Lessons on small and medium-scale maize flour fortification in Tanzania

Lessons learned from the Millers Pride – Lishe Bora project

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Acronyms

HKI	Helen Keller International
NFFA	National Food Fortification Alliance
TBS	Tanzania Bureau of Standards
MAFC	Ministry of Agriculture Food and Cooperatives
SDG	Sustainable Development Goals
TFDA	Tanzania Food and Drug Authority
TFNC	Tanzania Food and Nutrition Centre

Executive summary

Malnutrition and micronutrient deficiency remains a stubborn problem among the Tanzanian population. To support government policy and efforts DSM and World Vision Tanzania, supported by World Vision Switzerland, formed a partnership to implement the 'Millers Pride – Lishe Bora' project, which ran from 2013 to 2016. In late 2016, the Royal Tropical Institute (KIT) carried out an evaluation of the Millers Pride project. This public paper draws on the evaluation findings and aims to synthesize lessons learned for a wider audience.

Maize flour is thought to be an attractive vehicle for fortification because it is a staple food for a large proportion of the population, including poor and vulnerable households who consume it regularly. As in many lower- and middle-income countries, the maize milling industry in Tanzania is comprised of two distinct types of mills. Only around a dozen roller mills operate on a large-scale throughout the country, with an estimated 95% of maize flour being produced by small and medium-scale hammer miller operators.

The Millers Pride project recognized that the high number of hammer mills in the country presented an opportunity to identify a 'proof of concept' for maize flour fortification. The project aimed to support small and medium-scale millers to fortify maize flour, thereby boosting its micronutrient content, and ultimately improving the nutritional status of thousands of Tanzanians. The project engaged in a series of activities focussed on improving governance, facilitating change in the supply chain, building miller's capacity, and raising consumer awareness.

The project targeted an important cluster of small-scale maize millers located in the Tandale and Manzese areas of Dar es Salaam. Such a concentration of maize hammer mills was believed to be advantageous to the project because millers could receive close project support and efficient monitoring.

Small and medium-scale millers are often characterized by their limited technology and skills, and are highly uncoordinated. Millers face a number of challenges including endemic interruptions of electricity supply; seasonal maize production with associated price fluctuations; inadequate capital to procure sufficient quantities of maize throughout the year; customer attitudes towards quality and price; relatively expensive packaging materials; low maize quality; and, poor water supply for washing maize.

Prior to the project, millers in Tandale and Manzese were not well organized and lacked an established platform where they could meet, develop a shared agenda, advocate for members and lobby local government. The Millers Pride project has been successful in supporting millers through the formalisation of the UWAWASE millers' association.

The project supported UWAWASE through training on good manufacturing practices, food safety and hygiene, nutrition, and maize flour fortification procedures. The project delivered the training with the support of the Tanzania Food and Drug Authority, (TFDA), Tanzania Food and Nutrition Centre (TFNC) and Ministry of Agriculture, Food and Cooperatives. Contact between millers and institutions was found to be important for building relationships, and airing perspectives on challenges within the milling business. UWAWASE now has 228 millers, representing over 90% of all maize millers in the project area.

Hammer mill operators are often described as either 'medium' or 'small-scale'. However, definitions can vary considerably, and the terms 'small' and 'medium' are not particularly helpful for understanding the capacity of maize millers to fortify maize flour. The authors suggest that virtually all millers in the project areas should be considered small-scale based on their characteristics:

- 71 own a hammer mill, 149 rent a mill from a mill owner. The number who own their premises is unknown.
- Only 4 millers own more than one hammer mill
- Only 12 millers have a premise certificate from TFDA, 211 do not.
- Only 6 millers have a product certification, 222 do not.

Within the 'small-scale' categorization, millers can still be differentiated. Important considerations may include whether or not the miller owns the milling machine, whether they own the premises, and whether or not the miller has premises and product certification from TFDA.

Achieving fortification with small and medium millers is much more difficult than with large enterprises. Typically, small millers are characterized by low output levels, and tend to lack capacity, technical expertise and financial resources. Furthermore, because they are numerous, widely scattered and not registered with government authorities, they are much more difficult for supporting actors to reach out to. This has a major influence on the feasibility, scope and costs of any maize flour fortification programme.

The incremental costs of maize flour fortification are also likely to be higher for smaller millers than large-scale millers. Hammer mills require more human input, which raises concerns about quality control and adequate standard operating procedures. Additional costs and labour requirements are important reasons why small hammer mill operators are likely to be adversely affected by the introduction of fortification, and why they may resist it.

Due to the feasibility challenges of fortification, the authors suggest that future projects should focus most resources on small-scale mill *owners*, and preferably those with premises that can be modified to adhere to government regulations.

The Millers Pride project looked at three main options for adding premix to maize flour: the scoop method, microfeeders, and Sanku dosifiers. Each option faces various challenges and tradeoffs. The scoop method is the simplest method, but is also the least precise and was hence deemed unsuitable. Microfeeders, sourced from China, were modified and performed sufficiently under trial conditions. However, microfeeders require regular calibration, have manual start-stop operations, and do not have an automatic monitoring system, which raises some concerns as to how they would perform under normal business conditions. Sanku dosifiers are specifically designed for automatically dispensing premix with the hammer mill process and are the superior product available. The tradeoff is that one unit costs in the region of US$2000 and US$2500.

Fortifying millers require a reliable premix supply chain. Unfortunately, with a current lack of demand from millers, there are few signs that a reliable supply chain will be established in the next few years. To be sustainable, projects need to stimulate a supply chain with actors willing to import and distribute the premix product.

There are several costs likely to be incurred when fortifying maize flour. These include the following: Sanku dosifier (US$ $2,000-2,500) or microfeeder (US$ $300-500); variable costs to changes to milling premises as required for certification; application for milling premise certification US$75 and maize product certification US$320; cost of premix fortificant (TSH 20/kg); and variable costs of training staff.

The Millers Pride project evaluation found that millers acknowledge the public health case to fortify maize to fight malnutrition. In general they have a positive attitude towards fortification, provided they do not incur a business cost.

There is a general consensus amongst millers that there is a lack of a business case for them to raise finance and invest in maize flour fortification in the short- to medium-term. Consumers in the lower socio-economic brackets who would benefit most from maize flour fortification are also the most sensitive to higher prices, and least likely to pay more for fortified maize flour. Coupled with low consumer awareness and a lack of fortified maize flour currently on the market, millers correctly recognize that there is little prospect for them to generate a return on investments made on fortification.

The Millers Pride team only worked directly on fortification with millers who were able to acquire premise and product certification from TFDA. This was a reasonable project approach, and in line with government regulations. However, the approach faces an inconvenient reality – if projects only work with certified millers, very little fortified maize will be produced because there are so few millers capable of fulfilling certification requirements.

For future projects there is a precedent for a possible workaround. The Tuboreshe Chakula project recognized these constraints and obtained permission from TFDA, TFNC and Ministry of Health to start fortification activities concurrent with certification and registration processes. This is not a recommendation to begin fortification prior to certification, but it may be a practical option to discuss with the authorities and possibly accelerate maize flour fortification activities.

Since 2011, fortification by large-scale processors of wheat, oils and maize has been mandatory in Tanzania. However, small and medium-scale maize millers remain exempt. During the Millers Pride project evaluation, some actors suggested that mandatory fortification for small and medium-scale millers could be the answer. However, the Millers Pride project evaluation found that more regulations are unlikely to have an impact. Existing regulatory requirements, (including those for maize flour product and milling premises), are presently not adhered to by most small and medium millers. It is therefore unlikely that additional regulations will fare any better unless the underlying challenges are addressed.

