SANKU FORTIFICATION

Addressing the Challenges of Small-Scale Fortification

An innovative new technology

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The Problem

Vitamin and mineral deficiencies account for over 50 million disability adjusted life years (DALYs) lost globally[1]. Despite the increasing adoption of large-scale fortification programs as a means of addressing micronutrient malnutrition throughout the developing world, the majority of individuals living in rural and remote areas do not have access to centrally processed foods, and thus are denied the benefits of large scale food fortification programming. In these regions, a large percentage of consumers, 50% and reaching up to as high as 90% in some countries, depend on small to medium-scale milling to process staple foods. Addressing this gap becomes particularly critical considering the fact that these populations are the most vulnerable and, arguably, in the greatest need of strategies to combat this condition.

Considerable effort has been spent over the past ten plus years attempting to validate an effective method of adding appropriate amounts of vitamins and minerals at the rural, hammer mill level including various engineered devices, hand-scoop methods, and batch mixing techniques. These attempts have faced numerous and similar challenges including but not limited to: manual operations, dosing accuracy, limited distribution channels, miller burden, cost, scalability, and monitoring.

A 2008 summary report commissioned by the Micronutrient Initiative (MI)[2] on the Workability of Fortification via Service Hammer Mills provides a closer look at some of these barriers. Nine key findings / observations common to all three countries under review (Zambia, Zimbabwe, and Malawi) were outlined:

1. Existing commercial distribution channels for food and consumer products should be used to accomplish nationwide distribution of the premix blend required for fortification at small hammer mills (SHMs).
2. The method and technology of the addition process is not yet mature. Despite now nearly four years of experimentation, a viable addition process has yet to emerge from the pilot projects reviewed.
3. A minimum blending uniformity standard should be set for fortification via SHMs...It is not possible for SHMs to achieve a tight uniformity standard (i.e. within 10% of a target RDA dose).
4. SHMs and large-scale commercial mills need to be treated differently from a policy and regulatory perspective. The former should be required to meet an 'addition method' standard as the key test of performance as opposed to a specific sample testing standard more appropriate for large-scale commercial mills.
5. The efficacy (in terms of gains to human health) of fortification via maize meal needs to be established (this includes optimal form of iron, premix composition, and target RDA dose level).

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[1] WHO Global Burden of Disease report
http://www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html

[2] http://www.micronutrient.org/CMFiles/PubLib/SSF-Summary-Report_Revised-for-WFP-workshop_1NKD-3242008-9925.pdf

6. The prospects for achieving high levels of cost recovery and eventual commercial viability within a 6 to 8 year period appear promising.
7. SHMs are currently unregulated and not accountable to any Ministerial authority. There is a need for steps to bring SHMs under the jurisdiction of an appropriate health authority.
8. A new and tailor made institutional framework is likely to be needed in each country to manage implementation of a national fortification program via SHMs.
9. It is unlikely that an immediate 'dosifier' technology device would prove technically or economically workable for the purpose of fortification at SHMs.

With this historical understanding, Sanku has designed a model that specifically addresses these challenges at small and medium scale, village-level mills. The Sanku design is the result of over five years of field-testing in South East Asia and East Africa and rigorous study of key obstacles faced in previous attempts. The Sanku Dosifier has been specifically designed to overcome *dosing accuracy, cost, sustainability, scalability, and monitoring.* Additionally, all nine of the common elements listed above are addressed through Sanku's designed program.

About Sanku

Sanku is a socially driven initiative of Project Healthy Children (PHC), a US-based organization focused on the design and implementation of national food fortification programs. Designed to fill the nutrient gap of those not accessing centrally processed foods, Sanku works closely with village millers, NGOs, and governments to equip at-risk communities with fortification technology and nutrient premix.

Sanku is the 2013 Grand Prize winner of the Ashoka Changemaker's *Nutrients for All* competition. And, in 2014, after three years of rigorous testing, GAIN officially approved and recommended the use of the Sanku Dosifier for small and medium scale applications.

Through the implementation of a scalable, cost effective, and proven business model, Sanku's goal is to provide fortified foods to over 200 million people by the year 2020.

Previous Small-Scale Fortification (SSF) Attempts

A number of different organizations have tried various means of fortifying grain at rural level mills:

Between 2007 and 2011, the Micronutrient Initiative (MI) in Nepal developed a small-scale fortification device that operates on rural water mills in the southern region of the country. The device successfully fortified cereal flours with iron and other micronutrients[3]. Unfortunately, the technology did not prove to be scalable or sustainable – price (roughly USD $2,000 per unit), weight (X lbs), and effective monitoring proved to be significant challenges.

