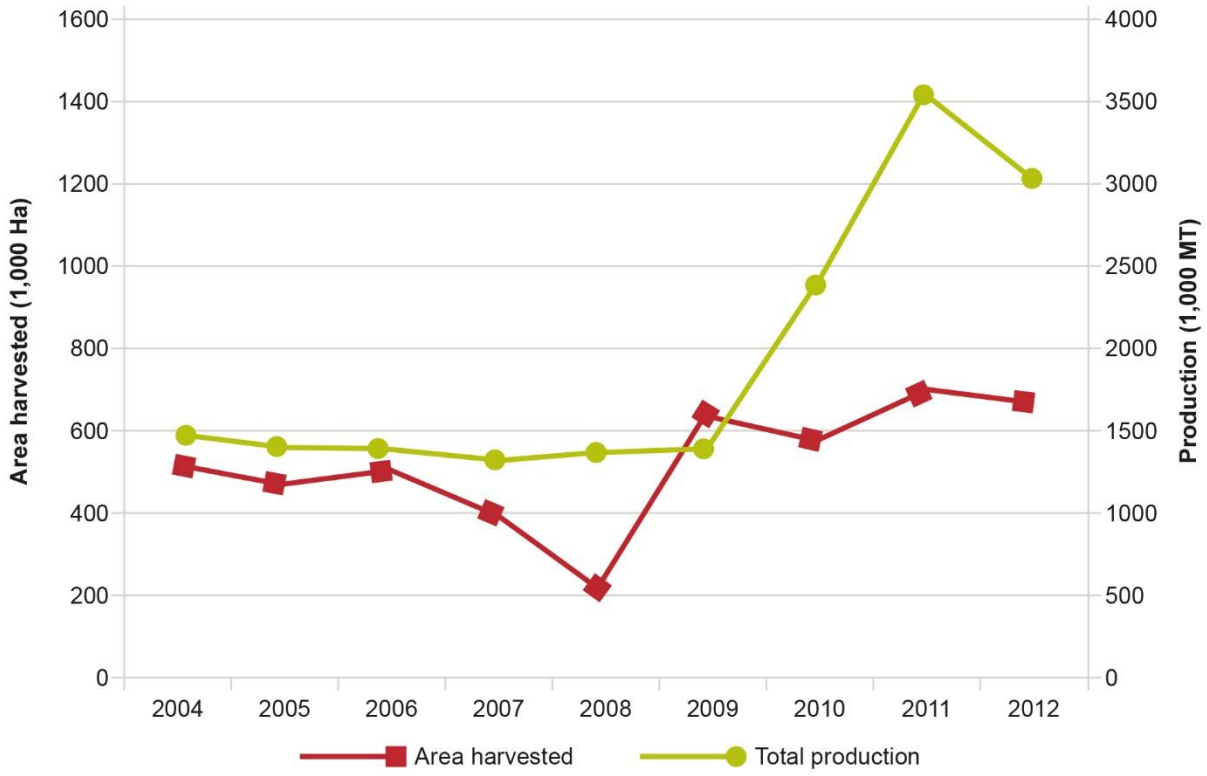
OFSP varieties in Tanzania are generally low yielding, narrowly adapted and susceptible to diseases and insect pests. A shortage of planting materials of superior OFSP varieties inhibits wider production (Kapinga *et al.* 1995, cited in Helen Keller International 2012). Farmers tend to source planting material from neighbouring farms rather than buying it, and this inhibits the dissemination of pure, improved strains (Carey *et al.* 1998, cited in Helen Keller International 2012).

5.7 Storage

As mentioned, the fact that OFSP can be stored in the ground is a principal advantage for small-scale farmers. However, once harvested, OFSP tubers are highly perishable: their shelf life is about one week. Thus, once they are dug up, tubers must be quickly sold and transported to retail points. In other countries, fresh OFSP is widely available for two to five months of the year, depending on local climate (HarvestPlus 2010). Storing the tubers in pits or processing them into dried products like *matoborwa* and *michembe* can prolong availability for up to ten months. The implication is that, in order for OFSP tubers to be available year-round (outside the farms where they are produced), they must be either processed or carefully stored during wholesale and transport. This will require appropriate technologies and creating incentives for value chain actors.

[21] The findings in this section refer to combined white- and orange-fleshed sweet potato because production data are not disaggregated between the two varieties. However, anecdotal reports indicate that the majority of sweet potato produced and consumed in Tanzania is WFSP.
[22] http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor, accessed 3 December 2013.
[23]The top-producing countries are Nigeria (3.3 million tonnes) and Uganda (2.7 million tonnes) (FAO FAOSTAT data, http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor, accessed 3 December 2013).
[24] FAO FAOSTAT data, http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor, accessed 3 December 2013.
[25] There are no data on what proportion of sweet potato production is for sale versus household consumption.

Figure 5.1 Production volume of sweet potato and area harvested in Tanzania, 2004–12 (combines WFSP and OFSP)



Source: adapted from FAO FAOSTAT data.[26]

5.8 Processing

At present, few processed OFSP foods are available in Tanzania; the majority of OFSP is consumed with little or no processing. There are only a small number of products, and these use simple and widely available processing techniques, such as sun drying and mechanical milling (see Table 5.3). Although recipes have been developed for an array of products, only a couple of these are produced commercially. Commercial processing tends to be at small scale and is undertaken at home or by micro-enterprises. Few enterprises have their own specialised equipment. For example, when making OFSP flour, firms generally pay cereal millers for use of their equipment.

Table 5.3 Stages and scale of processing for OFSP products

Product	Processing	Scale
Chips and snacks	Slicing, frying, packaging	Micro- and small enterprises
Matoborwa, michembe	Boiling or withering, slicing, sun drying	Homestead level for household consumption
Baked goods (flour-based)	Drying, mechanical milling	Small-scale millers; baking done by micro-enterprises and small bakeries
Complementary foods	Using flour or boiled OFSP tubers	Mixing done in the home
Dried OFSP leaves	Sun drying	Homestead level for household consumption

Source: Authors' own.

[26] http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor, accessed 31 March 2014.

5.9 Distribution and retail

OFSP has only recently begun to be distributed nationally in Tanzania, and it is transported and sold alongside WFSP. As mentioned, there are no specialised sourcing arrangements such as contract farming. Processors tend to source OFSP from local markets or order it from markets in the region of production.