The Millers Pride project tried to work with the National Food Fortification Alliance (NFFA) in Tanzania to raise consumer awareness of fortification and the health risks of micronutrient deficiencies. The project experienced a 'Catch 22' situation with regards to consumer awareness – raising awareness of, and demand for, fortified maize requires reasonable availability on the market. On the other hand, millers themselves are wary of investing in and producing volumes of fortified maize product without certainty of consumer demand. Therefore, awareness campaigns need to go hand-in-hand with production activities. As poorer consumers are believed to be particularly price sensitive, it has been suggested that fortified maize flour should not cost more than non-fortified maize flour.

The question of who should bear the costs of fortification remains open. The business case for small millers to invest in maize flour fortification is not strong at present, which is a reality that all project implementers and governments must acknowledge.

Overall, the Millers Pride project learned that maize flour fortification initiatives should take a value chain approach, which considers the particular interests of each actor. What barriers or constraints hold each value chain actor back, and what are the enabling factors that can help drive them forward in a positive way?

An important pathway to success is to identify incentives that will encourage actors to make certain investments or changes to their processes and business activities. Without incentives, small and medium scale maize millers are very likely to continue business as usual, missing an opportunity to reduce the incidence of malnutrition and micronutrient deficiency.

Introduction

Malnutrition and micronutrient deficiency remains a stubborn problem among the Tanzanian population. To support government policy and efforts, World Vision Tanzania[1] and DSM[2] formed a partnership to implement the 'Millers Pride – Lishe Bora' project, which ran from 2013 to 2016.

The overarching aim of the Millers Pride project was to engage small and medium-scale maize millers and support them to fortify maize flour, thereby boosting its micronutrient content, and ultimately improving the nutritional status of thousands of Tanzanians. Maize flour is an attractive vehicle for fortification because it is a staple food for a large proportion of the population, including poor and vulnerable households who consume it regularly.

The Millers Pride project targeted an important cluster of small-scale maize millers located in the Tandale and Manzese areas of Dar es Salaam. The area is home to over 300 millers, who supply maize flour to tens of thousands of Tanzanians daily. Such a concentration of maize hammer mills was believed to be advantageous to the project because millers could receive close project support and efficient monitoring[3].

World Vision Switzerland provided €200,000 of project funding and World Vision Tanzania implemented the project from its office in Dar es Salaam. DSM contributed a further €200,000 to support the project, provided premix for fortification trials, and offered nutritional expertise to the World Vision country office. The National Food Fortification Alliance (NFFA) was a key advocacy platform to engage government, private institutions and civil society and promote the project plans. The project included a series of activities, all of which were geared towards the goal of sustainable, fortified, maize flour production (Box 1).

In late 2016, the Royal Tropical Institute (KIT) carried out an evaluation of the Millers Pride project. This public paper draws on the evaluation findings and aims to synthesize lessons learned for a wider audience. Many challenges for small-scale maize fortification persist but it is hoped that, by sharing project lessons, other stakeholders may be better informed when designing fortification programmes or developing policy.

The Millers Pride project evaluation was based on an analysis of project documentation and a review of policy documents and papers on the maize fortification landscape. Fieldwork was conducted in Dar es Salaam during October 2016, and included interviews with key informants both directly and indirectly engaged in the project.

Box 1: Millers Pride project activities

Governance:
- Advocate for VAT exemption on fortified maize flour to reduce costs to consumers
- Advocate for tax-free import of premix
- Advocate for mandatory fortification for medium-scale maize millers
- Advocate for and promote fortification via NFFA forums and meetings
- Coordinate monitoring and certification of mills with local government

Supply chain
- Establish supply chains for consistent access to raw materials (pre-mix, maize)

Millers' capacity
- Establish and support the strengthening of the millers association (UWAWASE)
- Establish registered miller training academy and develop a training curriculum
- Training of millers on good manufacturing processes, food safety, hygiene and quality
- Training of millers on financial management and entrepreneurial skills
- Support millers to obtain official premises certification, product certification and fortification
- Conducting maize flour fortification trials with champion millers
- Coordinate exchange visits between similarly sized mills and create a forum for sharing best practices
- Provide millers with the necessary capital to improve and expand (premix dosifiers, grain storage, transport, packaging)

Consumer awareness
- Preparation of consumer campaigns
- Promote journalism award on the promotion of food fortification

Box 2: Stakeholders interviewed for the Millers Pride project evaluation

- World Vision Tanzania
- Tanzania Food and Drug Authority
- Tanzania Food and Nutrition Centre
- Tanzania Bureau of Standards
- Ministry of Health, Community Development, Gender, Elderly and Children
- National Food Fortification Alliance
- Millers' association and miller members
- TechnoServe
- DSM fortification consultant
- SANKU fortification technology
- Helen Keller International
- IMA World Health, (formally with Tuboreshe Chakula project)
- World Food Programme
- Basic Element (Large-scale miller)

[1] http://www.wvi.org/tanzania
[2] https://www.dsm.com/corporate/home.html
[3] Tom. C. (2013a)

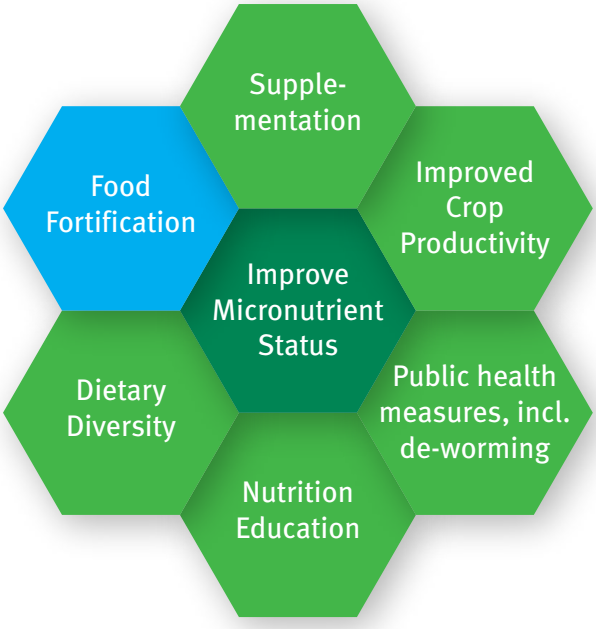
Background to maize fortification

In the past, developing countries tended to give most attention to the issue of 'food security'. But in recent years, governments, the donor community, non-governmental organizations (NGOs) and the private sector have begun committing more resources to nutrition in an effort to alleviate the poverty trap of malnutrition[4,5].

Nutrition in Tanzania was previously treated as a minor priority area, located within the Ministry of Health. However, in 2013, President Kikwete issued a 'Nutrition Call to Action' to declare undernutrition a national emergency and raise the profile of nutrition. Policy efforts have been championed by a group of parliamentarians, major development donors and a network of NGOs known as the Partnership for Nutrition in Tanzania (PANITA). Political support has led to a number of recent reforms with the aim of improving planning and implementation of nutrition-specific and nutrition-sensitive interventions[6].

There is global consensus that a mix of interventions that increase intake of micronutrients from the diet can reduce and prevent maladies associated with insufficient micronutrient intake. Possible interventions include supplementation, dietary diversification, food fortification and observance of public health measures that promote good hygiene and prevent infections and illnesses (Figure 1)[7].

