A Cost Analysis of Micronutrient Powder distribution by Community Health Workers

Developed by: IERC, BRAC Uganda
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The views and interpretations expressed in this report are the authors' and do not necessarily reflect those of BRAC Uganda or the World Bank.

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Contents

Quick Links
Cost Model: Draft Costing BRAC_MNP
MNP Sales Data: MNP Sales in all the branches

Executive Summary

Introduction

Prevalence of child malnutrition is a leading concern for Uganda. Of 7.7 million children aged under 5 in Uganda, 29% suffer from chronic malnutrition and stunting and 11% are underweight (USAID, 2018). The 2016 Uganda Demographic Household Survey (UDHS) reports that 28.9% of children under age 59 months are stunted and 3.5% are wasted. Additionally, 53% of the children covered in UDHS, 2016 suffered from some degree of anemia. Anemia is a serious concern for health as it impairs the cognitive development, stunt growth and increases morbidity from infectious diseases.

Micronutrient powder (MNP) have been shown to prevent child malnutrition which leads to stunting and anemia prevalence among children. The powder can be readily used at home by adding the sprinkles to semi-solid food. It is a multi-nutrient product with vitamins and minerals that are essential for child's survival and has been proven to be beneficial for child's development when coupled with other Infant and Young Child Practices (IYCF).

Even when the use of MNP has been widely promoted, the evidence on cost effective methods of delivery remains scarce. Sensitization, community awareness and accessibility are key concerns affecting uptake of MNP powder and the last mile delivery. BRAC has a Community Health Promoter (CHP) model where selected members of the community are trained as CHPs. They sell essential health products such as condoms, Oral Rehydration Solution (ORS) and other items in the community while educating them about the nutrition, personal hygiene, immunization, IYCF and family planning. CHPs purchase these goods from BRAC and sell them in the community at a smaller profit.

As delivering MNP becomes essential in public health interventions, costs of delivery through various mechanism need to be evaluated. This study assesses the costs of using BRAC CHP Model for delivering MNP in the community.

Methodology

We calculate the total cost of implementing the MNP program by breaking the program costs by (i) category of costs (such as training, administrative, management, procurement, MNP distribution and opportunity cost) and (ii) fixed, variable and start-up costs. Scale up cost of the programme were calculated by dropping the cost of capital investments and adjusting for the overhead costs.

We analyzed the MNP Sales data to measure the cost per sachet sold (total program cost/ number of sachets sold) and cost per implied child treated (total program cost/ number of children receiving 45 MNP sachets). We also employed a scenario model for testing the costs per sachet sold and cost per implied child treated had all the MNP sachets procured by BRAC were sold. Sensitivity analysis was performed to further investigate the cost range in our model.

Since there are other distribution mechanisms for delivery, we compare the costs of CHP model with Village Health Team model, Facility based delivery model and discuss the possible cost burden for Ministry of Health, Uganda if the distributional task is taken by the Government. We also identify key cost drivers affecting the delivery of MNP program.

Results/Key findings

BRAC Uganda procured 60,000 sachets of MNP powder at a price of USD 0.035 per sachet. A total of 7,065 sachets were sold in the community by Community Health Promoters over a period of three months. It would cost USD 3.15 to provide MNP for one child in accordance with WHO's suggested guidelines of no more than 90 sachets per child over a six-month period, excluding all programme implementation and freight costs.

At this price, the **Total cost** to develop the MNP delivery model, train Community Health Promoters, and deliver sales of 7,065 units was USD 33,970 over three months. Holding the MNP price level constant, the predicted total cost changes to USD 86,667 to deliver all 60,000 sachets, while the period of delivery increases to a total of 25 months.

Holding price and quantity constant, we estimate that the **cost to expand** the delivery of MNP through an existing CHP program to adjacent districts in Uganda with similar levels of anemia prevalence, and with similar population densities is USD 21,769 (for three districts) or about USD 7,265 per district.

The total **cost per sachet sold** is USD 4.81 per unit when 7,065 units of MNP were sold. The predicted cost per unit sold decreases to USD 1.44 when community sales are predicted for all 60,000 sachets.

The **cost per child treated** is USD 216.37 at the price of procurement for this study. The predicted cost falls to USD 65 when 60,000 sachets are sold.

Although this feasibility study does not estimate the cost per DALY averted from MNP, we draw on the evidence by Parischa et al, 2020. They find that the effect of MNP on Anemia alone can avert 63.2 years of life lived with disability per 10,000 children - roughly equivalent to the life expectancy at birth of a single individual born in Uganda in 2019.

Our findings suggest that the CHP Delivery model can function better compared to the National Procurement Process because of (i) the low opportunity and monitoring costs for CHPs for distributing MNP sachets compared to VHTs and relatively (ii) low costs of validation, reporting and personnel management. The use of incentives to increase household visits and sell MNP reduces the opportunity cost to CHPs of volunteering in the program and shifts the cost burden of purchasing MNP to the community. These incentives work as a more sustainable way to distribute MNP in comparison to National modes of free distribution.

The study is limited to directly compare the cost estimates with other similar studies such as SPRING, 2020 because of the differences in duration, location, distribution time, target audience, opportunity costs, dosage per child, MNP suppliers and other coordination activities. Despite a limitation to make a direct comparison with SPRING, 2020 estimates, we believe that lower opportunity costs of CHPs and a better incentive structure may contribute to lower distribution costs as compared to the VHT delivery model or a facility based delivery model.

Conclusion

This study evaluated the costs for delivering MNP through BRAC CHPs. We conclude that it will cost USD 1.44 to ensure the delivery of MNP sachet per child and USD 65 to treat one child with MNP sachets for 90 days through the BRAC CHP model. Primary data suggests that MNP product has been accepted by the community and the cost burden has been positively shared. However, more data for a longer program duration, coverage and in different contexts would be needed to effectively compare the costs of delivering MNP through a CHP program with other delivery mechanisms.

Recommendation

The cost estimates outlined in this study can act as a reference for development practitioners who plan to deliver MNP through community health workers in a similar demography. It recommends using CHP model to distribute MNP because it is a cost-effective, sustainable, and community-owned option for promoting nutrition for children. The breakdown of the cost by the study and its sensitivity analysis suggest that the governments should carefully consider the costs of partnering delivery agents and critically evaluate the opportunity cost and incentive structure of delivery agents, cost of supplier and source of shipment and context where MNP is being distributed.