At the point of retail, OFSP and WFSP are displayed and sold side by side or in mixed batches. The two varieties are generally sold at the same price. This retail practice provides an indication that consumers are not aware of the difference between WFSP and OFSP; it may also inhibit consumers from becoming aware of the benefits of OFSP. In urban areas, anecdotal accounts suggest that the availability of OFSP products is increasing, although still limited. The majority of foods continue to be those based on WFSP. A small number of packaged OFSP products are sold in shops and supermarkets in urban centres such as Morogoro or Dar es Salaam, aimed at middle- and upper-income consumers.

Retail and marketing are a key area for interventions to increase consumption of OFSP. Because of the tubers' orange colour, OFSP is easy for consumers to differentiate from WFSP varieties; simply cutting open one of the tubers demonstrates the product's nutritional value. This is a major advantage of OFSP compared to other nutrient-dense foods, especially those that rely on blending ingredients or fortification.[27] This approach has been attempted by programmes in Uganda and Mozambique, which were able to motivate retailers to sell OFSP and WFSP varieties separately and to provide information about the benefits of OFSP. Available evidence indicates that these interventions led to lasting change in the marketing of OFSP in a few regional markets. These efforts are discussed further in Section 5.11.

5.10 Development programmes and OFSP

In recent years, a number of donor-funded research and implementation programmes have sought to increase production and consumption of OFSP in Tanzania (Table 5.4). The majority of these have focused on breeding new plant varieties that appeal to consumer preferences and have better pest resistance. Several projects have also disseminated vines to farmers and sought to develop supply chains for disease-free planting materials. However, very few programmes have focused on increasing consumer demand or on improving the distribution and marketing of OFSP.

The recent Reaching Agents of Change Project has focused on training and advocating with a range of stakeholders, particularly agricultural extension agents and other staff in public agencies and NGOs. It aims to encourage these actors to promote public investment in OFSP after the project ends. Although one or two of these projects have included nutrition awareness components – such as informing people of the benefits for infants of eating OFSP and providing instructions on how to prepare it – these activities have not been the primary focus, and their reach appears limited. OFSP has also been included as one of a range of crops promoted by projects promoting 'kitchen gardens',[28] which aim to train people to produce nutrient-dense crops and encourage them to eat these foods themselves.

[27] The challenge of signalling nutritional value to consumers is discussed in more detail in the accompanying policy report (Robinson *et al.* forthcoming). It has also been discussed in the cases of Ghana and Nigeria (Anim-Somuah *et al.* 2013a; Robinson *et al.* 2014a; Robinson *et al.* 2014b).

[28] Current projects using this approach include the large USAID-funded Mwanzo Bora Nutrition Programme. For further discussion on kitchen garden programmes and their effectiveness, see Le Cuziat and Mattinen (2011) and Bonnard (2001).

Table 5.4 Development projects specifically promoting OFSP in Tanzania

Name of project	Regions	Time-frame	Implementing institution	Donor	Activities	Primary focus
Maximizing Incomes from Sweet Potato Production as a Contribution to Rural Livelihoods[29]	Dar es Salaam, Morogoro, Mwanza	1999–2003	Natural Resources Institute, UK; Tanzania Food and Nutrition Centre; Lake Zone Agricultural Research and Development Institution	DFID	Baseline studies on OFSP marketing; pilot and introduce improved storage technologies; pilot links to supermarkets	Storage
Sweet-potato Improvement	Lake Zone	2009–12	National Agricultural Research System, Ukiriguru	Alliance for a Green Revolution in Africa (AGRA)	Breeding and disseminating varieties	Breeding
SASHA	Lake Zone	2009–14	International Potato Centre (CIP), Helen Keller International	Bill and Melinda Gates Foundation	Breeding improved quality and pest-resistant varieties; developing seed systems; nutrition education; pilot projects to address market issues	Breeding and dissemination of vines
Eat Orange! Tanzania	Lake Zone	2011–13	Helen Keller International, Tanzania Home Economics Association	Monsanto Foundation	Nutrition education to create demand; supply planting materials; marketing	Demand creation
Reaching Agents of Change		2011–14	International Potato Centre, Helen Keller International	Bill and Melinda Gates Foundation	Advocate for investment in OFSP; train agri. extension workers; distribute disease-free vines	Building capacity of extension agents, NGOs etc.
Promotion of OFSP	Eastern and Central Zone	2012–14	National Agricultural Research System, – Kibaha	United Republic of Tanzania (URT)-COSTECH		Breeding and dissemination of vines

Source: Authors' own; adapted from Helen Keller International (2012).

5.11 Barriers, responses and assessment

OFSP products have potential for reducing vitamin A deficiency in Tanzania, but major efforts are needed to scale up their reach. At present, OFSP is available mostly to rural producer households and a small number of informed urban consumers. OFSP tubers have the major advantages of being the lowest-cost sources of vitamin A and being orange in colour, which makes them easy to distinguish from less nutritious alternatives. Finally, there is potential to make use of existing value chains for WFSP to stimulate rapid uptake. At

[29] The project 'Maximizing the Potential of Fresh Sweet Potato for Farmer and Trader Incomes' appears to have been a similar, parallel project; it too was funded by DFID and implemented by the same set of organisations.

present, OFSP already contributes to the nutrition of the farming households that produce it. If policy actors want OFSP to have a national impact, especially in urban settings, they need to introduce incentives for farmers to grow and commercialise the crop and work with traders and value chain intermediaries to market it. Efforts are needed to develop low-cost, commercially viable storage and processing systems in order to increase year-round availability. Finally, strengthening consumer awareness and demand is also key to creating viable value chains. The performance of OFSP as a source of nutrient-dense foods is summarised in Table 5.5.

For OFSP to have a wider impact, several substantial barriers must be addressed:

Develop new varieties and establish supply chains. Adults in Tanzania generally prefer the texture and taste of WFSP to that of OFSP. Efforts to breed OFSP varieties that appeal to consumer tastes should be continued. However, at present, most improved varieties are not widely used by farmers. Further investigation is needed to understand the reasons for low adoption and which traits farmers value most. However, farmers are only likely to adopt improved varieties if they have markets to sell them to.

Social marketing to increase demand. As discussed above, market development will require stronger consumer demand. Messages promoting consumption of OFSP can be incorporated into broader behaviour change communications and nutrition awareness programmes. These need to reach a much broader audience than previous small-scale efforts. They should specifically seek to overcome taboos that limit OFSP consumption and emphasise its health benefits, especially for infants.