Figure 1: Framework for improved micronutrient status



Source: J.P. Pena-Rosas, WHO Geneva, 2008

Staple food fortification – the addition of one or more micronutrients to foods consumed by a large proportion of the general population – has been demonstrated to be an effective and cost-efficient public health intervention to improve micronutrient intakes and micronutrient status[8,9,10,11]. One of the major advantages of food fortification is that it does not require consumers to change their dietary patterns or make individual decisions[12].

The Government of Tanzania has embarked on various efforts to decrease stunting and other forms of malnutrition[13,14]. National fortification of salt with iodine began in 1995 and fortification of wheat, vegetable oil and maize flour became mandatory in 2011 for large-scale processors[15,16]. However, at present, small and medium-scale maize millers remain exempt from mandatory fortification with essential micronutrients.

Figure 2: State of food fortification in Tanzania from the 2015 FACT survey

Source: GAIN. (2016)

Oil	There is high coverage of fortifiable oil, meaning high potential for impact from fortification. Risk factors such as poverty and dietary diversity have little impact on coverage. Further efforts are required to improve quality and address under-fortification, especially in Zanzibar
Wheat flour	Household wheat flour coverage is low except for Zanzibar where wheat coverage is much higher and most is fortified. There are big difference in coverage with households that are poor with lower dietary diversity consuming much less fortifiable wheat. There is potential for impact among a subset of the population, particularly in urban areas. Improvements in quality of fortification are needed.
Maize flour	Coverage of fortifiable maize flour is much lower than other vehicles due to high levels of home production but there is still potential for impact, particularly in urban areas and in Zanzibar where much of the maize consumed is industrially produced. Fortification quality remains a big challenge as virtually no maize is fortified.
Salt	Nearly universal coverage of fortifiable salt but there are big differences in coverage to fortified salt by poverty, particularly in rural areas. Further efforts are needed to improve quality and address under fortification.

[4] Zamora, G. and De-Regil, L.M. (2014)
[5] Barrett, C., Bevis, L. (2015)
[6] For a detailed background on agriculture and nutrition policies in Tanzania, see Robinson, E., et al. (2014)
[7] Tom, C. (2013b)
[8] Fiedler et al. (2014)
[9] Pachon H. (2013)
[10] Allen et al. (2006)
[11] World Health Organization (2009)
[12] World Health Organization (2009)
[13] DPG Nutrition. (2013)
[14] Ministry of Health and Social Welfare. (2011)
[15] This law does however not apply to Zanzibar, the semi-autonomous part of Tanzania in the Indian Ocean. GAIN. (2016)
[16] Mandatory fortification involves enriching maize flour with iron, zinc, folic acid and vitamin B-12. The addition of vitamin A, niacin, vitamin B-1, B-2 and B-6 is optional. Tom, C. (2013b)

Bags of fortified maize flour, displaying the levels of micronutrients and featuring the food fortification logo on the right-hand side of the bag.

The majority of the Tanzanian population, particularly those at the 'bottom of the pyramid', consume mostly starchy cereals. Foods rich in micronutrients are largely absent from diets of low income households[17] (Figure 3). Maize flour, known as *ugali*, is the most widely consumed 'fortifiable' processed food in Tanzania, providing 40% of household calories on average in Tanzania, and 23% of calories in Dar es Salaam[18]. Children under five eat on average around 220 g of maize flour per day, and the average Tanzanian woman consumes between 301 and 579 g of maize flour per day[19].

With such a large proportion of the population consuming maize flour, there is high potential for achieving health impacts through fortification[20,21].

Box 3: Maize fortification and international goals

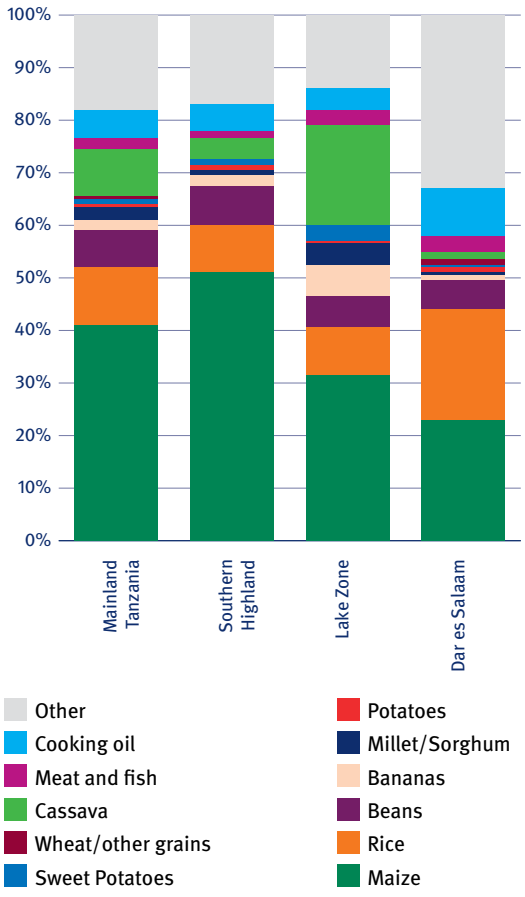
Fortification of maize flour contributes towards the achievement of the sustainable development goals (SDGs), in particular:

- SDG Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- SDG Goal 3: Ensure healthy lives and promote well-being for all at all ages[22].

It also supports efforts to achieve the global targets of the WHO comprehensive implementation plan on maternal, infant and young child nutrition[23] and the global strategy for women's, children's and adolescents' health (2016-2030)[24]

[17] Robinson, E., et al. (2014)
[18] Diets in Dar Es Salaam are generally more diverse than elsewhere in the country, perhaps because of higher average incomes and greater access to markets. See Cochrane, N. and D'Souza, A. (2015)
[19] Tom, C. (2013)
[20] Tom, C. (2013b)
[21] GAIN. (2016)
[22] https://sustainabledevelopment.un.org/sdgs
[23] WHO. (2014)
[24] WHO. (2015)

Figure 3: Calorie share of staple foods in Tanzania



Note: 'Other' includes fruits, vegetables, dairy products, nuts and spices, sugar and sweets, and beverages (alcoholic and non-alcoholic)

Source: USDA, Economic Research Service using data from Government of Tanzania, 2010-11, National Panel Survey

However, in Tanzania, large-scale maize flour processing is only done by around 10 companies with around 5% of the total market share. An estimated 95% of the maize flour consumed in urban and rural areas is milled by small and medium-scale millers[25,26].

Maize milling practices tend to differ between urban and rural areas. In rural areas, 'toll milling' (also known as 'service milling') is frequently practised, whereby a household takes maize they have produced themselves to the local mill, with the intention of using it for their own consumption. Most urban household consumers, on the other hand, buy maize from markets, kiosks, and supermarkets.[27] Due to the extremely fragmented nature of rural markets, the Millers Pride project made the decision to first focus on urban small and medium maize millers in the Tandale and Manzese areas of Dar es Salaam, who were thought to be easier to work with.