Nepal, 2007

[3] Micronutrient Initiative, Small Scale Fortification in Nepal: *http://www.micronutrient.org/english/View.asp?x=586*

Additionally, this device used a volumetric approach to fortify the grain meaning that a given volume of essential nutrients was added to a given volume of flour. Such a method is generally unable to adjust the volume of nutrients added to account for different grain densities, e.g. maize versus wheat. Finally, this device was only effective on rural-level water mills due to the low volume capacity and height of the device.

A small-scale fortification project led by World Vision in Malawi employed the "hand-scoop" method of adding premix[4]. Instead of using a device for the addition of the vitamins and minerals, millers manually added and mixed the micronutrients during the milling process. Although extremely low-tech, this project faced challenges of human error during the premix addition and mixing steps, lacked uniformity in premix dispensing, and proved unable to monitor the homogeneity of the end product. Finally, production of a pre-blend was required in order to dilute the concentrated premix and improve homogeneity introducing another opportunity for human error.

Zambia, 2002

Tried in a handful of other locations including Zambia (MI), Mali (MI), and Zimbabwe (CARE and MI), the hand-scoop method continued to face challenges. Risk of human error and the challenge of monitoring and sustaining the program once the implementing partner left, meant that these programs were unable to be scaled up past the initial pilot stage.

Finally, batch mixing has been tried in various locations. This involves a barrel of sorts with a handle whereby flour and premix are mixed manually outside of the mill. Although this form of small-scale fortification results in considerable uniformity of the fortified flour, a continual problem faced is the extra steps required to put the milled flour in the blender, add the premix, blend, and then transfer the fortified flour to the individual container[5].

Overcoming Obstacles

In 2013, after years of trial and error and various iterations of mechanical designs, Sanku manufactured a device that is fully automatic and that meets the following criteria:

- ✓ Low-cost yet accurate and robust
- ✓ Lightweight and easily transportable

[4] World Vision, *MICAH*, Small Scale Fortification in Malawi: *http://www.wvi.org/nutrition/publication/small-scale-fortification-micah-malawi*

[5] Wesley A. Micronutrient Initiative. 2003. http://www.micronutrient.org/CMFiles/PubLib/SSF-background-paper-Annie1NRA-3242008-8511.pdf

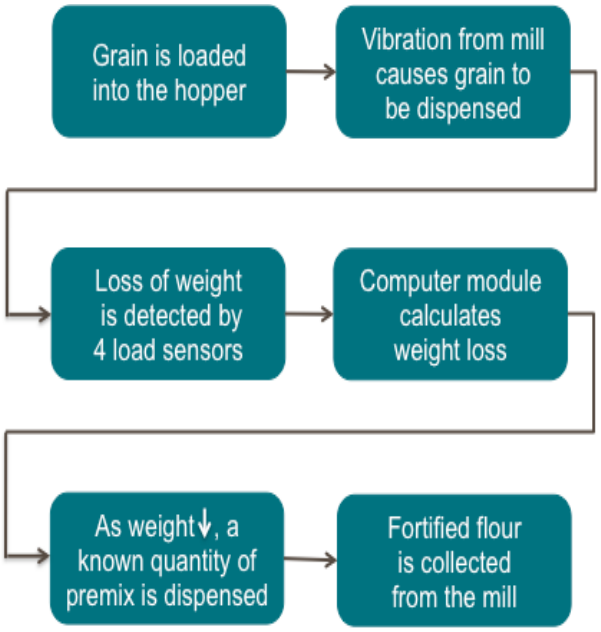
- ✓ Ability to be installed on the vast majority of flour mills with no extra steps for the miller
- ✓ Contains a built in monitoring mechanism
- ✓ Is complimented by a robust business model that projects sustainability by 2017

How this design overcomes the universal small-scale fortification challenges of dosing accuracy, cost, sustainability, scalability, and monitoring is outlined below.

Dosing accuracy

The *Sanku Dosifier* functions similar to an electronic scale. It uses a loss of weight technology to accurately dispense a pre-determined amount of premix (i.e. the national standard or other if required) into the flour as it is milled. The device consists of a fortificant dispenser and weight sensitive grain hopper. The hopper sits on four load cells that detect the loss in weight as grain pours into the mill. A simple yet robust electronic controller takes into consideration the weight of grain flowing into the mill to activate the fortificant dispenser, where a high torque motor drives a feed-screw to release a predetermined quantity of nutrient premix, ensuring accurate dosing every time.

Programmable firmware allows for continuous checking of the weight change, adjusting the premix-dosing rate to always match the milling rate. The dose threshold can be easily adjusted according to the specified addition rate of the premix being used. The thorough mixing of premix and grain within the mill, with the additional step of packing, ensures homogeneity of the end product.