Promote OFSP with value chain intermediaries. At present, very few businesses or actors distinguish between OFSP and WFSP varieties, and the two are sold together and at the same price. This makes it more difficult to convince consumers of the added value of OFSP. Experiences in Uganda and Mozambique suggest that traders and retailers can successfully promote OFSP with consumers and provide demand. Doing so successfully will involve training retailers to market OFSP, accompanied by social marketing campaigns. Traders themselves are unlikely to have the incentive or the means to promote OFSP using their own resources. Experience from other countries indicates that achieving change requires intensive intervention for a few years. Once consumers begin to demand OFSP themselves, however, these activities may be sustainable without donor support.

Facilitate commercialisation of OFSP products. A number of projects have demonstrated the feasibility of processing OFSP into various products, but there has been very limited commercialisation of these activities (Wheatley and Loechl 2008: iv). Business incubation programmes could facilitate viable business models around these products, while addressing issues of conserving nutrient content and increasing shelf life. However, the very small scale at which processors operate at present means there will be substantial challenges for any organisation wishing to provide support. Promoting the organising and clustering of processors might reduce these transaction costs.

In summary, OFSP has nutritional potential due to its low costs of production and the opportunity to build on existing value chains for WFSP. To make the crop more widely available, interventions need to expand from a focus on breeding alone to develop viable value chains and increase consumer demand.

Table 5.5 Performance of OFSP against criteria for addressing undernutrition

Criteria	Extent to which criterion is met	Comment
Nutritional content	Criteria satisfied	Rich in pro-vitamin A.
Availability	Not met	High seasonality and price fluctuations. Not available in many areas. Limited availability in retail shops.
Affordability	Fully met	OFSP is a low-cost source of vitamin A.
Acceptability	Partially met	Consumer familiarity with WFSP is a source of potential, but currently most prefer WFSP to OFSP. Most consumers are unaware of the health benefits of OFSP. Because of low dry matter content, OFSP is suitable as a food for young children.
Awareness and signalling of nutritional value	Partially met	Due to its orange colour, consumers can easily distinguish OFSP from WFSP.[30] At present, retailers do not differentiate OFSP from WFSP, inhibiting consumer choice.

Source: Authors' own.

[30] However, there may be problems for some foods derived from OFSP flour, which do not have an orange colour.

6 Complementary foods

A range of complementary food products is available in urban and rural areas in Tanzania. These foods target infants over the age of six months. If they are to support healthy child growth, they must be given alongside breastmilk, in sufficient quantities and with sufficient frequency. They must also be prepared hygienically. Proper complementary feeding remains a problem in Tanzania; foods and liquids are introduced too soon for most infants, and nearly half do not receive foods rich in iron and vitamin A. For these reasons, enhancing complementary foods is a key strategy to addressing child undernutrition, but it must be accompanied with education and health programmes to improve infant feeding behaviours.

Yet, even when feeding practices are adequate, traditional complementary foods in Tanzania are not sufficient to promote health. The most widely used complementary foods are made from unfortified cereals and do not provide enough energy, protein or micronutrients. A wide variety of locally made products are available, generally made from mixes of cereals and legumes. There is no information on the nutritional content of these products; however, research from other African countries suggests their content could vary dramatically (Masters 2012; Masters, Kuwornu and Sarpong 2011). In addition to local formulations, there are imported fortified products, but the high cost of these products makes them unaffordable for all but the smallest segment of wealthy urban consumers.

Over the past decades, there has been a surge in micro- and small-scale businesses making complementary food mixes. Thousands of these businesses – often a single woman manufacturing in her home – are present in towns and neighbourhoods across the country. There are also a handful of medium and large businesses. Yet, despite this business involvement, the most widely consumed complementary foods – especially among the poor – continue to be unfortified cereal mixes, which are processed at home.

There is considerable potential for enhancing the market for complementary foods in Tanzania: these products are already acceptable and widely used by consumers. There is a high degree of business interest and potential support from government institutions. The challenge is to address market failures and make nutritionally adequate products available and affordable to poor consumers. Because complementary foods are made from a variety of agri-food commodities, the ‘upstream’ portion of the value chain (production, wholesale, storage and transport) is no different than for other cereal foods. For this reason, the analysis on this report will focus on the ‘downstream’ issues facing processors, retailers and consumers of complementary foods.

6.1 Products

The most common complementary foods are made of unsupplemented cereals (frequently a mix of cereals) such as maize, rice, sorghum and finger millet. Protein sources such as groundnut, soya or cowpea are added in some formulations. These mixes are commonly made in the home according to consumers’ own recipes; there are also a variety of pre-mixed products available in markets.

There is wide variation in the formulation of complementary food mixes, with different producers using different blends according to which ingredients are available and which are preferred by customers. An intensive survey would be necessary to document all available products; for the purposes of this report, a quick survey was conducted to identify some of the most prominent products in Morogoro Region (Table 6.1). The survey identified eight Tanzanian producers and a variety of formulations. Most of these producers were very small scale, working in the informal sector. Previous work on complementary foods in Ghana

(Anim-Somuah *et al.* 2013b) highlighted the high degree of variability of nutrient content in such products.