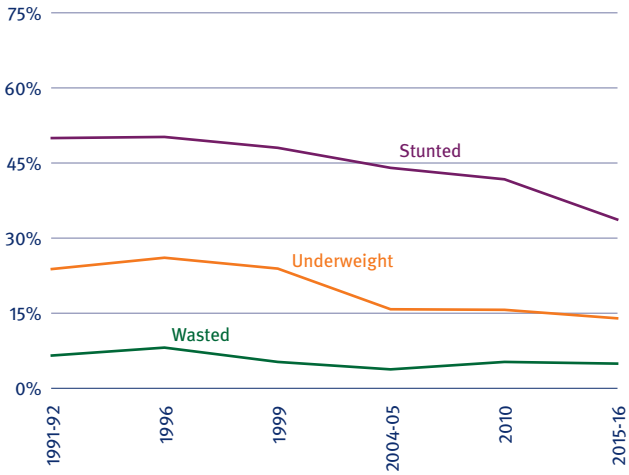
Nutrition status in Tanzania – the case for fortification

Micronutrient-deficiency is a major issue for the health and productivity of a population. The main micronutrient malnutrition problems include vitamin A deficiency (VAD), iron anaemia deficiency (IDA), and iodine deficiency disorders (IDD). Malnutrition is associated with maternal mortality, spontaneous abortions, premature births, and low birth weight[28]. In addition, micronutrient malnutrition is a major impediment to socio-economic productivity[29]. It has been estimated that, every year, deficiencies in iron, vitamin A and folic acid cost the country over US$540 million, around 2% of the country's GDP[30].

Results of the recently conducted Demographic Health Survey[31] confirm that micronutrient deficiencies continue to afflict a high proportion of pre-school children, school-going children and women of reproductive age. Despite progress since 1999, 34% of children under the age of five malnourished[32] (Figure 4). Almost half (45%) of Tanzanian women are anaemic, and this rate is little changed over the past decade[33].

Overall, malnutrition contributes to a cycle of underdevelopment through long-term effects on health, learning ability and productivity[34]. The poorest segments of the population suffer disproportionately because they are not able to grow, purchase and consume sufficient quantities of fresh meat, fruits and vegetables[35,36].

Figure 4 Trends in Children's Nutritional Status in Tanzania; Percent of children under 5 years

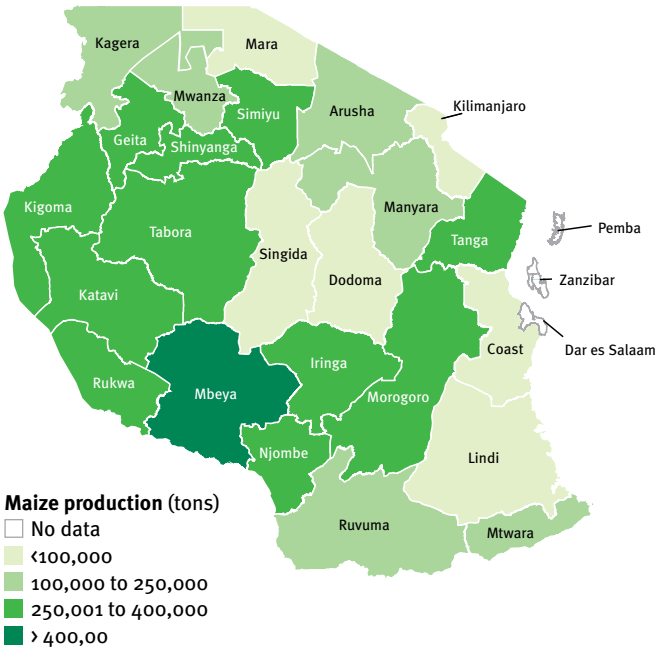


Source: DHS. (2016).

[25] World Vision Tanzania. (2015)
[26] Robinson, E., et al. (2014)
[27] HKI. (2014)
[28] WVI, DSM (2013)
[29] GAIN. (2016)
[30] DHS. (2011)
[31] DHS. (2011)
[32] DHS (2016)
[33] DHS (2016)
[34] Towo, E.(2013)
[35] The amount of absorbable iron in the diets of the poorest segments of society is low and the diet itself inhibits iron absorption because of high levels of phytic acid in whole grain cereals and polyphenols in tea and coffee, which inhibit absorption, and low intakes of meat and citrus fruits, which enhance absorption. See Philar, R. and Johnson, Q. (2005)
[36] For more information on the potential impact of micronutrients see: Sight and Life. (2011)

Maize supply to millers

Figure 5: Maize producing areas of Tanzania



Source: USDA, Economic Research Service

Almost half of Tanzania's national maize production comes from only a few regions, chiefly Iringa, Mbeya, Ruvuma, and Rukwa in the southern highlands. In the Millers Pride project areas of Manzese and Tandale, millers reported sourcing maize from a variety of areas including Dodoma, Morogoro, Iringa and Tanga (Table 1).

Table 1: Sources of maize milled in Tandale and Manzese 2014/2015

Source of maize milled in Tandale and Manzese	% of mills that source maize from each area	Distance from Dar es Salaam (kms)
Iringa	16	500
Dodoma	34	450
Tanga	14	350
Morogoro	22	190
Kahama, Singida, Songea, Rukwa	14	580-1000

Source: Makhumula, P. (2016)

A survey of hammer millers in the project area found that most millers buy maize stock from traders and agents, and then mill and sell the maize flour almost immediately. Almost 50% of sampled millers reported storing no maize stock whatsoever, with a further 33% storing maize for only a day before milling. Most of the remaining millers surveyed during the project reported only having the capacity to store maize for a maximum of 7 days[37].

[37] Makhumula, P. (2015)

Feeding maize flour into the maize hopper via the SANKU dosifier

The business environment for millers in Tanzania

The business environment in Tanzania has been well described in Robinson *et al.* (2014) who clearly highlight some of the key difficulties faced by small enterprises[38], including:

- High costs, delays and complex procedures required for registration and licensing a new business;
- Complex requirements for licensing products, including demonstrating compliance with relevant standards;
- Lack of field officer of relevant agencies, requiring businesses in rural areas to travel long distances to register;
- Fragmented tax structure creates confusion; the requirement for upfront tax payments when starting a business can be unaffordable for small enterprises;
- Low levels of formal education and low access to information among business owners; and,
- Low membership in business associations and lack of representation for small enterprises in policy processes.

As in many lower- and middle-income countries, the maize milling industry in Tanzania is comprised of two distinct types of mills; roller mills and hammer mills. Roller mills are used only by large-scale millers[39] and it has been estimated that there are only around a dozen or so large-scale roller mills in Tanzania, with around 5% of total market share.

The large majority of maize flour is produced in the informal sector by small and medium-scale hammer mills, which are typically powered by a diesel or electric motor[40]. Hammer mills typically have one dehuller installed and employ an average of five people. Maize milling typically involves a process of soaking the maize, dehulling, sifting the dehulled maize, and finally milling the maize to produce maize flour[41].

Estimates of the number of small and medium hammer millers in Tanzania vary greatly. Most literature and reports estimate that there are between 1,000 and 2,000 small and medium-scale hammer mills in Tanzania, although there is no definitive survey establishing this. According to some reports, milling capacity in Tanzania is increasing, perhaps having doubled in the last 10 years, especially in urban areas[42]. In the project areas of Manzese and Tandale, it has been estimated that hammer mills produce roughly 84% of the 600,000 MT of maize flour milled in Dar es Salaam annually[43].