1. Overview

Micronutrient deficiency during the foster years can severely hamper a child's development. Micronutrient powder (MNP) has been shown to be beneficial for a child's development when coupled with other Infant and Young Child Practices (IYCF). For example, Salam et al, 2013 find that MNP reduced prevalence of anemia by 34%, retinol deficiency by 21% and improved hemoglobin levels among children. The Nutrition Guidance Expert Advisory Group (WHO, 2011) recommends the use of home fortification of foods for infants and young children, where caregivers mix MNP 'sprinkles' with semi solid food. Even though MNP is shown to be an effective treatment for childhood anemia (Tam et al, 2020), households may not take-up and use MNP for a range of reasons. These include limited affordability, availability, accessibility and information regarding the benefits of MNP. Limited sensitization and communication efforts with the community can also lead households not to recognize MNP as an option for treating childhood anemia.

Home based fortification requires an efficient system for providing the caregivers with the micronutrient product and raising awareness on the ways to prepare and consume MNP. Several mechanisms and delivery channels can be used for providing MNP sachets in the community. These could be home based delivery with the help of Community volunteers, facility based delivery or delivery through pharmacies.

BRAC Uganda conducted a study to test the feasibility of delivering MNP sachets using the Community Health Promoters (CHP) in Uganda. BRAC CHPs are community volunteers responsible for delivering essential health services in the community. They are incentivized to sell health products in the community by making a small profit on the sales.

The purpose of the program was to provide vulnerable households with greater access to affordable MNP packets and reduce harm to children's health that can result from micronutrient deficiencies.

The intervention trained and supplied CHPs with knowledge, skills, and incentives to deliver MNP to households with children between the ages of 6 to 59 months. The programme first trained the Project Assistants (PAs) on the need and use of MNP, who then trained the CHPs on the benefits, use and marketing of MNP. BRAC team procured 60,000 sachets of Mixme MNP product from South Africa and the distributed the boxes to BRAC branches in Luwero, Bombo, Bundibugyo, Mayuge and Nyahuka. The boxes were sold to CHPs, who then sold the boxes within the community.

In this study, we estimate the cost for BRAC CHPs to deliver MNP during the feasibility study. This cost analysis estimates: (i) the total and scale up costs of the CHP model, (ii) the cost per child treated, (iii) the value of a reduction in mortality risk from anemia in children treated with MNP, (iv) compares programme costs per packet with alternate models of delivery and (v) provides recommendations based on the analysis.

2. Background and Intervention

2.1. BRAC Community Health Promoters (CHPs)

To improve household's access to essential healthcare services, BRAC Uganda trains local female CHPs to provide essential health care services. BRAC's CHP program reaches 3.2 million individuals through the 4,082 CHPs it has trained. These CHPs serve in 101 branch offices spanning 72 districts, and seven regions. CHPs are selected using the same criteria the Ministry of Health uses to select its Community Health Workers. Eligible community members who are seconded by local village community leaders and elders are selected to receive two weeks of training in Integrated Community Case Management and Mobile-health platforms[1].

After successful training completion District Health Offices certify the CHPs. BRAC teams at the branches then equip the CHPs with all the essentials (mobile phone, medicine cupboard, high impact items and uniforms) to aid them in reaching women of childbearing age and children under five years of age. CHPs are volunteers who work on the following key activities:

- *Conduct Household visits:* During household visits, CHPs provide health education in sanitation, nutrition, personal hygiene, IYCF, immunization and family planning. They register pregnancies, advise pregnant women to seek antenatal services, and to deliver at a health center. The conduct postnatal care visits and carry out assessments for Malaria, Diarrhea, and Pneumonia.
- *Make Referrals*: of complicated/severe cases to government Health Centers and other private health facilities, and conduct follow-ups to assess the condition of the patients.
- *Lead Community Health Forums*: at Microfinance groups as well as other community meetings/gatherings.
- *Organize community mobilization* meetings for discussion on key healthcare services and needs.

CHPs purchase essential healthcare products from BRAC at a subsidized price and sell the products in the community in return for a profit. These sales act as an incentive for the CHPs to earn a living for themselves while serving the community. In addition, each CHP earns USD 8 per month if she visits at least 80% of the households in her assigned village. The combination of incentives is intended to motivate CHPs to delivery essential health services to the last mile.