Fortified flour results fall within the +/- 10% coefficient of variation (CoV) range, which is the universally accepted industry standard. This means that the device is accurately and uniformly dispensing premix per the level indicated.

Cost

The Sanku Dosifier fits onto most rural level flour mills found in East and West Africa, the Middle East, and Asia. Built using high-quality food grade materials, all *Sanku Dosifier*'s are tested according to strict quality standards. Current unit price ranges from US$1,000 to US$2,000 based on order quantities. Other dosifiers on the market cost US$5,000 - US$8,000. A financing model has been projected that would allow for the device to be available to millers free of charge assuming Sanku's micronutrient premix formulated for use with the *Sanku Dosifier* is purchased.

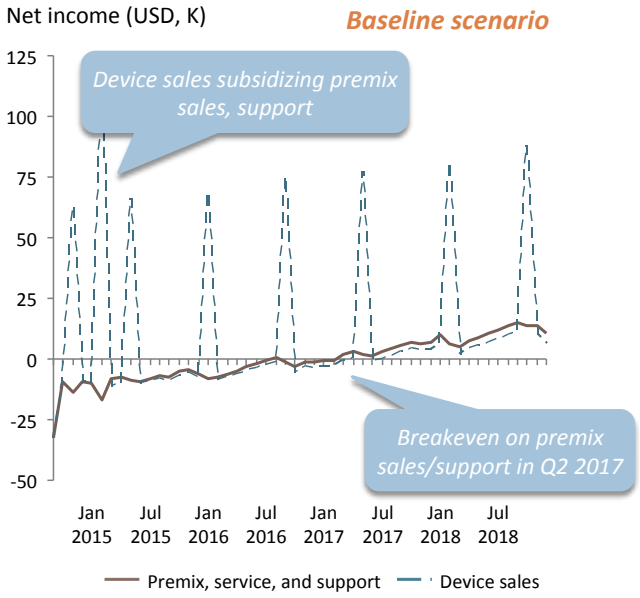
The premix is sourced only from companies that adhere to good manufacturing practices and are certified by the Global Alliance for Improved Nutrition (GAIN). National nutrient standards are used in each market Sanku supplies. Based on current consumption patterns, deficiency rates, and approved bioavailable nutrient forms, Sanku's formulated premix ensures enough nutrients are absorbed to fill the identified nutrient gap.

Sustainability

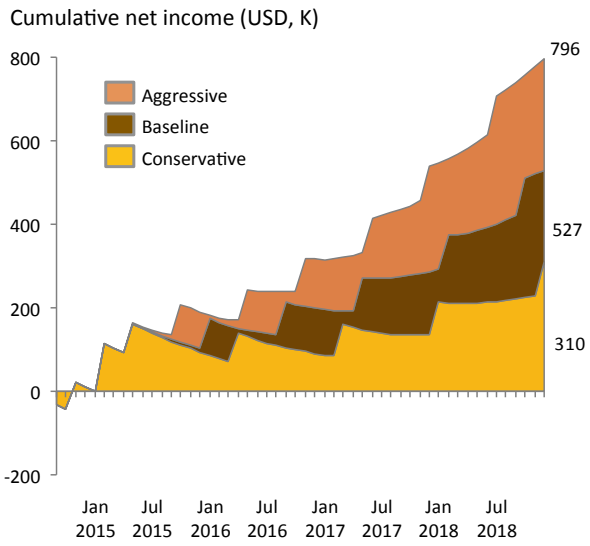
Since Sanku's goal is to reach self-sufficiency, a business model for sustained growth and impact has been developed. This model forecasts that Sanku is on pace to achieve true sustainably by March 2017. Based on projected growth rate, this represents approximately 350 dosifiers installed and 386MT of premix sold.

Effective implementation scenarios have been modeled including in-country device installation, miller training, premix supply chain logistics, equipment maintenance, final product and premix usage monitoring, and financing models for securing equipment and premix.