Small and medium-scale millers are generally characterized by their limited technology and skills, and are highly uncoordinated. Millers face a number of challenges including: endemic interruptions of electricity supply; seasonal maize production with associated price fluctuations; inadequate capital to procure sufficient quantities of maize throughout the year; customer attitudes towards quality and price; relatively expensive packaging materials; low maize quality; and, poor water supply for washing maize[44].

Maize millers in Tandale and Manzese

Millers in Manzese and Tandale are located in areas with poor sanitation and road infrastructure, which is highly problematic for acquiring premise certification from the Tanzania Food and Drug Authority (TFDA) (see p.19). Ideally, Manzese and Tandale millers should to be located in an industrial area, fit for purpose. The local government has recognized this, and there are ongoing discussions about relocating the millers to Kiluvya on the outskirts of Dar es Salaam. This appears to be now moving ahead, with some millers having acquired loans from Akiba Commercial Bank to pay for the land. UWAWASE millers association (see below) has played a pivotal role in discussions between millers, local government and loan providers.

UWAWASE miller's association

Clusters or associations have been recognized as one way to overcome small and medium enterprise (SME) fragmentation. A coordinating organization has the potential to reduce transaction costs, support access to infrastructure and utilities (such as storage, electricity and water), disseminate information on product standards and manufacturing procedures, coordinate technical trainings and improve access to finance. Furthermore, associations have the potential to reduce the costs incurred by authorities who need to interact with, monitor, and regulate millers. Nevertheless, good evidence on the effectiveness, the incentives, the viability, and efficiency of clustering is still largely absent[45].

Prior to the Millers Pride project, millers in Tandale and Manzese were not well organized. They lacked an established platform where they could meet, develop a shared agenda, advocate for members and lobby local government[46]. The Millers Pride project has been successful in supporting millers to be better organized through the UWAWASE millers' association.

[38] Robinson, E., et al. (2014)
[39] Fiedler et al. (2014)
[40] Tom. C. (2013a)
[41] Makhumula, P. (2015)
[42] HKI. (2014)
[43] HKI. (2014)
[44] Tom. C. (2013a)
[45] Robinson, E., et al. (2014)
[46] Tom. C. (2013a)

UWAWASE was supported by the project through a range of capacity building activities. The project successfully trained over 200 millers on good manufacturing practices, food safety and hygiene, nutrition, and maize flour fortification procedures. The project delivered the training support alongside the TFDA, Tanzania Food and Nutrition Centre (TFNC) and Ministry of Agriculture, Food and Cooperatives[47]. Contact with these institutions was also found to be important for building relationships, and airing perspectives on challenges within the milling business.

Following support from the Millers Pride project, UWAWASE now has 228 millers, representing over 90% of all maize millers in the project area.

Miller profiles and definitions

The terms 'small' and 'medium' are frequently used to describe miller profiles, however, definitions differ considerably (see Table 2). Definitions matter because they can lead to incorrect targeting of millers in a project, or incorrect estimations of a miller's capacity.

Some authors associate small millers with toll millers in rural villages, who mill customer's maize on demand[48]. Others distinguish small millers by the processing capacity of their milling machines, whilst others distinguish small millers by the average volumes that they are estimated to actually mill.

The Millers Pride project surveyed 63 millers with the aim of obtaining estimates of daily maize flour production based on capacity of mills and production patterns. However, the researchers found that determining *mill capacity* and *actual production* is a challenge because millers may provide incorrect information. The survey found that millers in the project area mill approximately 6 MT/day on average. Some authors have calculated the theoretical capacity of these hammer mills by multiplying by a 24 hour period[49]. However, in practice, this is not realistic. Millers depend on a steady maize supply and electricity supply, neither of which are consistent. It is also not uncommon for millers to scale back milling outside of the peak seasons as the price of maize increases.

Table 3: Estimated daily capacity of hammer mills in Manzese and Tandale (kgs)

Hours operating	100 type hammer mill [50]	75 type hammer mill
per hour	400	250
8	3,200	2,000
12	4,800	3,000
16	6,400	4,000
20	8,000	5,000
24	9,600	6,000

Source: Calculations based on figures from Makhumula (2015)

A further project survey was conducted with 224 millers in the project areas of Manzese and Tandale. Key findings were:

- 71 own a hammer mill, 149 rent a mill from a mill owner. The number who own their premises is unknown.
- Only 4 millers own more than one mill (and could be regarded as medium-scale).
- Only 12 millers have a premise certificate from TFDA, 211 do not.
- Only 6 millers have a product certification, 222 do not.

Source: Project database of millers

The authors suggest that the designation of 'small' and 'medium' scale millers based on milling volumes is not particularly helpful for understanding the capacity of maize millers to fortify. In the authors' view, virtually all millers in the project areas should be considered small-scale. Only those owning and operating more than one hammer mill could be considered 'medium' scale (4 of

Table 2: Varying definitions of small, medium and large-scale maize millers in Tanzania

Small	Medium	Large	Source
‹10 MT/day	10-20 MT/day	›20 MT/day	*HKI. (2014).*
‹20 MT/day Single hammer mill or single roller mill; Fortification using scoop and bucket method; Toll or service milling; No packaging or labelling	20-50MT/day; Roller mill and or hammer mill(s); Fortification with a conventional feeder/ conveyor system or Sanku dosing system; Packaging & labelling done	20-50MT/day; Roller milling; Fortification (conventional feeder conveyor system); Packaging & labelling done	*FFI. (2016).*
1.1 MT/day average; Capacity 2,871 kg per day (range: 230-8,600 kg/day) Mainly provide service milling and located in the villages	5-60 MT of flour per day. They have the potential to increase this production if the identified challenges are addressed	›100 MT/day	*Tom. C. (2013a).*

[47] World Vision Tanzania. (2015)
[48] Tom, C. (2013b)
[49] Makhumula, P. (2015)

[50] The mills used in the project areas are usually in the categories of 100 and 75. The 100 type would mill up to 400kg of maize per hour. The 75 types would mill 200-250kg of maize per hour. See Makhumula, P. (2015)

Warehouse checks on fortified maize flour

224 millers). It is arguably more helpful to consider the differences and similarities within the 'small-scale' categorization. These include:

- Whether or not the miller owns the milling machine and dehuller;
- Whether or not the miller owns the premises;
- Whether or not the miller has premises certification and product certification from TFDA, (or are likely to be able to attain certification).

An important finding of the Millers Pride research was that roughly two-thirds of all millers in Manzese and Tandale do not own their mills (149 of 220 millers). Such millers lease the use of the mills from other mill owners who do not have the capacity and maize supply to mill continuously. Furthermore, of the 71 mill owners in the sample, a considerable (though unknown) number do not own the premises on which the milling business operates.

Considering the feasibility challenges of fortification, the authors suggest that future projects should target most resources on small-scale mill owners, and preferably those with premises that can be modified to adhere to government regulations.

Millers' attitudes

The Millers Pride project evaluation found that millers acknowledge the public health case to fortify maize to fight malnutrition. In general they have a positive attitude towards fortification, provided they do not incur a business cost[51]. Whilst competition certainly exists between millers, the UWAWASE millers' association is evidence that millers see the importance of coming together on key issues.

[51] Discussed during miller interviews, interview with association chairman, interviews with the project team

Feasibility of fortifying maize flour

Unfortunately, achieving fortification with small and medium millers is much more difficult than with large enterprises. Typically, small millers are characterized by low output levels, and tend to lack capacity, technical expertise and financial resources. Furthermore, because they are numerous, widely scattered and not registered with government authorities, they are much more difficult for supporting actors to reach out to[52]. This has a major influence on the feasibility, scope and costs of any maize flour fortification programme.