Table 6.1 Complementary foods available in Morogoro Region

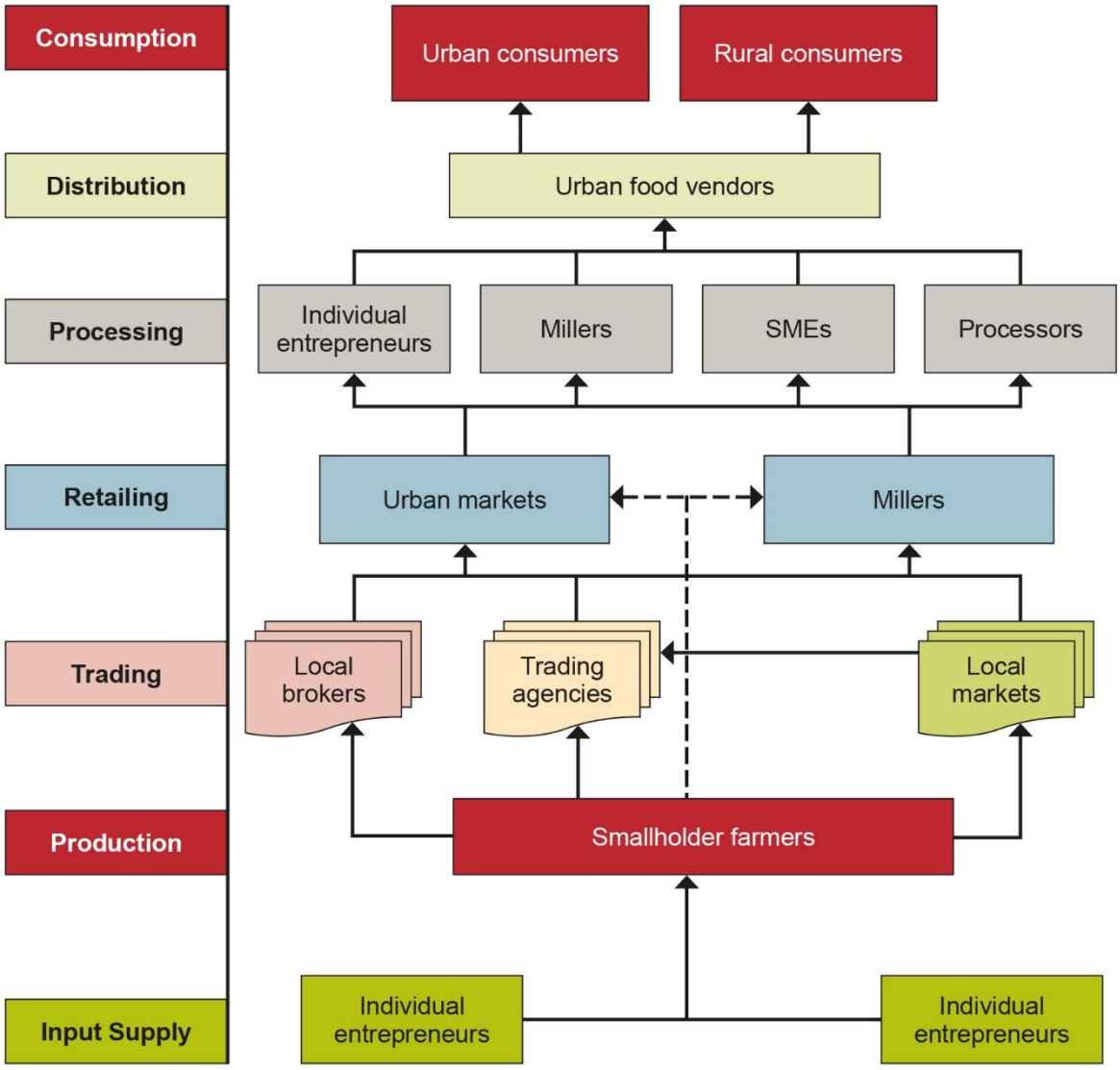
Company/ Producer		Product name	Contents	Price/kg	Company location
Informal sector product					
	Micro- and small-scale processors	Generic maize flour	Maize	TSh1,000 (US$0.65)	Country-wide
Tanzanian processors					
	Anoint food products	Anoint Lishe Flour	Finger millet, soya, maize, sorghum, simsim, groundnuts and wheat	TSh3,000 (US$2.00)	Morogoro
	Lusiga's Suppliers	Lusiga Lishe Flour	Finger millet, soya, maize, sorghum, rice and groundnuts	TSh 3,000 (US$2.00)	Morogoro
	Robasa Health Foods	Robasa Lishe Flour	Finger millet, soya, maize, sorghum, rice, groundnuts and wheat	TSh 3,000 (US$2.00)	Morogoro
	Saadan Food Products	Shibe Lishe Flour	Maize, finger millet, rice, soya and groundnuts	TSh 3,000 (US$2.00)	Morogoro
	Imara Foods	Imara premium Lishe Flour	Maize, finger millet, rice, soya and groundnuts	TSh 3,500 (US$2.30)	Iringa
	Iga Foods	Iga porridge flour	Maize, finger millet, wheat, soya bean and groundnuts	TSh 3,500 (US$2.30)	Morogoro
	Eden Women Group	Turudi Edeni	Maize, finger millet, rice, soya, millet and groundnuts	TSh 3,500 (US$2.30)	Morogoro
	Power Flour (division of Power Foods)	Lishe Nut	Finger millet, soya, groundnuts, wheat and rice	TSh 3,800 (US$2.50)	Dar es Salaam
		Baby Porridge*	Maize, soya, germinated millet, rice, sweet potatoes and micronutrient premix	TSh 5,000 (US$3.30)	
		High protein porridge	Maize, finger millet, rice, cooked beans and roasted groundnuts	TSh 5,000 (US$3.30)	
Imported products					
	Powa Brand	Jazia Instant Meal*	Maize, soya, micronutrient premix, colourants and salt	TSh 13,000 (US$12.50)	South Africa
	Nestlé	Cerelac*	Wheat, milk, honey and micronutrient premix	TSh 20,000 (US$12.80)	Nairobi (under licence)

*Product fortified with micronutrient premix.
Source: Authors' own, market survey, 2014 (non-exhaustive).

6.2 Value chain actors

As mentioned above, there is little or no difference between complementary foods and other cereal-based foods at the stages of production, wholesale, storage and transport. Crops are produced by smallholder farmers, usually on a semi-subsistence basis. Farmers market a portion of their crops on an *ad hoc* basis and also keep a portion for their own consumption. Production is purchased by local brokers, who work for large urban-based traders. These traders assemble and store the commodities, and sell them on to retail traders and food processors. The market is controlled by a few wholesale traders, who exert considerable control over prices. Processors usually buy ingredients from local markets, although one or two larger firms have their own sourcing agents. They either retail products themselves in their area or sell to shops of all sizes. Figure 6.1 outlines a typical complementary food value chain in Tanzania.

Figure 6.1 Value chain map of the complementary foods in Tanzania



Source: Authors' own.

6.3 Nutrient content

Cereal-based complementary foods tend to be low in energy, proteins and micronutrients, especially zinc and iron (Martin *et al.* 2010; Mamiro *et al.* 2004; Mosha, Laswai and Tetens 2000). Mosha *et al.* (2000) assessed a variety of home-made and commercial formulations and found that most had insufficient fat, iron, calcium, zinc and phosphorus. Research has shown that formulations can achieve sufficient energy and protein through combining cereals with legumes such as cowpea, soya or common beans (Martin *et al.* 2010; Muhimbula *et al.* 2010). However, fortification is generally required to achieve the full suite of micronutrients. There are no comprehensive studies assessing the nutrient content of various products in Tanzania, and the nutritional information on product labels is generally incomplete and considered unreliable.