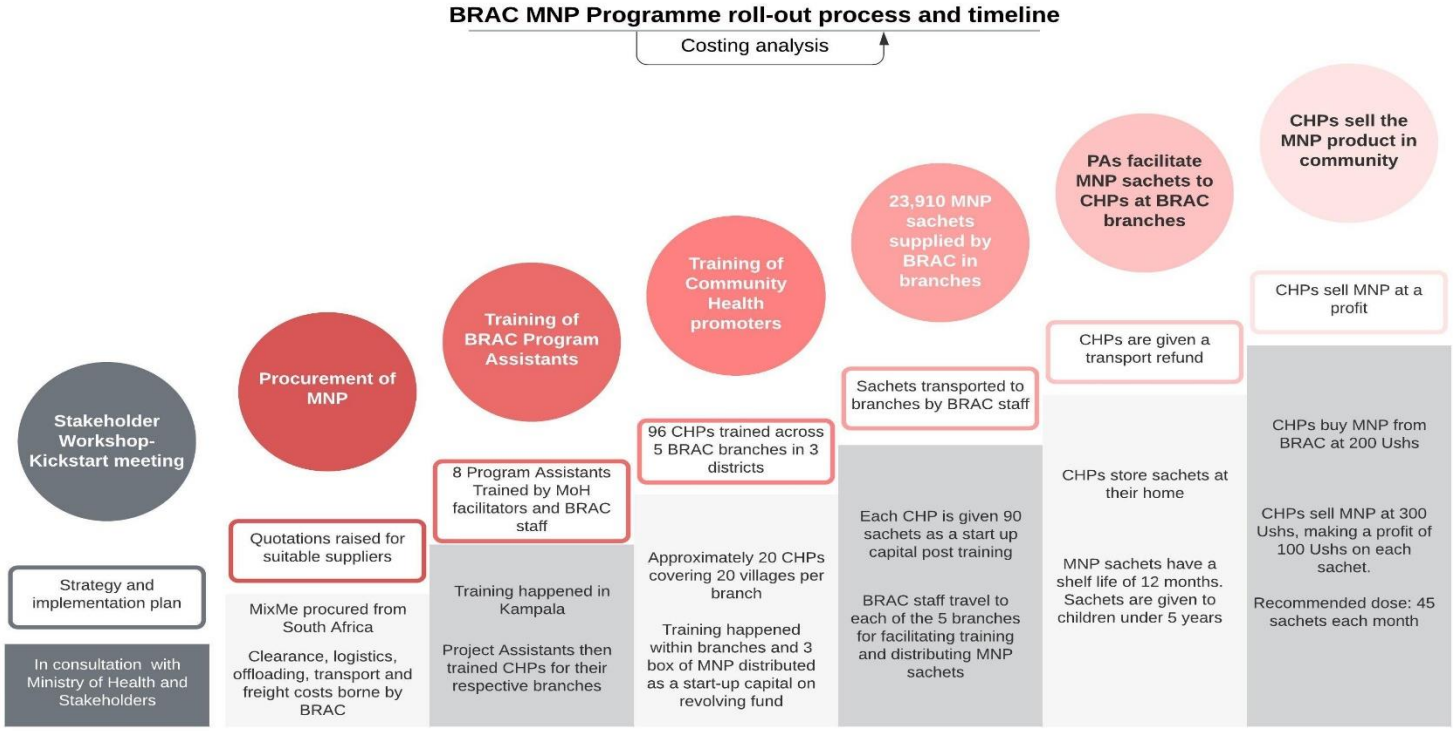
2.2. MNP Program

The feasibility study added a program of MNP delivery to the list of essential health products for CHPs to sell in three districts of Bundibugyo, Luwero and Mayuge. The MNP program model has three distinctive features:

[1] The mobile health platform utilizes both messages and phone calls to enable patients communicate heath concerns to the trained health workers.

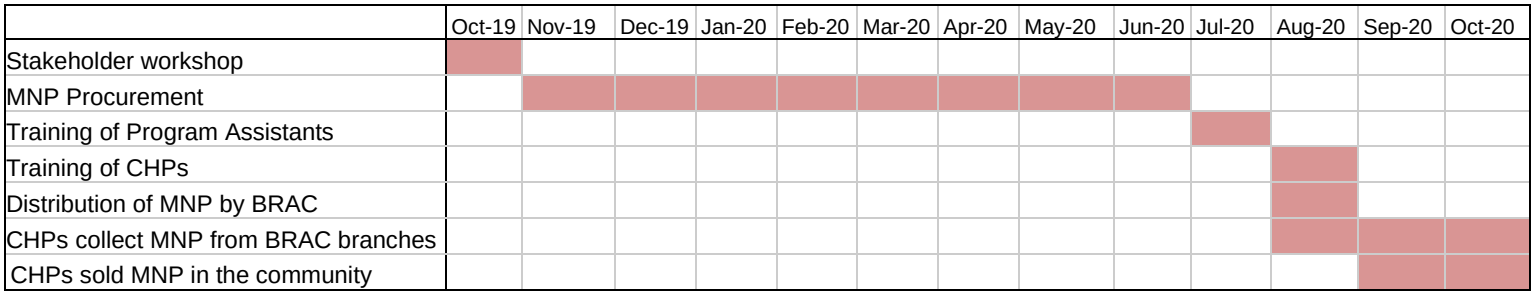
- *Knowledge:* The model provided CHPs with training in the appropriate use and marketing of MNP to target households.
- *Compatibility:* The training was added as a new element onto the existing CHP program in which CHPs receive monthly trainings from BRAC.
- *Incentives:* The model incentivizes CHPs to market and sell MNP to the households in their villages in return for a small profit.

The MNP program intervention was rolled out over the course of a year starting in October 2019. The program began with a stakeholder workshop in October 2019 to kick-start the project and engage stakeholders in the research design. Between November 2019 and June 2020, the team researched alternative micronutrient procurement options and purchased 2000 boxes of a packaged and branded MNP product (MixMe) from a supplier in South Africa.



Also, during this time an MNP training module was developed to be rolled out using a cascade training approach. The MNP module was designed as an additional element of training and to be compatible with existing CHP training schedule. In July 2020, eight Project Assistants (PA) were trained in the marketing and use of MNP during a two-day training of trainers at BRAC's Country Office in Kampala. Afterwards, the PAs in Bundibugyo, Luwero and Mayuge selected 20 CHPs working across five branches to receive a two-day training on the benefits, uses, and marketing of MNP packets to high-risk households. A total of 96 CHPs were trained in the appropriate use and marketing of MNP. Each of the 96 CHPs is assigned to cover one village with 100 households in each village.

Figure 1: MNP Program Rollout



The CHP training was combined with refresher training in infant and young child feeding (IYCF)—inclusive of refresher training in WASH, Malaria, and Diarrhea—as was advised by representatives of Uganda's Ministry of Health. The training was conducted by BRAC PAs and was facilitated by Health Program, Project Lead and Field Supervisors in a venue nearby BRAC's Branch offices.

At the completion of training, each CHP was required to purchase an initial inventory of three boxes of MNP (90 sachets) on a 'revolving fund' to sell for profit in the community. CHPs were allowed to purchase as many boxes as they wanted and as many as they could afford. The cost to purchase the initial inventory was USD2.43 per box and the community sale price was USD3.24. CHPs were required to pay back the cost of the initial inventory using the profits they earned from the sale of boxes. In the months of September, October and November 2020 CHPs marketed and sold over 235 boxes of MNP product in the community.

Table 1 shows the number of CHPs trained by district and branch. In total, the MNP-trained CHPs were estimated to have visited 100 households each during the rollout of the MNP program in a period of 90 days (3 months) from September 2020 through November 2020. The number of visits per day was feasible because CHPs have a targeted list, and households often are clustered together in small villages allowing CHPs to visit between 7-8 households per day. In addition, BRAC encourages CHPs to keep a list of 100 target households (households that have a child 59 months or younger or a pregnant woman). These households would be a prime target for MNP in addition to any others with a child between the ages of 6-59 months.

Table 1: Number of CHPs trained by district and branch

District	Luwero		Mayuge	Bundibugyo		Total
Branch	Luwero	Bombo	Mayuge	Bundibugyo	Nyahuka	5
# of CHPs trained	20	20	20	20	16	96
# of villages each CHP visited	20	20	20	20	16	96
# of HHs visited by each CHP in each village	100	100	100	100	100	
Total Households visited	2000	2000	2000	2000	1600	9600

Collectively, the CHPs undertook approximately 9,600 home visits during the three-month window.