The feasibility of fortifying maize flour in a country depends on a variety of characteristics of the maize flour market, as described by Fiedler *et al*. (2014). These include:

1. Consumer demand and consumption considerations – the proportion of the population that consumes maize flour (coverage), the average quantity of maize flour consumed daily, and the source of the maize flour being consumed; and,
2. Production (or the supply side) characteristics of the market, such as the number, types, and mix of mills producing maize flour, and the incremental cost of fortifying; together with
3. Factors that reflect the interaction of demand and supply, such as the anticipated impact of the increased costs due to fortification on the price of maize flour and on maize flour purchasing behaviours[53].

All of these factors were found to be relevant to the Millers Pride project.

The incremental costs of maize flour fortification is likely to be higher for smaller millers than large-scale millers. Hammer mills require more human input, which raises concerns about quality control and adequate standard operating procedures. Additional costs and labour requirements are important reasons why small hammer mill operators are likely to be adversely affected by the introduction of fortification, and why they may resist it[54].

However, the Millers Pride project also recognized that the large number of hammer mills also presents an opportunity to try to identify a 'proof of concept' for maize flour fortification with hammer millers. The project targeted small millers in Manzese and Tandale precisely because, combined, they comprise such a large segment of the market, serving thousands of consumers daily.

Options for the addition of premix in hammer mills

Over the past decade or so, considerable effort has been spent on validating an effective method to add premix to maize flour. For large-scale roller mills, industrial solutions are available. However, for the Millers Pride project, there were three main options. Each option faces various challenges and trade-offs, including: manual operations, dosing accuracy, limited distribution channels, miller burden, cost, scalability, and monitoring[55].

Scoop method

The scoop (or sachet) method is the simplest technique for adding premixed fortificant. For this method, a simple scoop of premix may be manually added by the miller or consumer to the maize flour. Scoops come in several sizes to adjust the dosage of premix to the size of maize flour bag. This method is the least costly because it does not require additional equipment. However, the method is also the least precise. Furthermore, experiences from previous projects suggest that end-consumers will not routinely purchase and add the premix. There are also major challenges with regards to monitoring, scalability and cost bearing. The scoop method may be the best option at the village level, where toll milling is frequently practised. However, this was rightly deemed to be an unsuitable and unsustainable option for the Millers Pride project.

Microfeeders

The Millers Pride project trialled two microfeeders sourced from China, costing between US$ 300 and US$ 500. A fortification consultant and local engineers installed and tested the Chinese microfeeders in mid-2015[56]. These relatively simple machines need to be fitted to the hammer mills and configured to add premix in a predetermined dosage. The process requires adequate training for mill operators to determine flow rates and calibrate the machines regularly, and to manage the stop-start operations of the microfeeder.[57] The results of the project trials found that microfeeders can produce acceptable results, but this is yet to be confirmed under normal business conditions.[58]

Whilst a relatively affordable option, the authors are concerned by the fact that the Chinese-made microfeeders require considerable manual attention to function as per the supervised trials. Small hammer mills may experience a high turnover of seasonal staff, necessitating regular training on how to determine flow rates and calibrate the machines, as well as regularly stopping and starting the microfeeders when milling. Small hammer mills tend to operate with fairly informal processes. Therefore, it is difficult to express confidence that microfeeders are a reliable solution for adding premix at the correct quantities given the amount of manual operations required, coupled with a lack of monitoring and oversight. Further piloting may offer more conclusive answers to their suitability for daily milling.

[52] Robinson, E., et al. (2014)
[53] Fiedler et al. (2014)
[54] Fiedler et al. (2014)
[55] SANKU. (n.d.).
[56] Makhumula, P. (2015)
[57] World Vision Tanzania. (2015
[58] Makhumula, P. (2015)

Sanku dosifiers

Sanku dosifiers are a product of Project Healthy Children, a US-based organization focused on the design and implementation of national food fortification programmes[59]. The dosifiers have been specifically designed to be installed on small hammer mills and automatically dispense the correct amount (dose) of premix according to milling speeds, thereby eliminating the potential for human error. The machines also feature a built-in digital monitoring system, whereby data on all aspects of the machines performance can be downloaded via USB. In the authors' view, the Sanku dosifiers are clearly a superior machine compared to the Chinese microfeeders. The machines are produced to a high quality and may be expected to have a longer life and suffer fewer breakdowns. Sanku has an established presence in Tanzania, with at least 50 of the machines in operation in other projects at the time of writing. The tradeoff, however, is the price per unit, which varies depending on the number of units bought, and ranges between US$2,000 and US$2,500[60]. As the cost of a dosifier is too high for most millers, Sanku instead offers millers a contract agreement. Millers agree to purchase flour bags only from Sanku, and in return they receive a dosifier and premix, as well as ongoing service and support. Sanku believes that this model creates an incentive for millers to fortify, which encourages compliance. Sanku will become profitable by 2022 through the revenue from flour bag sales.

Micronutrient premix

Micronutrients include vitamins, minerals, and trace elements. These micronutrients are required in the right quantities and are an essential component of the diet to ensure optimal health.[61,62]

Adding micronutrients separately can be a complex process. A more practical approach is to add premixed micronutrients to maize flour, which include the micronutrient's excipients (carriers, fillers, to match the density of the premix to the flour), and a free-flow agent (which keeps the premix from clumping and bridging in the mill hopper). The advantage of premix is that it is easy to test, utilizes a single feeder, can distribute nutrients uniformly, and is less expensive than buying individual micronutrients[63].

Fortifying millers require a reliable premix supply chain. Unfortunately, with a current lack of demand from millers, there are few signs that a reliable supply chain will be established in the next few years. To be sustainable, projects need to stimulate a supply chain with actors willing to import and distribute the premix product.

Table 4: Recommended levels of micronutrient fortificants in maize flour, First Schedule under section 4, 2011, United Republic of Tanzania

Micronutrient	Micronutrient compound	Addition levels (mg/kg)	
		Max	Min
Iron	Sodium Iron EDTA	5	25
Zinc	Zinc oxide	20	25
Vitamin B12	Vitamin B12	0.0002	0.01
Folate	Folic acid	0.5	2.5

Source: The Tanzania Food, Drugs and Cosmetics (Food Fortification) regulations (2011)

[59] GAIN has officially approved and recommended the use of the Sanku dosifiers for small and medium scale applications.
[60] http://sanku.com/info-for-mills/
[61] Micronutrients_Macro_Impact.pdf
[62] For detailed discussion of vitamins and minerals, see WHO. (2016)
[63] Food Fortification Initiative. (2016)