Monthly net income spiky due to device financing and sales



Cumulative net income shows strong sustainability even in 2015



Scalability

Over the next 12 months, Sanku will work with an identified premix partner to run three different "tests" or models of small-scale implementation with the ultimate goal of determining which proves most effective (market-driven, donor-driven / rural, and donor-

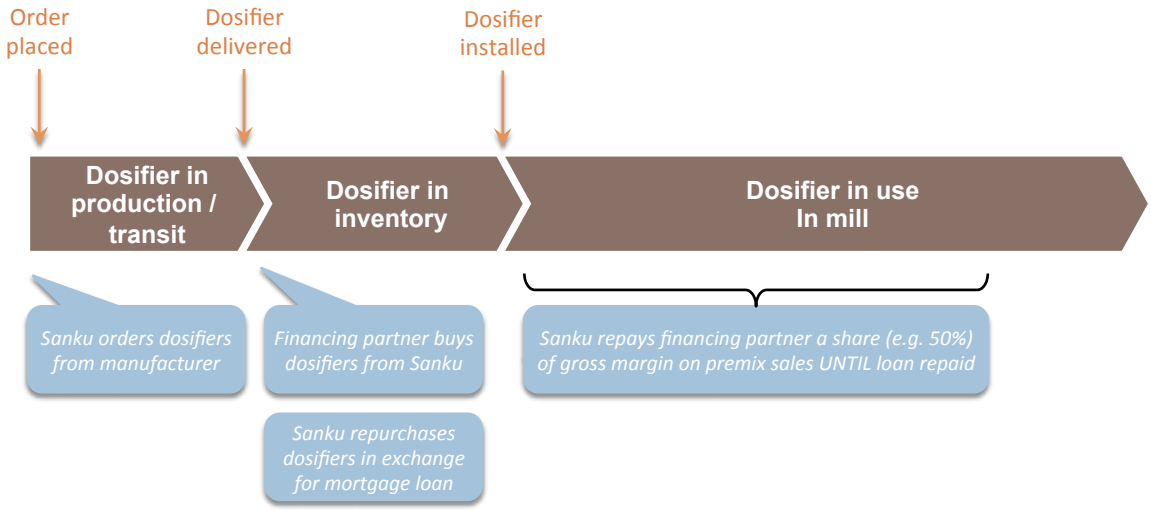
driven / urban). The three-pronged approach will allow for a better understanding of what is needed to scale-up and what, in fact, the market demands and can sustain.

1. Market-driven model
    - Donor purchases devices from Sanku
    - Donor and / or premix manufacturer seeds first batch of premix
    - Subsequent premix orders are financed via working capital, with premix partner providing terms that are 5-10 days beyond what we expect the millers terms to be.
    - Premix manufacturer sells Sanku premix at the cost of $4.00, which Sanku then sells to millers for $6.25 (during the test, we will learn if the market can bear this price, the spread is sufficient to cover Sanku expenses, and whether this price point works for premix supplier)
    - Premix manufacturer provides Sanku credibility assistance to the donor
    - Premix manufacturer takes credit risk if Sanku is not paid by millers

2. Donor-driven model / Rural
    - Premix manufacturer buys devices from Sanku and leases to donor
    - Premix manufacturer gets primary economics on the sale of premix, sold directly to the donor
    - Premix manufacturer takes credit risk if premix orders from the donor cease prior to recouping the cost of the devices (although the devices could then be returned to Sanku/ premix partner)
    - Sanku charges a fee for additional work (i.e. service a device out of warranty, training)
    - Sanku creates opportunity and establishes / secures monitoring / logistical support through the donor's already-established delivery system

3. Donor-driven model / Urban
    - Same as above put location would include urban slums (e.g. Kibera in Nairobi)

By partnering with a finance institution, Sanku is able to provide millers with access to a dosifier at no or very low cost, free training and service as well as convenient access to high quality low-cost premix. A three-year warranty is provided on all parts and equipment. In exchange, the only requirement is that mills use the dosifier with Sanku premix.



Monitoring

An important component of the Sanku Dosifier is the electronic controller that stores and displays critical monitoring data such as hours of operation, total grain milled, and total premix consumed. Real time data capturing of the milling process enables the accuracy of doses to be monitored either locally or remotely if sent via SMS, substantially lowering ongoing monitoring costs.

This data capture mechanism will also prove useful in better understanding rural maize flour consumption patterns. This targeted information can then be used to ensure that the nationally established maize flour standard is also appropriate for the rural population based on their potentially unique consumption quantities and patterns. This should be coupled with consumption data at the rural level for all other nationally fortified vehicles (e.g. wheat flour) since each fortified staple and the added nutrient levels are intended to compliment one another. If the rural population is not consuming all identified fortified staples (i.e. maize and wheat flour), then the maize flour standard should be reviewed accordingly.

The monitoring reports allow the user to retrieve stored mill production data in order to monitor the dosifier's accuracy, both daily and over the course of an entire year (+/- 10%).

Homogeneity - Sanku currently provides a premix with an addition rate of 1:1000 (i.e. if 1MT of de-hulled grain was milled then 1kg of premix will be dispensed). Since the report displays the grain loss in MT and the premix dispensed in kg, these two figures should always match.