3. Cost Research Questions

This study is intended to respond to the following primary research questions:

1. What are the total costs of delivering the CHP-based model?
2. What are the expected costs if the program were to be scaled to adjacent districts of Uganda using the same approach?
3. What is the cost per CHP sale and per implied child treated?
4. How does the CHP model compare with other modes of delivery?

We generate an estimate of the economic cost to implement this public-good program.

4. Methods

Program provider perspective - We undertake the costing from the perspective of the program provider, BRAC, asking: What is the total cost to deliver the MNP program using the CHP method and how many packets of MNP did CHPs purchase and sell at the price that was offered to them?

Baseline cost model ~ To answer these questions we build a core/baseline costing model using a micro-costing approach. This detailed model breaks the program delivery costs down in two major ways: 1) by category of cost (e.g. administrative and managerial costs, monitoring & evaluation costs, training costs) to ensure there is fidelity between the activities undertaken to implement the program and cost capture; and 2) by fixed, variable, and start-up costs to allow for further investigations and modeling of various scale scenarios.

Within categories we further breakdown costs according to standard inputs, e.g. by salaries, fringe benefits, allowances, consultants, travel, direct costs, sub-awards and contracts, indirect costs, equipment, and other costs.

Key Assumptions of the Baseline model

1. The costing assumes CHP programmes already are in place in Uganda and that a new MNP programme would be (built into / added on) to the existing health community team structure.
2. We exclude research / evaluation design and implementation costs, asking what is the cost of the program implementation in the absence of the feasibility evaluation?
3. We include routine monitoring costs (e.g. costs associated with ensuring the fidelity of implementation to the planned model, or associated with tracking progress against management goals).
4. Cost data are generated from expenditures and budgets developed between October 2019 and October 2020. Since we do not know the precise timing of

expenditures and most activities were conducted during 2020, we report costs in nominal terms.

5. All costs are reported in USD. We adjust for differences in the currency of expenditure (or budgeting) based on the average annual exchange rate prevalent during the period of program implementation. The rate of exchange for UGX:USD is 3700:1 and the rate of EUR:USD is 1.18:1.

4.1. Cost Category Description

4.1.1. Administration & Management

- Includes labor and other activities to coordinate human and material resources needed to achieve overall project goals; shared program costs such as cost of rent of in-country facilities, utilities, communication services, legal fees, software licenses, liability insurance, vehicle pool, security costs; and other expenditure relating to the general management and operations. It also includes the cost of starting the project up and closing it down. In-country and headquarters administrative and management expenditures are reported separately as overhead.

- No direct administrative cost was assigned to the MNP program. The indirect costs incurred for administrative departments at BRAC are contained in the 9% overhead (salaries etc.). The direct costs of research personnel to carry out the needed management and administrative tasks were allocated to Administration and Management based on self-reported time estimates.

4.1.2. Training of Trainers (Project Assistants) - Development and Implementation

- Training (Development) - LOE of technical staff or consultants who developed training sessions or materials, or who conducted workshops, or field testing of curricula (e.g. developing materials for training trainers). After materials are finished and ready for use, staff involved in training development billed to implementation (below) even if they continue to make changes to the materials.

- Training (Implementation) - All costs associated with conducting the teacher training, including the LOE of training staff (e.g. training of trainers) or outside trainers hired, participant costs such as travel, meals and hotel, and the cost of reproducing training materials.

- MNP Project Assistants were trained by the Field Supervisor and Project Manager, and some external representative from the Ministry of Health. Training of Project Assistants trainers took place over two days, from 9-4pm (seven hours per day)

4.1.3. Training of CHPs Training - Development and Implementation

- Teaching and Learning Materials (development) - LOE of technical staff or consultants who participate in developing curriculum and related materials for use in classrooms or facilitated learning settings, translating materials, and development or review workshops, or field testing (e.g. developing materials for training of CHPs)

- Teaching and Learning Materials (implementation) - CHP implementation training sessions; and materials printing and distribution costs; storing, sorting and packing TLMs prior to distribution; any supplies purchased for use in CHP training

- Community Health Promoters were trained by already trained Project Assistants in their respective branches. This training was convened by the Field Supervisor and Project Manager in the presence of Ministry of Health officials. Each of the trainings lasted for two days from 9-4pm

4.1.4. Product (MNP) Procurement

- Personnel costs to manage and negotiate an MNP price.

- Includes the cost of the MNP product, as well as shipping, fees, VAT and any other tariffs and transportation costs associated with delivery to BRAC Uganda's distribution center.

4.1.5. Product (MNP) Distribution Cost

- Includes the cost of distributing the MNP product for CHP's trained in MNP excluding cost of shipping, fees, VAT, and any other tariffs and transportation costs associated with delivery to BRAC Uganda's distribution center.

4.1.6. Monitoring & Evaluation

- Monitoring, evaluation, assessment and reporting activities to track performance and meet management targets. This includes project results evaluation, reporting to funders and stakeholders, routine data collection, analysis and reporting activities.

4.1.7. CHP opportunity cost

The program relies on the volunteer labour of CHPs. CHPs give up time to receive MNP training and are provided with a travel subsidy. Opportunity cost is the value of an individual’s time given up in an alternative activity. There are several ways to value the opportunity cost of a CHP’s time. For example, we may value CHP time using a shadow

price such as the fair market wage they could obtain in the labor market for their level of skill, training, and experience. The alternative way to value CHP time is to consider that the marginal profit from their MNP sales is equal in value to the marginal opportunity cost of training. The presence of BRAC's profit incentive shifts the cost burden from the NGO, BRAC to the consumer, assuming those caregivers are willing to pay for MNP. Attributing the opportunity cost of training time to the cost of the MNP program would double count the income benefits to CHPs and are excluded from this costing.

4.2. Data

Three primary sources of data were used for this analysis of costs:

A mix of budgeted and actual expenditure data from BRAC Uganda's Operational Feasibility Study of home fortification of MNP. The data source depends on the activity category.

- Administrative costs were estimated using actual salaries and time allocation estimates derived from interviews with the program managers responsible for implementation.

- Stakeholder meeting costs, all training costs (training of trainers, and training of CHPs) were based on actual expenditure reports from the training sessions.