6.4 Consumers and acceptability

In general, all Tanzanian consumers find mixed cereal complementary foods to be acceptable. Although technically intended for children aged 6–24 months, people of all ages eat these products – including older children, adults and the elderly. However, there are acceptability problems for some formulations. For example, some infants have allergic

reactions to products containing soya or cowpea. Another consideration is that price is by far the most important factor driving which products a household uses.

Preparation in the home continues to be the most common way that consumers access complementary foods, especially because this may be a cheaper option than packaged products. However, due to changing urban lifestyles and the growing number of women working away from the home, more urban consumers are buying products that are pre-packaged and convenient to prepare. Very few households purchase fortified imported products. The TDHS survey found that less than 4 per cent of infants had been given a fortified product in the previous 24 hours (National Bureau of Statistics and ICF Macro 2011).

6.5 Affordability and availability

The prices of complementary food products range dramatically. In general, simple, unfortified cereals (especially maize) are the cheapest, while packaged products are unaffordable to the poor, whether in urban or rural areas. Fortified products are beyond the means of all but the wealthiest few. Thus, in the survey conducted in Morogoro Region, unfortified maize cost just TSh1,000 per kilo (US$0.65), while mixes made by small businesses were more than three times more expensive, ranging from TSh3,000 to 5,000 (US$2.00–3.30). Nestlé's Cerelac (manufactured in Kenya) was more than 20 times as expensive as maize, costing TSh20,000 (US$12.80). This price gap suggests that packaged complementary foods do not adequately reach low-income groups.

Although cereal prices undergo seasonal price fluctuations, the prices of packaged complementary foods tend to be relatively stable. This is because processors stock ingredients during periods of low price and store throughout the year. Although data are not available, it is likely that products made by micro- and small-scale processors exhibit stronger fluctuations.

6.6 Production, supplies and storage

Complementary food mixes are made from a wide variety of agri-food commodities. A review of production issues facing all of these value chains is beyond the scope of this report. Instead, this section points out a few issues related to sourcing that impact the processors of complementary foods. The cereals and legumes used as ingredients in complementary food mixes are generally available throughout the year in the urban markets. However, because of the transportation issues, in rural areas availability depends on local agricultural production, and even basic commodities may become unavailable during seasonal periods of scarcity or low production years. Complementary foods are impacted by food safety issues that affect cereals in Tanzania (Box 6.1).

Most complementary food processors source ingredients that are available in their local markets and do not undertake their own sourcing. One or two of the larger firms have semi-integrated sourcing operations, through established relationships with traders in various regions of the country. One processor attempted to establish its own contract farming arrangement but was unable to prevent side-selling (Maestre *et al.* 2014). In a few areas, new marketing systems for cereals are emerging, including collective marketing by farmer organisations and warehouse receipt systems. However, these schemes remain at a nascent stage. In addition to cereal and legume ingredients, micronutrient premix can be used to increase the adequacy of complementary foods. This study identified only one Tanzanian firm that fortified some of its products; this firm sources its premix via the global procurement system managed by the Global Alliance for Improved Nutrition (GAIN).

Box 6.1 Aflatoxin contamination in complementary foods

Complementary foods produced in Tanzania are reported to be contaminated with aflatoxin, a harmful compound produced by strains of mould that grow on grains. Rates are reported to be particularly high in rural areas where maize is used as the principal ingredient (Kimanya *et al.* 2014; Kimanya *et al.* 2012). Over 30 per cent of children using complementary foods are reported to be exposed to levels that are dangerous to human health (Kimanya *et al.* 2014). At present, the only method established in Tanzania to avoid contamination is to exclude the worst-affected commodities, especially maize (Kimanya *et al*. 2012; Van Camp *et al.* 2003). One research project is seeking to reduce aflatoxin levels in complementary foods by introducing improved on-farm practices.[31] However, research has shown that there are important constraints that prevent farmers from using these practices[32] (Kimanya *et al*. 2012).

6.7 Processing

As mentioned, there are three kinds of actors processing complementary foods: households processing for their own consumption, micro- and small enterprises, and medium-size firms. Home processing is probably the most common source, especially for low-income and rural households. However, the commercial sector has expanded rapidly in recent years. In Morogoro Region alone, more than 20 small firms are active (not including the countless micro-scale operations). The majority of small firms undertake processing in their homes, and do not have their own facilities or equipment; they often purchase milling services from local grain millers. In addition to these small operations, there are a handful (approximately five) of medium and large processors. These businesses differ from the small players in that they have dedicated production facilities, distribute across larger areas and sell at higher prices.

The relative disorganisation of the processing market creates major challenges for introducing standards and addressing food safety issues (see Box 6.2). Only a handful of firms are registered with the Tanzanian regulatory agencies, the Tanzania Food and Drugs Authority (TFDA) and the Tanzania Bureau of Standards (TBS). Many firms are unaware of regulatory requirements or of food safety and nutrition issues associated with processing complementary foods. A USAID-funded programme is currently targeting small and medium processors of complementary food mixes in two regions and aims to introduce good business practices and micronutrient fortification. However, the project has faced major hurdles and delays in building the capacity of businesses and helping them to meet the relevant standards. After two years of operation, it has not yet been able to introduce fortification. (For more detail on building the capacity of SMEs, see the accompanying policy guidelines, Robinson *et al*. forthcoming.)

The regulatory environment for processors appears inadequate, even when firms are able to meet manufacturing and quality standards. As seen in the discussion of affordability in Section 6.5, larger firms tend to sell products at higher prices. This is precisely because complying with standards increases their costs substantially, and they pass these costs on to consumers. Further, larger firms offset their investments in product quality by marketing their products as premium brands, which helps to differentiate them from informal sector competitors and sell to middle- and upper-income consumers (for a Tanzanian example, see Maestre *et al*. 2014).

[31] The project, titled 'Developing effective pre-harvest strategies to minimize exposure to mycotoxins on maize based complementary food in Tanzania', is a collaborative project between Ghent University and Sokoine University of Agriculture. The project aims at developing good agricultural practices to prevent mycotoxins from forming during maize production and harvesting.

[32] This mirrors an assessment of aflatoxin contamination in groundnuts in Ghana, where it was found that there were few if any incentives for farmers and other value chain actors to adopt improved practices (Anim-Somuah *et al.* 2013a).