Flow Rate - Another system of monitoring is ACTIVE HOURS vs. GRAIN LOSS. For example, if the mill is rated and performs at 1MT per hour, then ACTIVE HOURS and GRAIN LOSS in MT should always match. Alternatively, if the mill

is rated and performs at 500kg per hour, then ACTIVE HOURS should be twice as much as GRAIN LOSS in MT.

Inventory Projections - The stored data for LIFE DAYS, ACTIVE DAYS and ACTIVE HOURS allow the user to calculate mill production patterns, and therefore forecast bulk premix consumption. For example, average mill production hours per day can be calculated by dividing total ACTIVE HOURS by total ACTIVE DAYS.

To calculate total mill production days in an entire year, simply divide 365 by the LIFE DAYS and then multiply by ACTIVE DAYS. For example, if a dosifier's LIFE DAYS are 45, and ACTIVE DAYS are 32, then it can be estimated that the total production days for that year will be 260 (e.g. 365/45 * 32 = 259.5). For more accurate estimates, the regions high and low seasons for grain production must be taken into account.

Policy, Regulation, and Consumer Demand

It is critical, however, that the Sanku program look beyond simply the technological constraints that have faced small-scale fortification and place a strong focus on supply chain, country-specific policy and regulatory environments, and consumer demand. Without considering these elements, the program risks losing true sustainability.

Upon beginning a program, the Sanku team works closely with government officials and existing national fortification alliances to ensure a) policy is in place that mandates the fortification of *all* flour produced in-country (this is ideal, although not a requirement), b) there is a structure whereby the enforcement of any such policy / legislation can be carried out, and c) there is a plan for the creation of consumer demand for fortified products (particularly critical where there is no mandate for small-scale fortified flour production in place).

Currently in Tanzania, Sanku works alongside the country's regulatory body (the Tanzania Food and Drug Administration or TFDA) to monitor (through Sanku's data capture reports and the use of iron spot checks) and enforce the country's flour fortification mandate. Sanku works with a local implementing partner and the national fortification alliance to design a consumer awareness campaign that will penetrate into rural communities accessing small posho mills. This environment serves the dual purpose of enforcing a national mandate and enabling miller compliance, while ensuring consumers understand the importance of purchasing the new product.

Finally, where possible, Sanku works with government officials to ensure small-scale fortification is written into existing nutrition strategies and / or fortification action plans allowing for harmonization with current interventions.

The “How”: Supply Chain

When and where relevant, Sanku ensures the “last implementation mile” of the supply chain is in place:

- Sanku’s partnership with a GAIN certified premix producer ensures quality premix is sourced at the most competitive price, is relevant for the unique country context, and is available on a timely basis.
- Sanku’s partnership with a third-party local distributor at the Port ensures premix is cleared, handled, stored, and dispatched as needed free of import duty or VAT and transported to Sanku’s operating regions.
- Regional warehouses are used in each operating region to adequately store premix before being dispatched to millers.
- Sanku’s Miller Support Team (MS Team) consists of trained staff assigned to each region. This team is responsible for the distribution and sales of premix from regional warehouse to miller, servicing the dosifiers if needed, and identifying new mills in order to grow the Sanku program. The MS Team along with an in-country lead and remote headquarter support make up the total human resource requirements for the program.





Import from manufacturer	Port clearance	Inter-region distribution	Warehousing	Regional distribution
▫ Imported by 20ft container from manf. partner	▫ Cleared by Sanku third party clearing agent ▫ No import duty or VAT due to fortification / agro exemption	▫ Each container split into pallets and distributed to Sanku’s operating regions (three initially)	▫ 20kg boxes of pre-mix warehoused in each region in third-party managed warehouse	▫ Sanku miller support staff to distribute premix during monthly service trips ▫ Collect money through M-Pesa or similar

Costing Estimates

The cost of such a program will depend on many factors including which implementation model is chosen, how many devices are required, where they will be shipped, and the level of “last mile” support that is needed. However, to give the reader a general idea, a program consisting of a 50-unit order, shipment to East Africa, and installation and training could range from US$80,000 to $130,000. Such a program would have the estimated daily reach of over 350,000 people.

Current Program in Tanzania

Tanzanian's major staple food is maize flour, produced almost exclusively at the small and medium scale level. With an estimated rural population of 33 million and 10,000 small and medium scale maize mills across the country, the Government identified small-scale maize flour production as a means of reaching vulnerable populations with critically needed micronutrients. As a result, the Tanzanian Food and Drug Authority (TFDA) established a 2015 deadline for the mandatory production of fortified maize flour at all mills, regardless of production capacity.