- Procurement costs were based on expenditure receipts obtained from BRAC, with the exception of airport clearing costs which were estimated from interviews with airport staff.

- Product (MNP) Distribution Costs were estimated on the basis of program manager's knowledge of staff allocation and time use.

Detailed data on total MNP sales in all branches were provided by BRAC and based on self-reports by CHP's during the knowledge, attitudes, and practices (KAP) survey.

Two Key Informant Interviews were conducted at National and District level with the Ministry of Health officials. At National Level, the Senior Nutritionist in charge of Micronutrient interventions in the country based at the Ministry of Health was the main Key Informant. At District level, it was the Assistant District Health Officer ADHO), Nutrition Focal Persons and District Health Educator who were interviewed following a Key Informant Interview (KII) guide. The KIIs were done in the districts of Luwero and Mayuge where the MNP intervention had been implemented by the CHPs.

At National level, the team asked the official about experience in importing MNP, procurement costs, expected future costs of importing MNP, storage cost of MNP. transport costs to distribute MNP to the districts, comparison of VHT / CHP cost of MNP to establish whether under the current VHT/CHP operational structure, VHT model will incur any additional costs to introduce MNP for VHT/CHP. At District level, questions included details on delivery of MNP

from National Medical Stores to district stores, storage of NMS at district stores, distribution of MNP to the CHPs /VHTs and community and costs involved and willingness by the community to pay for MNP.

5. Findings to Primary Evaluation / Research Questions

5.1. Total costs

The estimated total cost to design and implement a program capable of delivering MNP to households in the five branches (in the three districts of Bundibugyo, Luwero and Mayuge) was approximately USD33,970. This estimate is based on the price the organization paid to purchase 2,000 boxes of MNP from the manufacturer at a cost of USD1.06 per carton.

During the implementation of the program, sachets were sold to households at a retail price of USD3.24 per carton (or approximately USD 0.108 per sachet). Each carton contains 30 sachets.

Table 2 provides a summary and activity breakdown of the estimated total cost in USD.

- **Administration & Management** was USD8,600, about 25% of the total MNP program cost. This includes personnel responsible for organizing the program and managing staff, overhead costs (calculated at 9% of the total cost of the program[2]), and the cost of a workshop held at the onset of the program to engage stakeholders.
- **Training of Trainers**. The cost to design and develop the MNP training module, to secure an appropriate training space, mobilize and implement the training of 20 trainers and provide travel reimbursements as well as refreshments during training was approximately USD6,986 or 21% of the total cost.
- **Training of CHPs.** The cost to design and develop the CHP training and to implement training of 96 CHPs was approximately USD8,290, inclusive of training model development activities. The cost of the CHP training was approximately 24% of the total program cost and averaged USD 86 per CHP trained (inclusive of development costs).
- **Product (MNP) Procurement.** The cost to procure 2,000 boxes of MNP (60,000 sachets) was estimated to be USD5,527 and represented approximately 16% of the total cost of the MNP program. The cost of the MNP product itself (purchased in packaged form from South Africa was USD2,124 or approximately USD1.06 per box. The cost of staff time to coordinate and manage the procurement process was estimated to be USD1,171, while shipping and import tariffs totaled USD2,233.
- **MNP product distribution**. The cost of organization's staff time to package and prepare MNP for distribution to the districts was USD704. We do not have precise data to estimate the storage costs of MNP, however we expect storage costs to be minimal, at

[2] BRAC overhead covers rent, utilities, BRAC International operational costs, Director's Salary, Security personnel costs, Cleaning and salaries of the cleaners, Head of HR, Accounts, Procurement and M&E, Stationary for office & Maintenance costs

the branch level, and limited to space use. According to the World Health Organization, MNP packages are shelf stable for two years and require no refrigeration.

- **Monitoring and Evaluation**. M&E costs were estimated for an M&E advisor at USD360 for the program.

Table 2: Estimated Total Cost to Deliver MNP in USD

Administration & Management		Cost	$8,600	25%
	Personnel	$4,905		
	Overhead	$2,739		
	Stakeholder workshop	$3,695		
Training of Trainers (Project Assistants) - Development and Implementation			$6,986	21%
	Personnel (development)	$4,178		
	Personnel (implementation)	$1,647		
	Mobilization	$8		
	Venue	$23		
	Food	$135		
	Travel & Transport	$835		
	Materials	$161		
Training of CHPs Training - Development and Implementation			$8,290	24%
	Personnel (development)	$6,282		
	Personnel (implementation)	$469		
	Mobilization	$17		
	Venue	$108		
	Food	$238		
	Travel & transport (trainers)	$757		
	Per diem (participants)	$279		
	Training Materials	$32		
	Media	$108		
Product (MNP) Procurement			$5,527	16%
	Personnel	$1,171		
	Product	$2,124		
	Shipping	$1,416		
	Tariffs	$817		
	VAT	$0		
Product (MNP) Distribution Cost			$704	2%
	Personnel	$214		
	Branch level-overhead	$761		
	BRAC distribution costs	$490		
Monitoring & Evaluation			$360	1%
	Personnel	$360		

Total			$33,970	

5.2. Scaling to an Adjacent District

To estimate the cost to scale this MNP model of delivery—while keeping the price level of MNP fixed at the rate it was procured for this feasibility study—we first review each line item in the primary costing model to distinguish recurring from capital expenses. We mark as recurring, those items that are used up in the course of a year and that are purchased regularly. We mark as capital expenses those single-year tangible expenditures on equipment (vehicle, office furniture, generator; software) and bulk purchases, e.g. books or classroom materials; or expenditures on intangibles such as labor to develop training manuals and materials or LOE to design programs.

The scale scenario drops the cost of capital investments in personnel to develop the curricular and training materials for training trainers and CHPs. It also adjusts the overhead costs downward. BRAC invested USD10,942 to develop training materials, just over 32% of the total program cost.

The recurring costs of the program are expected to be USD21,769 when the cost of development is excluded, overhead is adjusted and when we include the cost of training CHPs to learn how to sell MNP.

Thus, the estimated cost to extend the current program to an adjacent district in Uganda with similar levels of anemia prevalence, similar population densities and that already has a CHP program in place would total USD 21,769 for the coverage of three districts - about USD12,200 fewer dollars compared to the total program when development costs are included. On average, we estimate that the cost to implement the BRAC MNP program in a single additional district will be approximately USD7,256.