Box 6.2 Low adherence to food standards and regulations

Most complementary food processors are not registered with regulatory authorities (TFDA) and do not receive support or monitoring for compliance with hygiene and manufacturing standards. The survey conducted for this study identified only one product that bore the TFDA/TBS registration mark.[33] Low compliance with good manufacturing and hygiene practices may contribute to the documented incidents of contamination of complementary foods with harmful bacteria (especially coliform and Enterobacteriaceae) (Kung'u *et al.* 2009). Avoiding contamination is especially important for complementary foods, since young children are vulnerable to food-borne pathogens (Lanata 2003). Researchers have thus argued that improving the manufacturing practices of small processors is a key priority (Kung'u *et al.* 2009; Van Camp *et al.* 2003).

The 2013 Complementary Foods Act[34] mandates specific standards for the formulation, packaging, distribution and marketing of complementary food products. However, only one or two firms currently meet this standard. Under current conditions, the Act does not appear to be implementable or to address food safety or nutrition issues affecting micro- and small enterprises.

6.8 Distribution and retail

The availability of complementary foods is patchy; however, micro- and small enterprises provide coverage in many urban areas. No firm has national coverage. Even the large firms distribute regionally or within a few urban centres, while small enterprises distribute within a single town or neighbourhood. The size of the country, poor transport infrastructure and low average incomes in rural districts mean that wider distribution is not profitable, even for larger companies. For home production, consumers simply buy raw commodities in local markets. For packaged products, the most common retail points are small shops and mini-supermarkets. In addition, small processors often sell their products from their homes, through food kiosks or door-to-door.

Marketing practices for complementary foods have developed substantially in recent years. Consumers tend to have loyalty towards a single brand, often because they know the producer personally, and may regard their product as more likely to be safe and uncontaminated.[35] Brand loyalty suggests that consumers are already looking for products they perceive to have high-quality ingredients and processing. This presents a potential leverage point for efforts to introduce signalling mechanisms that can differentiate products based on their nutrient-density. However, nutritional value does not seem to be an important factor in product differentiation. Most products are sold unlabelled. Even when they are labelled, they rarely indicate the ratio of ingredients used or the products' nutrient contents. Only 5 of the 11 products surveyed in Morogoro provided information on nutritional composition and/or formulation ratios (see Table 6.1 above).

6.9 Barriers, responses and assessment

Complementary food products in Tanzania have high potential to help address undernutrition among children between six months and two years old. In addition to targeting this key age group, they are widely accepted by consumers and are available in most urban areas. The high level of demand creates business interest from micro-enterprises and larger firms. Yet, although complementary food products already contribute to child nutrition, a number of barriers restrict their potential. There is a strong trade-off between price and quality, such that nutritionally adequate products are not affordable to the poor, while low-cost products

[33] Note though that one producer (Power Foods) stated that it was registered with authorities and complied with all relevant standards (Maestre *et al*. 2014).
[34] Government notice no. 60 issued 15/03/2013. Tanzania Food, Drugs and Cosmetics Act (Marketing of Foods and Designated Products for Infants and Young Children) Regulations, 2013.
[35] Personal trust seems to be an important factor. Even wealthier consumers reportedly may trust a local producer more than large domestic or multinational firms.

are often not good quality. The key to enhancing these products' impact on nutrition is to create mechanisms to signal nutritional quality and create incentives for businesses to market products with adequate nutrient content. This would make it possible for companies to sell nutritionally adequate products at lower prices. It would require long-term programmes that organise players into clusters or associations and extend the coverage of quality controls. Efforts should build on the successful elements of the current system: micro-processors make products available nationwide, something that large-scale manufacturers are unable to do at present. They are also much better able to reach lower-income populations.[36] Finally, to be effective, value chain interventions must also be accompanied by efforts to improve infant care and feeding practices, especially exclusive breastfeeding and adequate complementary feeding. The performance of complementary products as a source of nutrient-dense foods is summarised in Table 6.2.

Donor agencies and public–private partnerships have options for how to engage with businesses in the complementary foods market; in-depth investigation will be needed to assess the costs and benefits of these options. However, this analysis has indicated that policy engagement to change market conditions will be critical to enabling the private sector to produce nutrient-dense, safe and low-cost products in a way that is commercially viable. Interventions that target small numbers of firms – without transforming larger market conditions – are unlikely to be successful in the long term. These issues are discussed in greater detail in the forthcoming policy guidelines. Potential avenues for public and private institutions to strengthen complementary foods include the following:

Organise the industry and build capacity to meet quality standards. As described above, the processing sector is highly fragmented; businesses are unregistered, scattered and use variable facilities and procedures. This makes it difficult and costly to identify, monitor and support businesses, and contributes to problems with food safety and quality. The first step for public institutions is to organise processors into clusters or associations so they are easier to provide with services and to monitor. At the same time, development programmes need to strengthen the capacity of decentralised regulatory institutions, which are ultimately necessary to ensure the safety and nutritional quality of products – even when industry is organised. This also requires that government provides sustained funding for regional and district-level institutions and aligns incentives for enforcement. Finally, simplifying and reducing the cost of business registration[37] would bring more enterprises into the formal sector and help increase regulatory coverage. However, experience of programmes working with food SMEs in Tanzania shows that building the capacity of SMEs is extremely resource- and time-intensive.[38]

Develop a certification scheme to guarantee nutrition quality to consumers. At present, there are few mechanisms that signal to consumers the nutritional value of complementary foods. Consumers rely on personal relationships to provide some guarantee of the overall quality of a product. Whether this correlates with nutritional quality is unclear. Many products are unlabelled, and what labels there are tend to be incomplete and unreliable. This lack of signalling discourages businesses from investing in nutrient-dense formulations, since they will not be able to differentiate their products from cheaper, less nutritious alternatives. A certification scheme has the potential to create incentives for businesses to improve the nutrition quality of their products. Such a scheme would require three components: (1) a system for businesses to submit their products for certification; (2) robust enforcement to ensure that products continue to meet hygiene and nutritional standards; and (3) a way to signal to consumers which products are certified, using a logo. Similar programmes have

[36] However, no class of packaged product is currently affordable to the urban poor or the majority of rural residents.
[37] The process for food processors to register their business and products can take several months or longer. In addition to meeting the requirements of the TBS and the TFDA, processors must also seek certification of their manufacturing premises, technical teams, packaging, labelling and nutritional content.
[38] Experiences of working with SMEs in order to improve food quality and nutrition are reviewed in the accompanying policy options report (Robinson *et al*. forthcoming).

been recommended for complementary food markets in Ghana (see Masters *et al.* 2011). The central challenge of this approach is that even private certification requires effective enforcement institutions. To succeed, it would require that the market was somewhat consolidated (see the previous point). (For further details on the options for structuring such a certification scheme, see Anim-Somuah *et al.* 2013a; Masters *et al.* 2011.)