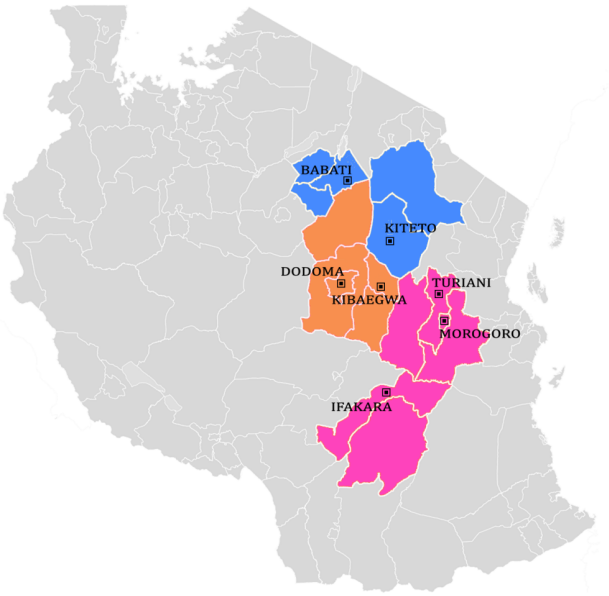
In order to facilitate this mandate, in 2013 Sanku joined forces with the USAID Feed the Future Project, Tuboreshe Chakula. In May 2014, Sanku Dosifiers were installed throughout three regions of Tanzania. To date, these 8 small-scale mills have been able to reach over 25,000 people on a daily basis, producing 755MT of fortified flour in the last 6 months alone.

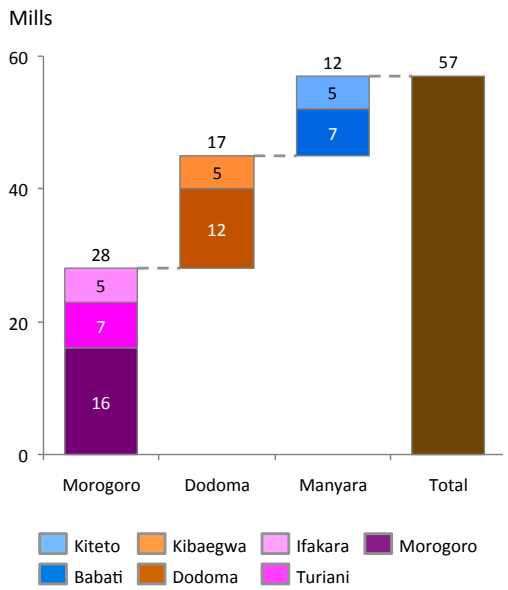
2014 Dosifier Monitor Report

		Cumulative data reports from Dosifier								
	Mill Name	**Monitor date**	**Days since install**	**Total active days**	**Total active hours**	**Total MT flour**	**Total Kg premix**	**MT flour per active day**	**MT flour per active hour**	**Population reach per day**
1	Mkude's Milling	12/11/14	188	45	184	53.17	53.99	1.182	0.289	1414
2	Kindai super sembe	4/11/14	187	105	484	314.9	314.9	2.999	0.651	8420
3	Kibaigwa Flour Supply	5/11/14	160	47	96	47.22	46.69	1.005	0.492	1476
4	Gabe Super samba	12/11/14	184	82	116	28.37	28.27	0.346	0.245	771
5	Rahisi Group Mills	12/11/14	178	76	299	88.09	87.99	1.159	0.295	2474
6	Kilonda Mills	4/11/14	169	48	179	76.02	76.02	1.584	0.425	2249
7	Katundu traders Ltd	17/9/14	112	53	325	132.9	132.9	2.508	0.409	5933
8	2pm Milling	6/11/14	24	11	44	14.4	14.39	1.309	0.327	3000
		TOTALS	**1202**	**467**	**1727**	**755**	**755**	**1.511**	**0.391**	**25,737**