5.3. Cost Per CHP Sale and Per (implied) Child Treated

This section discusses the unit economics of the program using available data. We begin with the data in Table 3 which presents a summary of MNP boxes and sachets sold per program dollar. The data presented in columns five and six illustrate CHP sales activity by district and sales efficiency of the programme. The total numbers given at the bottom of these two columns give an estimate of the cost to sell one unit of MNP under the total cost and scale cost assumptions. The cost per sachet under the total cost model is USD4.69: for every sachet sold, the organization expended approximately USD4.69 in program activities. Under the scale model assumption (that the program already has been developed) the cost per sachet sold falls to USD3.65.

Assumptions (Table 3)

Sachets per Box	30

Treatment Dosage	45
Total Program Cost	$33,970
Scale Program Cost	$21,769

Table 3: Summary of MNP Boxes and Sachet Sold per Dollar

Branch	MNP Boxes	Sachets	Total Sales (Sachets)
Luwero	57	300	2010
Mayuge	46	10	1390
Bombo	64	65	1985
Nyahuka	25	0	750
Bundibugyo	31	0	930
Total	223	375	7065

Total Program Cost per Sachet Sold	$ 4.81
Scale Program Cost per Sachet Sold	$ 3.08

In Table 4 we investigate the implied cost of treating a child with MNP under a simplified assumption of dosage. BRAC's recommended dose of MNP for a child under five who is suffering from micronutrient deficiency is one sachet every-other-day for 90 days, or 45 sachets per child.

We apply this dosage to estimate the implied number of children treated based on the number of sachets that were sold by CHPs trained using BRAC's MNP model. Implied number of children treated = (# sachet sold / full treatment dose, 45 sachets). Here we find that the cost to treat a child using this program model is USD216.37 per treated child under the total program cost assumption which falls to USD138.66 under the scale program assumption.

Table 4: Implied Number of Children Treated with MNP per Dollar

Branch	MNP Boxes	Sachets	Total Sales (Sachets)	Implied Number of Children Treated
Luwero	57	300	2010	44.7
Mayuge	46	10	1390	30.9
Bombo	64	65	1985	44.1

Nyahuka	25	0	750	16.7
Bundibugyo	31	0	930	20.7
Total	223	375	7065	157

Total Program Cost per Implied Child Treated	$ 216.37
Scale Program Cost per Implied Child Treated	$ 138.66

The data in Table 4 show that there is some variation in the ability or motivation of CHPs to sell MNP by branch. For example, CHPs sold 2010 sachets in Luwero branch and 930 sachets in Bundibugyo branch.

If CHPs pay USD2.43 per carton and sell each carton at a retail price of USD3.24 per carton, you may ask how many boxes CHPs need to sell to breakeven after repaying the cost of the three boxes they initially acquired from BRAC after training?

The breakeven point for the CHP can be calculated using the following simple equation:

$$3.24Q - (-7.30) = 0$$

Solving for Q we have: $Q = (7.30/3.24)$

$$Q = 2¼$$

Thus, each CHP needs to sell $2¼$ boxes of MNP to breakeven after repaying BRAC.

Using detailed data from BRAC on sales by branch, we can estimate the number of CHPs that have exceeded the breakeven point.

As Table 5 shows, on average 48% of all CHPs are able to achieve sales above the breakeven point of 2.25 boxes of MNP sachets. Breakenve sales also seem to vary by branch. In Luwero 95% of CHP agents sold more than the breakeven number of boxes which enabled them to make a profit. In comparison none of those CHPs trained to sell MNP in Nyahuka cleared the breakeven hurdle.

Table 5: Breakeven Sales by Branch

Branch	# CHP with Sales > breakeven	# CHP agents	%age
Luwero	19	20	95%
Mayuge	9	20	45%
Bombo	12	20	60%
Nyahuka	0	16	0%

Bundibugyo	6	20	30%
Total	46	96	48%

The findings of the Feasibility Study (Ferris, 2020) suggest that community members often request the MNP packet on credit from the CHP and have limited purchasing power for buying MNP.

Only 38.5% of the caregivers could afford to buy the MNP sachet. Despite low sales, MNP was found to be accepted in the community, with caregivers from the in-depth interviews suggesting that they were 'very likely' to buy MNP in the future to meet the nutritional needs of their children. Since, the study also reported that awareness and trust about MNP was high among the caregivers and that nutritional information on MNP was provided by the CHPs, we attribute the low sales to low purchasing power of the households. This is a valid assumption based on the findings of the feasibility report, where a number of caregivers suggested reducing the price of MNP to 200 Ugx (USD 0.054) – which is half the price at which CHP sold MNP in the community (USD 0.108). This price was also supported by the District Health Official from the Key Informant Interview.

"Preferred price is USD: 0.05 or Two sachets for USD: 0.05"

- *Ministry of Health, District level*

However, given the limited timeframe for this intervention, further investigation among a larger sample of caregivers and CHPs is required to understand why sales may have varied so widely and the appropriate selling price at which the product becomes affordable for most caregivers. Without additional observations, it is difficult to know if any assumptions about the linearity of sales (and the profit motivation of CHPs) will be valid as the program considers the question of scale-up to adjacent districts.

5.4. What is the cost to distribute the remaining MNP units?

The scenario presented here considers the cost to distribute the remaining MNP sachets that already were procured by BRAC-Uganda, and assumes we do not need to increase the number of districts and branches for distribution. We're additionally assuming that BRAC will not have to host another workshop, train more trainers, train more CHPs, or procure more MNP.

To explore this scenario, we classify each line item according to whether it is a fixed or variable cost - under the assumptions described above. Variable costs are those that increase with the key output, which is the number of MNP sachets sold. Fixed costs remain unchanged when the quantity of MNP sachets sold increases or decreases.

We take BRAC's procurement costs as fixed for the 2000 boxes of MNP (60,000 sachets) BRAC procured for this feasibility study. To date, just 7065 sachets have been sold over a

period of three months. We want to model the additional cost to sell the entire inventory of 52,935 sachets. To do this, we first calculate the variable cost to sell each sachet.