Fund public procurement and distribution of complementary foods. The discussion above shows that organising SMEs and introducing certification systems are difficult, costly and uncertain endeavours. This suggests that, under present conditions in Tanzania, it will be difficult for private markets to produce and distribute products at a price that is affordable to the poor. A strategy of public procurement and distribution will be more predictable. Experience from other countries shows that public purchasing can guarantee the nutritional quality of products and ensure they reach poor and vulnerable populations. It also appeals to businesses, by providing them with a guaranteed market (Robinson and Humphrey 2014). This approach has been attempted on a limited scale in Tanzania through the school feeding programme, which sourced relatively small quantities from one complementary food producer (see Maestre *et al*. 2014). This strategy obviously involves challenges. Sustaining funding is clearly a challenge for donors, and mobilising domestic resources may also be difficult. Furthermore, a product that is successful in a public distribution model cannot necessarily be transitioned to a private model (Nwuneli *et al*. 2014). Donors and government will need to conduct in-depth assessments of the costs and risks of alternative strategies before determining whether public distribution is most viable.

Where other approaches are unfeasible, use behaviour change communications to promote home fortification. Creating market governance systems to overcome the absence of signalling mechanisms is institutionally complex and uncertain. Policy actors may judge that it is too expensive to create the conditions for private markets to function effectively, or for a public institution to undertake the distribution function itself. An alternative approach is to promote consumption of products *whose value consumers can already assess easily*: these are essentially raw commodities – such as cowpea, soya or OFSP – that are widely available through local markets. Public programmes could encourage consumers to undertake their own fortification of complementary foods using ingredients that are available locally. Motivating behavioural change will be a challenge, especially given consumers' lack of awareness of hygiene and nutrition issues, and the time and labour required to process foods at home. It would require a campaign that informs and shapes the behaviour of massive numbers of consumer households, rather than the smaller numbers of commercial processors. Further, this strategy will not be able to address constraints that are beyond the control of individual households, such as aflatoxin contamination in supplies. It may be less effective for the urban poor, where those in charge of infant feeding (almost always women) may not have time to process and mix foods themselves.

Pass reforms that facilitate marketing of complementary foods. Some regulatory reforms could facilitate complementary food producers. First, as discussed above, present requirements for registering food businesses are too onerous and complex for small businesses. Simplifying these procedures could encourage more enterprises to formalise, and simplify the task of regulation. Second, the present application of the code on breastmilk substitutes appears to discourage processors from making complementary foods.[39] The code is currently interpreted as forbidding advertising of any food targeting children under five. For this reason, no manufacturers promote or advertise their products. This means it is impossible for complementary food processors that make nutritionally adequate products to communicate these benefits to consumers. As a result, it may inhibit mothers from identifying which products are nutritionally adequate. However, it should be emphasised that these reforms on their own will not address the market constraints identified above.

[39] It should be noted that this code is poorly enforced, and that restrictions probably only discourage the larger processors from advertising. Small producers are unlikely to use advertising, but instead rely on personal relationships.

Table 6.2 Performance of complementary foods against criteria for addressing undernutrition

Criteria	Extent to which criterion is met	Comment
Nutritional content	Insufficient information	No data comparing the micronutrient content of commercial complementary food products.
Availability	Partially met	Packaged products available in urban areas. Availability of nutrient-dense ingredients in rural areas is unclear.
Affordability	Partially met	Products with some guarantee of being nutritionally adequate are too expensive. Nutritional adequacy of affordable products is not clear.
Acceptability	Met	Consumers are familiar with mixed flour complementary foods and they are widely consumed. Some ingredients can cause allergic reaction, i.e. soya.
Awareness and signalling of nutritional value	Not met	Consumers cannot distinguish between packaged products based on fair nutritional adequacy. Little or no guarantee of accuracy of label claims. This problem is a major contributor to low affordability.

Source: Authors' own.

7 Conclusion

This report has analysed the value chains for three types of foods (cowpea, OFSP and complementary foods) in order to assess their potential to reduce undernutrition in Tanzania. The report identifies constraints that currently inhibit these products' potential and identifies a set of potential responses. Cowpea, OFSP and complementary foods were selected from a larger set of commodities by a group of experts. They therefore represent a subset of products with especially high potential for achieving the criteria of availability, affordability, acceptability and nutritional quality. The purpose of this report is to inform programmes and partnerships aiming to promote the consumption of nutrient-dense foods and the development of new products. To this end, the report highlights possible ways to respond to the current challenges, as well as the risks these responses entail. However, rigorous assessment of the feasibility of the various options is beyond the scope of this report. Before pursuing any option, policy actors should develop a business case to assess costs and benefits. It is hoped the evidence presented here will contribute to the choice and design of future interventions.

Key findings for each of the product types are reviewed below.

7.1 Cowpea

Cowpea production has only recently gained momentum in Tanzania, and the crop remains primarily for subsistence use by farmers. However, it has high potential as a low-cost source of protein, iron and folates, and is relatively acceptable given that consumers are already familiar with other types of beans. Yet important barriers to cowpea's nutritional impact remain: crucially, demand is low and the crop is still not widespread in commercial markets. One reason is that most consumers are unaware of the potential benefits of cowpea. Second, cowpea is highly susceptible to pests during storage, which leads traders to use chemical pesticides that create serious health risks. Finally, cowpea has generally been neglected by government and donor agricultural programmes. Options for future programmes include:

- *Promoting the use of safe, improved storage technologies.* This requires creating viable supply chains for these technologies and ensuring that value chains provide incentives to use these technologies.
- *Increasing demand with awareness campaigns* promoting nutritional benefits and addressing acceptability concerns.
- Providing support to businesses to commercialise products that appeal to consumers' tastes.