Scaling The Program

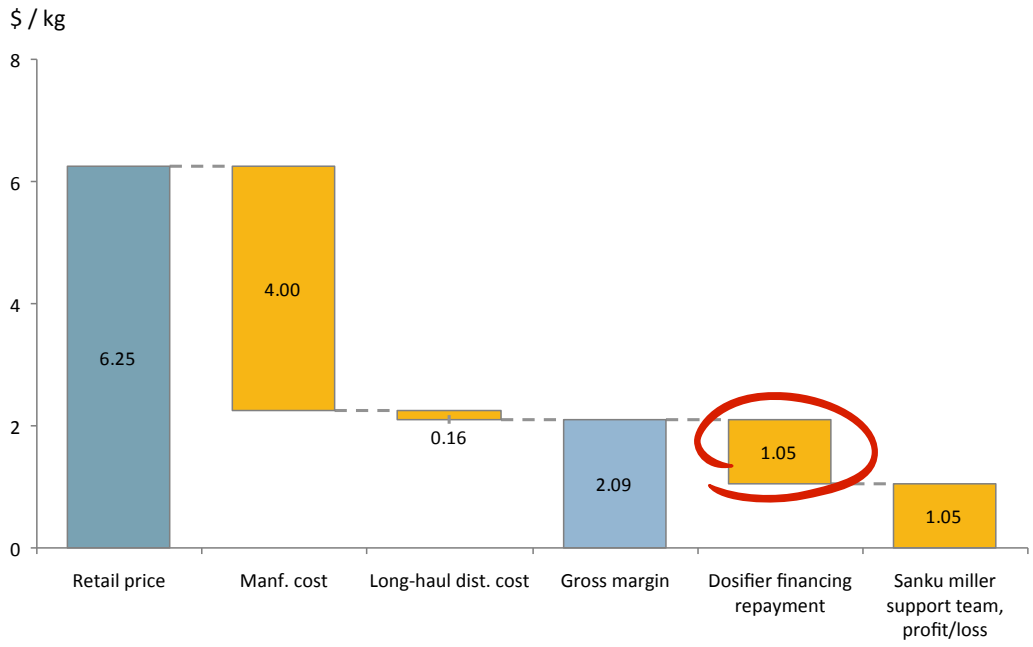
With grant support, Tuboreshe Chakula plans to purchase and install an additional 50 dosifiers throughout the regions of Dodoma, Morogoro and Manyara. The current goal is to manufacture the 50 dosifiers in November 2014 and install by February 2015. The 57 mills will have a total annual production capacity of approximately 52,000MT of fortified flour and a population reach of close to 700,000 Tanzanians daily.





Working Capital

Sanku has tested the Tanzanian market and learned that fortification adds minimal cost to the retail price of maize flour. Millers thus far can bear the price point of US$6.25. The cost of distribution (i.e. port clearance, transportation and warehousing, and final delivery to mill via MS Team) adds an average of US$1.21/kg. If premix is bought for US$4.00, this leaves US$1.05 to payback dosifier financing (see graph below).



Reach

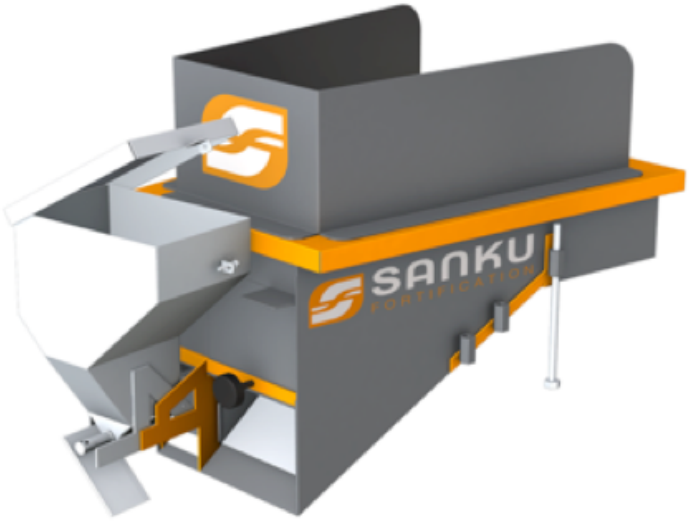
Our growth scenario indicates that this small 57 mill program in Tanzania will expand to 364 mills by 2018, reaching an estimated 7.1M people (20% of the rural population). The levels of added iron, zinc, and folic acid comply with the adopted Tanzanian standard for maize flour[6] moving the country closer to reaching its stated goals of reducing anemia in children by 20% and women of childbearing age by 30%, reducing NTDs by 30%, and reducing vitamin A deficiency by 30%[7].

[6] It should be noted that Sanku recommends a review of the nutrient gap filled or % EAR addressed with Tanzania's current national maize flour standard among rural populations that do not benefit from the consumption of both fortified maize and wheat flour. For rural populations consuming maize flour but not consuming centrally processed wheat flour, there may be a need to re-evaluate maize flour fortificant addition levels to achieve a desirable impact.

[7] Action Plan: Provision of vitamins and minerals to the Tanzanian population through the enrichment of staple foods. Reviewed and adopted by the High Level Forum called by the Government of Tanzania on 10 September 2009.

What does it look like / How does it work?

Watch the Sanku video here.