- After capital expenses are subtracted (for the scale scenario), the fixed costs of the MNP program were USD16,290 (around 75% of total program costs). In this scenario, fixed costs include overhead costs at the central and branch levels, all training activities for trainers and CHPs, and procurement of 2000 boxes of MNP sachets.
- Variable costs make up the remaining cost of the MNP program, totaling USD5,479, around 25% of program costs.
- Dividing the variable cost of the program by the total number of sachets (USD5,479 / 7065) gives us a variable cost of USD0.78 per sachet delivered.
- After month three of the MNP program, the incentive structure of CHP's changes. Each CHP gets a monthly incentive of USD8 for visiting 80% of the households in their catchment area.
- Assuming all CHPs surpass the 80% threshold, we estimate the total cost of the incentive by multiplication: (96 CHP * USD8 * 22 additional months) = USD17,124.
- We estimate that the variable cost to sell the remaining sachets will be $41,052. We add to this the cost of the additional incentive USD17,124 plus the fixed portion of the total cost of the program implementation, $28,491 to arrive at predicted total cost for delivery of 60,000 sachets of USD86,667
- The predicted cost per sachet sold in case all 60,000 sachets were sold is USD 1.44. This cost is considerably lower than the total cost (USD 4.81) and scale up estimates (USD 3.08) outlined in Table 3 which outline the cost per sachet sold based on the current sale of 7065 sachets.
- The predicted cost per child treated in this scenario is USD 65. Upon the sale of 7065 sachets, the total cost per implied child treated was USD 216.37 and the scale up cost was USD 186.66 (Table 4). We predict these costs to go down when all the procured sachets are sold.

Table 5: What-if Scenario

Total sachets sold	7065
Sum of variable program costs	$5,479
Variable cost per sachet sold	$0.78
Sachets sold per month	2355
Sachets left to be sold	52935
Number of additional months for selling all sachets	22
Number of CHPs	96
Additional monthly incentive	$8.10
Variable cost to sell remaining sachets	$41,052
Cost of additional incentive per CHP	$17,124
Fixed cost of implementation	$28,491

Predicted total cost for delivery of 60,000 sachets	$86,667
Predicted cost per sachet sold	$1.44
Predicted cost per implied child treated	$65

Sensitivity Analysis

We conduct a simple sensitivity analysis to further investigate the cost to distribute the remaining sachets. The largest component of cost is the variable cost to sell the remaining sachets. We have assumed it is linear, but what if we are not correct and the average cost increases or decreases? We model three additional scenarios where the marginal cost is half of what we expect, 1.5 times and 2 times of our previous estimate.

Table 6: Sensitivity analysis of variable costs

	1X	.5X	1.5X	2X
Variable cost to sell remaining sachets	$41,052	$20,526	$61,578	$82,104.18
Cost of additional incentive per CHP	$17,124	$17,124	$17,124	$17,124
Fixed cost of implementation	$28,491	$28,491	$28,491	$28,491
Predicted Total cost for delivery of 60,000 sachets	$86,667	$66,141	$107,193	$127,719
Predicted cost per sachet sold	$1.44	$1.10	$1.79	$2.13
Predicted cost per implied child treated (for treating 1,333) children)	$65	$50	$80	$96

6. Estimated Benefits of Treating Anemia with MNP

Valuation research on Uganda is limited and we found no studies that estimate averted Anemia outcomes for children 59 months and younger. A single microsimulation study estimates the net benefits and cost-effectiveness of treating young children in 78 countries with universal iron-containing multiple micronutrient powders, inclusive of Uganda (Pasricha 2020). Estimates of Anemia prevalence were based on DHS data and effect sizes were drawn only from systematic reviews of intervention trials identified using a keyword literature search of articles published on Medline between 1966 and 2019.

Pasricha et. al. (2020) estimate country-specific net disability-adjusted life years (DALY), years lived with disability (YLDs), and years of healthy life lost due to disability (YLL) from anemia, malaria and diarrhea averted that result from a six-month course of micronutrient supplementation starting at six months of age, compared to a no-intervention counterfactual. The study assumes 100% coverage of children under 18 months in Uganda and models the combined effect of MNP treatment net of the benefits of reducing Anemia and costs of malaria or potential infection which can be exacerbated by treatment with MNP. A separate analysis models the effect of MNP on Anemia prevalence alone.

The microsimulation study focuses on children under 18 months. In contrast, the population of interest to BRAC MNP is children under five years. Country-level demographics reported in Pasricha et.al. (2020) (income, age, gender) and population density are reasonably close to the average values for the three districts where the BRAC MNP feasibility study was tested. We do not adjust the estimate based on age differences between the population studied and the target population of interest. For simplification purposes we assume the estimate of DALY estimates represents the lower bound of impact with MNP treatment. Treating a larger number of children under five would lead to additional health gains, although we do not have sufficient data to estimate the magnitude of this effect.

The study results indicate that at 100% coverage of Uganda's 6-12 month-old population, universal home fortification with MNP for six months would avert 28 DALYs per 10,000 children compared with control - however the results were not statistically significant at the 5 % level, with a [95 % CIs = -92 to 137]. "Of these averted DALYs, -33.2 [95 % CIs = -145 to 68.7] were years of life lost (YLL) and 61.2 [95 % CIs = 52.9 to 68.1] were (averted years of life with disability) YLDs" Only the measure of averted years of life with disability was positive and statistically significant.

The effect of MNP on Anemia alone was estimated to avert 63.2 years of life lived with disability per 10,000 children - which for comparison purposes is roughly equivalent to the life expectancy at birth of a single individual born in Uganda in 2019.

We do not use the country-level estimates from Pasricha et. al. (2020) to estimate the cost per DALY averted for this feasibility study. This is because a number of strong assumptions would be required to estimate the corresponding national-level cost of delivering MNP at-scale using the CHP program. We are limited by the available cost data and just three months to observe MNP sales. We do not have valid underlying data to estimate some cost-drivers that may affect the national-scale estimate. For example, we have no information on CHP travel and the cost to deliver to last-mile. We believe these costs are likely to be significant since -- prior analysis suggests these costs may constitute 30% of the total program for a similar program (SPRING). Additionally, our sales data is limited to a three-month window which does not allow us to observe how MNP sales change with time and geographic distance.

7. Comparison with other modes of delivery

We are aware of three other mechanisms to deliver MNP in addition to the CHP model. This section outlines the key differences between the alternative delivery mechanisms.