The costs of fortification

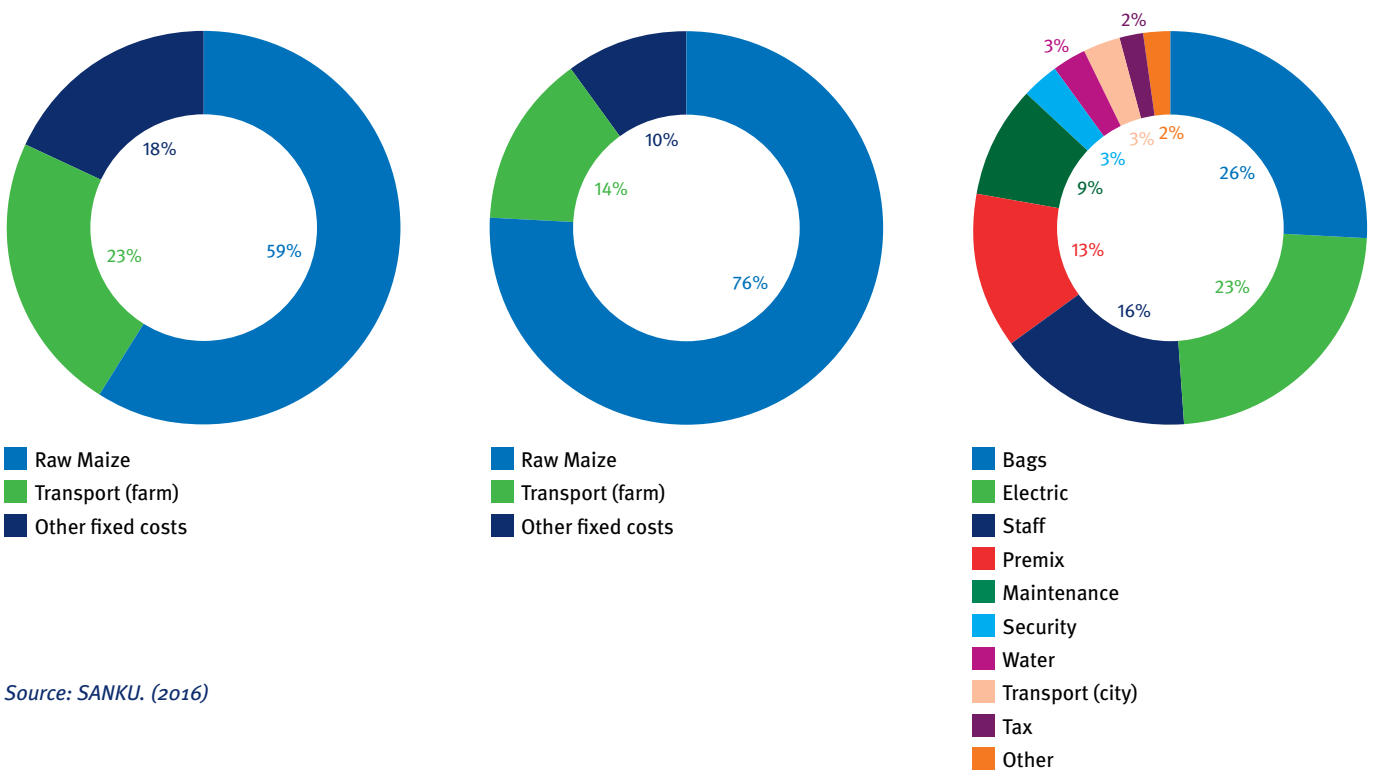
There are several costs that are likely to be incurred when moving to fortify maize flour. Projects need to consider who will be expected to bear these costs, and whether there is a business case to doing so. The following costs were identified during the Millers Pride project:

- Cost of a Sanku dosifier (US$ $2,000-2,500) or Chinese microfeeder (US$ $300-500).
- Costs of changes to premises (variable costs). Very few millers in the project area had existing premises and product certification. Virtually all millers would be required to invest in the physical infrastructure of the milling area to meet health and safety standards.
- Costs of application for premise certification US$75 and product certification US$320
- Cost of training staff (cost unknown). Mill owners and employees need to be trained to use the fortification equipment and monitored to ensure perfect use.
- Cost of premix (TSH 20/kg). The premix cost represents only 1.4%-2.3% of the overall production cost, depending on the time of the year[64]. Whilst a small proportion of the total production cost, this would need to be paid for out of miller's existing profit margins, unless millers can pass on costs to consumers, or find other methods of cost saving and cost sharing.

Finance

The Millers Pride project discussed financing options with millers, however this activity was not rolled out. This is partly due to the fact that millers were either not ready to fortify maize flour (because they lacked knowledge or certification) or were not interested in raising finance to purchase microfeeders or dosifiers. Opinions differ as to the business case for maize fortification in the long run. However, the authors found a general consensus amongst millers that there is a lack of a business case for them to raise finance and invest in maize flour fortification in the short- to medium-term. Consumers in the lower socio-economic brackets who would benefit most from maize flour fortification are also the most sensitive to higher prices, and least likely to pay more for fortified maize flour. Coupled with low consumer awareness and a lack of fortified maize flour currently on the market, millers correctly recognize that there is little prospect for them to generate a return on investments made on fortification.

Figure 6 Maize flour milling costs



Source: SANKU. (2016)

[64] SANKU. (2016)

Regulations and standards

At present, Tanzania's agri-food sector remains lightly regulated. Unregulated and non-standardized products remain common, even in relatively easier-to-regulate urban centres. This naturally presents challenges for safe, fortified maize flour[65].

A central food safety policy is currently still missing in Tanzania[66]. The central authority lies formally with the Tanzania Food and Drugs Authority (TFDA). However, responsibilities are shared with a number of other ministries, departments and local government councils. A good example is food inspections, which are the joint responsibility of the TFDA, the Tanzania Bureau of Standards (TBS), the local government, and even sectoral ministries. Without a central authority, coordination, enforcement and efforts to increase awareness becomes a considerable challenge[67].

Premises registration

Registration of premises is a pre-requisite requirement prior to commencing milling and fortification. This requirement is stipulated under section 18 of the Tanzania Food, Drugs and Cosmetics Act (TFDC) 2003. This legislation prohibits the use of any premises for the manufacture, sale, sell, supply or storage of food unless the premises have been registered by the TFDA for that purpose. Section 20 of the TFDC Act requires all dealers in such business to apply to TFDA for licenses and obtain such a license before starting operation.

Product registration

In Tanzania, drugs, pre-packaged food, cosmetics, herbal drugs, medical devices and food supplements are evaluated and registered by TFDA before being approved for distribution and marketing in the country. Certification is a requirement to ensure that only safe, quality and efficacious products are used in the country. Approval for product registration is expected to take between 45 and 60 days from the date the application was received at TFDA[68].

Standards have also been developed for maize flour fortification (ICS: 67 060.00). However, for small and medium-scale millers, TBS and TFDA certification requirements are difficult to meet, and millers require a lot of support to do so[69].

The Millers Pride project found that very few millers in the Manzese and Tandale project areas have TFDA certification, for either their premises or maize flour product. This is an important finding, as maize flour ought to be of safe and acceptable quality prior to fortification[70].

[65] Robinson, E., et al. (2014)
[66] Ndabikunze et al. (n.d.)
[67] Ndabikunze et al. (n.d.)
[68] World Vision Tanzania. (2015)
[69] HKI. (2014)
[70] Makhumula, P. (2015)

Project approach to certification

The Millers Pride project sensitized all millers in UWAWASE millers association on the importance of fortification and offered members a series of trainings on good manufacturing processes. This sensitization and capacity building was expected to lead to improvements in business practices and to premise and product certification.

In practice, most millers were unable (or unwilling) to make the necessary changes required for certification. In some cases, millers were not able to make modifications to the premises because they only leased the facilities. In other cases, millers were concerned about the costs involved for premise modifications, equipment investments or premix purchases without a clear business case to recoup those costs.