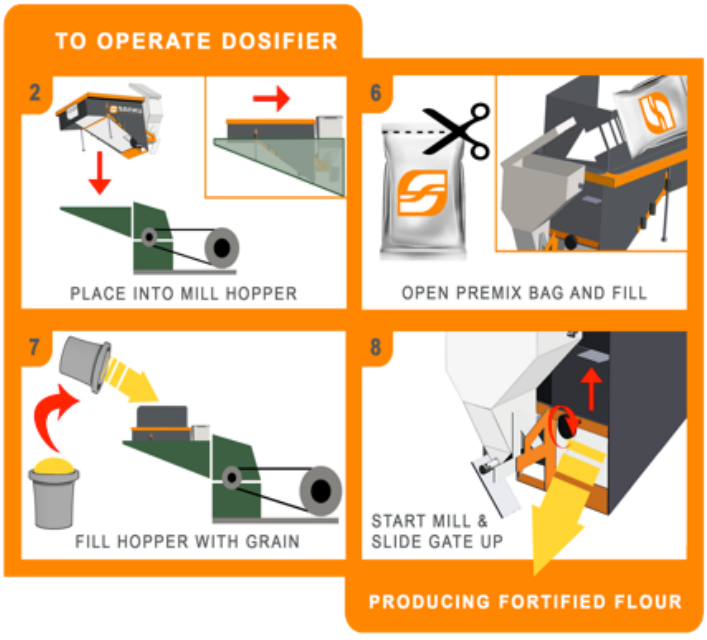


Installation

Hammer mills are the most common village-level mills in Africa and feature a shallow sloped trapezoidal shaped hopper. The *Sanku Dosifier* includes features that facilitate its placement within the existing hammer mill's hopper (e.g., adjustable legs for variable hopper slopes).

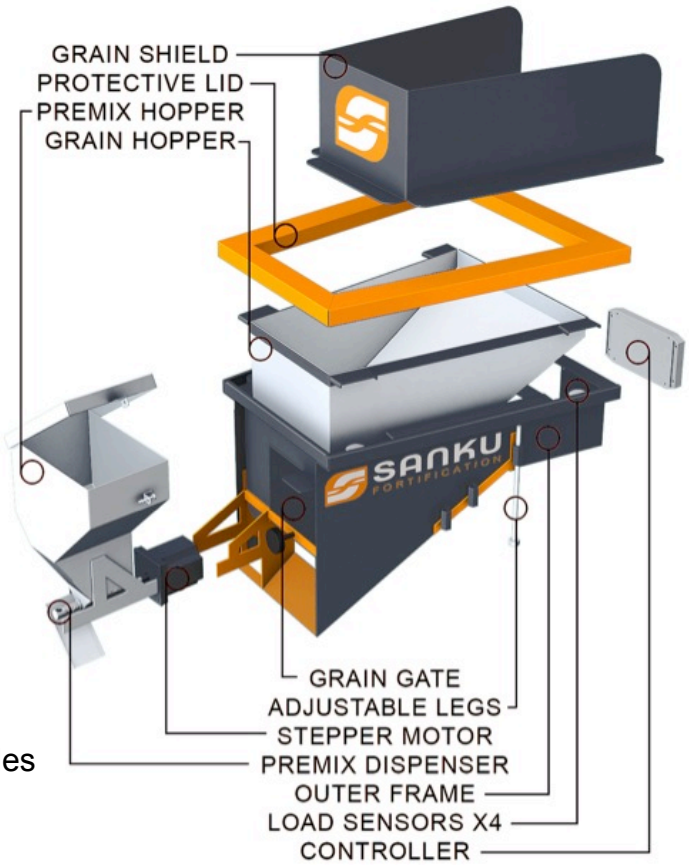
With its "universal mill" design, installation is quick and seamless with no need to modify the existing mills technology.

Minimal training is required since the dosifier is fully automated, causing little to no disruptions to the miller's daily routine.



Technical Specifications

- Type: Fully Automatic, Gravimetric Dosifier
- Material: Food-Grade Stainless Steel & Plastic
- Dimensions: L 86cm, W 55cm, H 40cm
- Empty Weight: 17kg
- Input Voltage: 90 - 265 VAC
- Output Voltage: 24 VDC
- Power Consumption: 75W
- Motor Holding Torque: 5.2N-m
- Grain Hopper Capacity: 50kg
- Premix Hopper Capacity: 5kg
- Max Feed Rate: 2kg/hour (Premix)
- Min Feed Rate: N/A
- Accuracy: +/- 10%



Features

- LED Weight Display
- Data Storage
- Adjustable Pitch for Installation
- Adjustable Grain Flow Rate
- Programmable Dose Threshold
- Detachable Grain Shield
- Both gravimetric and volumetric modes