7.2 Orange-fleshed sweet potato (OFSP)

Orange-fleshed sweet potato is an extremely good source of vitamin A and could be incorporated into already-established value chains for white-fleshed sweet potato. Although adults tend to prefer white-fleshed varieties, OFSP is highly suitable for infants. However, at present, production remains localised and there is little commercial production. A number of programmes have promoted OFSP, but these have focused on supply-side issues and have neglected issues around marketing structures and demand. One crucial constraint is that retailers do not distinguish between OFSP and white-fleshed varieties. Future interventions need to support OFSP products that appeal to consumer preferences, increase consumer awareness, and encourage traders to differentiate OFSP and promote it with consumers. The golden colour of OFSP is an advantage that should not be overlooked; it makes this product much more likely to succeed in private markets compared to products whose nutritional value is not easily identifiable. The key to strengthening OFSP is to increase

consumer demand and to build markets to make tubers more widely available. Options include:

- *Strengthening supply chains for improved varieties.* Investigate why new varieties are not adopted. Identify ways to create incentives to use enhanced varieties.
- *Social marketing* focused on increasing demand from consumers in regional and national markets.
- *Targeting traders and value chain intermediaries.* Evidence from other countries indicates that traders can differentiate OFSP and market it to consumers, if they are convinced this will improve their revenues.
- *Supporting processors to release new products* to help overcome low acceptability among adults. Promote organising and clustering to reduce the transaction costs of working with small businesses.

7.3 Complementary food products

Improving complementary foods is a key challenge in Tanzania – along with improving infant feeding practices. There is potential in the strong demand in this market and dynamism among small processing businesses. However, most products are still nutritionally inadequate and lack not just key micronutrients, but also protein and energy. Only a handful of large firms operate in Tanzania, and their products are vastly too expensive for lower-income populations. Interventions should seek to enable the private sector to provide affordable, safe and nutritionally adequate products. Options for donors, governments and partnerships include:

- *Organising small-scale processors into clusters* to make them easier to support and monitor. This is key to the success of regulation and certification, but experience shows that it will be time- and resource-intensive.
- *Developing a certification scheme to guarantee nutrition quality.* This could incentivise businesses to produce more nutritious products. To succeed, the scheme would need to be able to effectively cover and monitor SMEs.
- *Funding public procurement and distribution of complementary foods.* The above options are uncertain. Public distribution is the fastest and most certain way to reach vulnerable populations and will appeal to businesses. Mobilising funding for such a scheme will be the key challenge.
- *Encouraging care-takers to fortify complementary foods using local ingredients.* If none of the other options is deemed feasible, behaviour change communications could seek to motivate consumers to fortify using locally available ingredients**.** This may be a lower-risk strategy, and may be the only option in remote areas.

7.4 Cross-cutting challenges

Finally, a set of cross-cutting challenges impact all three of the value chains examined and relate to the broader environment for nutrient-dense foods. Cross-cutting challenges are examined in more detail in the accompanying policy guidelines (Robinson *et al*. forthcoming).

- *Nutrition awareness is low.* Awareness of the nutritional needs of mothers and infants is generally low in Tanzania, as is awareness of which foods contain essential nutrients. Nutrition is rarely a major consideration in purchasing decisions. These factors lead to low demand and disincentivise businesses from producing nutrient-dense foods. Almost all approaches to nutrient-dense foods will require efforts to increase awareness and demand, particularly among low-income groups.

- *Targeting poor consumers through the private sector.* Developing a viable commercial business selling nutrient-dense food products to bottom-of-the-pyramid consumers is a challenge for several of the products examined in this report. Businesses struggle to achieve price points affordable to low-income consumers, as a result of the costs of distribution and of signalling nutritional quality. The policy challenge is to enable businesses to target the poor and ensure that products reach populations affected by undernutrition, especially those in rural areas.
- *Working with small and medium-size businesses.* All of the value chains reviewed in this report involve large numbers of small businesses at the processing and retail stages. This fact suggests that there are success factors in the small-scale model; what is more, small producers' products appear to be more affordable and available to the poor. For these reasons, efforts to improve products' nutritional quality will need to engage with SMEs. As discussed, organising processors into clusters or associations may be the first step, in order to reduce the costs of engagement for public institutions.
- *Assuring nutritional quality through value chain integrity and signalling.* This report has shown that the lack of mechanisms to guarantee nutritional quality and to signal this to consumers leads to low nutritional quality in products. These problems affect a wide range of products, including fortified flours, lipid-nutrient supplements and micronutrient powders. It is not unique to Tanzania, but affects markets in most developing countries. A body of evidence shows that assuring access to accurate information about product quality and safety is key to the efficient operation of markets (Dranove and Jin 2010). But consumers face major barriers to acquiring accurate information about certain product traits, including nutrient content and contamination with harmful substances. A variety of policy approaches can address the problem of signalling nutritional quality; which approach is appropriate depends on the characteristics of the value chain in question. In Tanzania, options include formal certification schemes, franchising to increase control over retailers, and upgrading capacity among businesses in the informal sector to meet and enforce standards.

The forthcoming policy guidelines complement the analysis in this report, outlining the implications of the current policy environment, reviewing experience with policy interventions to promote nutrient-dense foods, and recommending approaches for tackling the major challenges in Tanzania.

Annex 1: Results of scoring workshop

Table A.1 Composite commodity scores, Tanzania (1=lowest, 5=highest)

Commodity	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	Comp. average	Rank
Cowpea	3.25	2.63	3.00	3.38	3.50	2.88	3.43	3.57	3.13	3.13	3.75	3.24	6
Sesame	2.50	3.29	3.00	3.25	3.38	2.75	3.86	3.14	3.25	3.13	4.00	3.23	7
Kisamvu (cassava leaves)	3.13	3.00	3.38	3.50	2.38	2.88	3.86	4.00	3.88	2.88	3.50	3.31	5
OFSP	3.38	3.13	3.13	3.88	3.75	3.38	2.86	3.88	4.13	2.63	4.13	3.48	4
Local chicken	2.88	4.00	3.63	3.38	3.00	3.13	3.71	4.00	3.50	3.75	4.38	3.58	3
Tamarind	2.25	3.00	3.25	2.75	3.38	1.88	3.57	3.43	3.25	2.75	3.88	3.03	9
Green gram	2.50	2.57	3.00	3.50	3.00	3.00	4.00	3.57	3.25	3.38	3.88	3.24	6
Soya bean products	2.38	3.00	2.75	3.00	3.50	3.00	2.86	3.57	3.25	2.25	3.88	3.04	8
Mango	3.00	4.13	3.63	3.88	2.50	3.88	4.43	4.43	3.75	4.25	4.63	3.86	1
Amaranth	3.38	3.71	3.75	4.00	2.13	3.88	4.29	4.25	3.63	3.88	4.63	3.77	2

Note: P stands for participant.

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