The Millers Pride team only worked directly on fortification issues with millers who were able to acquire premise and product certification from TFDA[71]. This was a reasonable project approach, and in line with government regulations. However, the approach faces an inconvenient reality – if projects only work with certified millers, very little fortified maize will be produced because there are so few millers capable of fulfilling certification requirements.

For future projects, there is a precedent for a possible workaround. The Tuboreshe Chakula project[72] recognized these constraints and obtained permission from TFDA, TFNC and Ministry of Health to start fortification activities concurrent with certification and registration processes[73]. This is not a recommendation to begin fortification prior to certification, but it may be a practical option to discuss with the authorities and maybe accelerate maize flour fortification activities.

Other perspectives on regulation

Since 2011, fortification by large-scale processors of wheat, oils and maize has been mandatory in Tanzania. However, small and medium-scale maize millers remain exempt. During the Millers Pride project evaluation, some actors suggested that mandatory fortification for small and medium-scale millers could be the answer.

However, the Millers Pride project evaluation found that more regulations are unlikely to have an impact. Existing regulatory requirements, (including those for maize flour product and milling premises), are presently not followed by most small and medium millers. It is therefore unlikely that additional regulations will fare any better. Furthermore, government agencies lack the capacity to effectively monitor and enforce existing regulations. New laws should not be expected to have an impact on small-scale maize flour fortification unless the underlying challenges are addressed.

[71] World Vision Tanzania. (2015)
[72] USAID. (2015)
[73] Ohresser-Joumard, C. (2015)

Consumer attitudes

Fortified maize flour has limited market penetration in Tanzania. By some estimates only 0.02% of all maize flour on the market is fortified[74].

In 2013, Helen Keller International surveyed 1,000 Tanzanian women on nutrition, food fortification, and micronutrient awareness. Results on awareness on food fortification showed more than two-thirds of respondents (69%) had never heard about food fortification, and 65% did not understand the terminology 'virutubishi' (nutrients) on the food fortification logo (Figure 6)[75].

The Millers Pride project tried to work with the NFFA in Tanzania to raise consumer awareness of fortification and the health risks of micronutrient deficiencies. The project experienced a 'Catch 22' situation with regards to consumer awareness – raising awareness of, and demand for, fortified maize requires reasonable availability on the market. On the other hand, millers themselves are wary of investing in and producing volumes of fortified maize product without certainty of consumer demand.

Therefore, awareness campaigns need to go hand-in-hand with production activities. Millers may seek assurances that they will be able to market their fortified maize product in the trial period.

Because poorer consumers are believed to be particularly price sensitive, it has been suggested that fortified maize flour should not cost more than non-fortified maize flour. However, as discussed below, if poorer consumers are not willing or able to bear the costs, then this falls to other actors.

Figure 7 Food fortification logo, Tanzania

Milling with the SANKU dosifier installed on the hopper of the hammer mill

[74] HKI. (2014)
[75] Towo, E

Addressing maize fortification through a value chain lens

The Millers Pride project learned that maize flour fortification needs to take a value chain approach. Within the value chain there are many different actors, each with particular interests and concerns.

A project must consider the position of each actor in the chain, and what their particular interests may be. What incentives will encourage an actor to make certain investments or changes to its processes and business activities? What barriers or constraints hold each value chain actor back, and what are the enabling factors that can help drive them forward in a positive way?

Projects should take a *business orientated approach* because otherwise, in the long run, projects will not be able to achieve change at scale. The government must play a facilitating or enabling role alongside the private sector, in the form of public-private partnerships. The success of such an approach rests with the different commercial incentives throughout the value chain.

Unfortunately, the business case for small millers to invest in maize flour fortification is not strong at present. This is not a failure of the project, but rather a reality that all project implementers and governments need to face up to. In order to drive change at scale, someone needs to bear the costs of fortification, be it government, millers, NGOs, donors or consumers. The question of who remains unanswered.

From the point of view of millers, milling is a commercial activity. If private sector millers are to be involved in addressing micronutrient deficiencies through fortification, it is almost a pre-requisite that profit incentives are in place for them to participate. At the very least, small millers would expect that their profit margins are not affected.

Conclusion

The Millers Pride project experienced many challenges in its efforts to advance small-scale maize fortification. The project team learned just how complex the maize flour value chain is, and how each actor has different interests and needs. Like other projects, Millers Pride has not been able to identify a definitive 'proof of concept' for how small-scale maize milling can work sustainably, but it has contributed to the body of knowledge that future projects should draw on. The following is a summary of key findings relevant to future projects:

- Maize flour fortification projects require time and considerable resources. Significantly greater investments are required to achieve measurable changes in the chain.

- Projects must have a good understanding of the maize flour value chain. It is important that a project takes a 'business perspective' and understands the (commercial) interests of each actor. Without incentives, actors are likely to continue business as usual.

- Partnerships are important. Millers Pride contributed to the strengthening of the UWAWASE millers association, and worked closely with the NFFA to advocate and lobby for maize fortification.

- The government of Tanzania is a supporter of maize flour fortification, but government agencies such as TFDA and TBS have limited capacity and resources to really drive the maize fortification agenda forward. They will need support.

- Projects and researchers often talk about 'small and medium-scale' millers. Among the conglomeration of millers in the project area, very few could be considered medium-scale. Almost all hammer mill owners are small-scale millers.

- A more interesting distinction is whether or not millers own their milling equipment and premises, or lease them. Mill owners may be of a slightly higher capacity, and premises owners may be better able to make changes to their facilities. Projects should focus on this profile of miller first.

- Most millers do not have product or premises certification. This is due to a combination of factors such as complex bureaucracy, lack of miller knowledge on certification processes, the cost of certification, the inability of millers to make changes to rented premises, and the fact that regulations are rarely enforced by agencies.

- Officially, product and premises certification is a requirement prior to fortification, however this can be very challenging for millers and can take a long time to make required changes and complete the process. Future projects should discuss with government agencies how this might be done concurrently with maize fortification trials and miller training in order to expedite small-scale maize fortification experiences.

- The fact that nearly all small millers in the project area frequently do not adhere to existing regulations suggests that a new regulation mandating maize flour fortification by small and medium millers will not be effective on its own.

- Projects should be aware that there is not, as yet, a strong business case for small hammer mill owners to make investments in equipment and facilities to fortify maize flour. Millers are business owners and have commercial interests, and are unlikely to make investments they cannot recoup. While millers have shown they are sympathetic to health and nutrition issues, they require support and incentives to change their practices.

- Small-scale maize flour fortification involves a range of upfront and ongoing costs including premise modifications, certification, staffing, machinery, and premix. Projects need to acknowledge these and be clear about who is expected to bear the costs – donors and NGOs, millers, government, consumers, etc. Millers are highly unlikely to purchase dosifiers themselves given the lack of return on investment.

- The Millers Pride project was not able to establish a commercially viable premix supply chain. This is vital for millers to be able to fortify maize flour beyond the life of any project.

- Millers Pride, together with the NFFA, have worked to promote the health benefits of fortified maize flour to consumers. These efforts need to be ongoing, particularly with regards to brand/logo recognition of fortified products. However, efforts to promote fortified maize flour is hampered by very poor availability of product in the market. It is difficult for a project to promote something that is not available. Empirical data on consumer behaviour, price responsiveness, and the most effective marketing channels, is still lacking.

- Data is important for evidence-based decision-making. There remains a lack of high quality data sampled from a large number of millers, focusing on a range of production and marketing issues. There is space for a project to invest in such a database, ideally making it publically available to other actors in the sector.

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