1- Government procures through NMS and trains the VHTs to deliver MNP

In this mechanism, the Ministry of Health facilitates the procurement, storage and distribution of essential vaccines, medicines and other healthcare products supplied through

the National Medical Stores (NMS). NMS is the procurement agency for procuring essential healthcare products in Uganda.

"Since government has never procured, the anticipated costs will be borne by National Medical Stores (NMS) who have the mandate to procure, medicines, drugs and other related medical logistics on behalf of government."

- *Ministry of Health Official, National Level*

Based on a review of the Government guidelines on procurement of essential health supplies, the below steps outline a hypothetical NMS procurement and distribution process for MNP (OAG,2016). We additionally outline the process for training VHTs and distributing MNP in the community.

a) Ministry of Health develops key guidelines in consultation with the micronutrient focal person and nutrition experts.
b) NMS procures and distributes MNP. This process would involve first sending a list to all healthcare facilities. The responses to this list would act as a basis for planning and quantification of MNP as per the nutritional needs of the region. Quantification would be done with technical assistance from the Ministry of Health-Pharmacy Division, Nutritional group and NMS Sales and marketing department. The Sales and Marketing Department would provide specialist support throughout the quantification and in drawing the procurement plans according to the Clinical Guidelines, nutritional needs and the available budget. The NMS procurement plan would then be approved by the Board of Directors before onward submission to the Permanent Secretary/ Secretary to Treasury (PSST) and PPDA as prescribed by law. Once procurement is initiated by the relevant department, the quotations from potential bidders and Market surveys would be rolled out and valid contracts will be handed over by the relevant department.
c) Delivery at the airport would include the logistical, transport, packaging, freight and clearing costs. Additional handling fees would be charged by NMS to transport the MNP to the health facilities. After drugs have been stored in NMS stores, the push orders by Ministry of Health would be received by Customer Care Assistants, who check the orders for authenticity. Facility procurement plans determine the required quantities which further go through a clearance and clerical procedure of collecting, matching and fling the necessary documents.
d) Once the product has been delivered at the facilities, the health personnel at the District Health Office would be responsible to manage the distribution of MNP sachets in the community. This would be done in coordination with the staff at Health facilities or the VHTs. Training of VHTs by the District team, review meetings with VHTs and community forums would be organized by the team at District level.

"If the District Health Team was to distribute MNP from the district store to VHTs, costs would be incurred in the areas of transport to the health facilities, allowances for technical officer and driver. Rate per day: 20,000/= for the officer and 17,000/= for the driver and fuel depending on distance"

- *Ministry of Health official, District level*

Given the validation and reporting requirements built into the national procurement process, we expect that the cost to procure, manage, and distribute MNP through the centralized NMS will increase costs relative to procurement by an NGO like BRAC. This finding is consistent with SPRING, 2016. The large number of approvals, the need to engage different Government departments within the Ministry of Health (at the central, district and facility level) and NMS would increase the number of personnel involved in the process and the administrative costs relative to the CHP delivery model. The CHP delivery model uses fewer personnel and does not require the same degree of approvals and clearances.

In the NMS/VHT model, once MNP is procured, it is then delivered to health centers and to the volunteer corps of VHTs for distribution to the community. During delivery, VHTs will incur opportunity cost to collect and distribute the sachets from the health facilities. In the absence of incentives, or reimbursement, employment benefits, insurance or profit frameworks, these costs to VHTs may be substantial.

Additional costs include monitoring to ensure VHT's follow correct procedure and that sachets are not stolen/displaced at any stage.

The sustainability of the NMS/VHT model may be in question because health facilities may not prioritize the purchase of MNP in the first place, given the limited budget for distributing the free MNP sachets in the facilities.

In comparison, the CHP delivery model does not incur opportunity costs for personnel to deliver MNP, rather it shifts that burden on to households who are willing to pay out of pocket for the expense of MNP. The CHP incentive structure thus, directly rewards CHPs for delivering to the last mile and may therefore be more sustainable.

"If programme is introduced, there is a need for a partner to support motivation of VHTs who are volunteers. e.g., VHTs under the ICCM programme get 30,000/= per quarter."
-Ministry of Health, District level

2- Government collaborates with other agencies and distributes through Health facility OR
3- Government collaborates and distributes through VHTs

The costs associated with VHTs and facility based delivery model were analyzed in a recent study conducted by the United States Agency for International Development (USAID). USAID's Strengthening Partnerships, Results and Innovations in Nutrition Globally (SPRING) project was implemented in Namatumba district in rural Uganda. The study evaluates the costs of MNP delivery over three years using two delivery platforms: (i) facility-based delivery where caregivers receive MNP at a health facility and a (ii) community-based delivery using the volunteer village health teams (VHTs) (SPRING, 2016).

Under this delivery mode, SPRING partnered with Uganda's Ministry of Health to procure and deliver around 2 million MNP sachets to the health facilities in Namatumba district during February-December 2016. SPRING trained health workers and VHTs in distributing MNP

sachets to the community. Sachets were distributed to mothers who came to the facilities for postnatal care and other check- ups. VHTs picked up the sachets from the facility to distribute in the community. Unlike the scope of the present feasibility study which focuses on children between 6-59 months of age, the SPRING study focused exclusively on younger children between 6-23 months.

The cost to implement SPRING included monthly fixed costs; procurement costs; capital investments (including training of relevant staff members); monitoring and evaluation costs; capacity building, logistics and communication activities and opportunity costs for reaching last miles and engaging in other activities. The SPRING study measured cost-effectiveness by calculating the total cost of the program divided by the total number of packets delivered by VHTs.

Table 6: Cost per MNP packet

	Total Sales (Sachets)	Total program cost	Total Program Cost per Sachet Sold
VHTs*	277,396	$ 1,797,517	$ 6.48
Facility-based	87,538	$ 1,225,133	$ 14.00
CHP model**	60,000	$ 86,667	$ 1.44

*VHTs and facility based estimates have been acquired from SPRING, 2016

**Predicted estimates from Table 5

At the offset, program cost per sachet sold is lower for BRAC CHP model. However, differences in the inclusion/exclusion costing criteria and variation in programme delivery (1 district covered by SPRING vs 3 districts in CHP model) make it difficult to compare differences in the total cost of the different MNP delivery models we have outlined here in Table 6.

First, SPRING implemented the MNP program at a much larger scale, over a longer duration (three years) and focused on distribution in a single district. In comparison the BRAC CHP program delivered 7065 sachets over 3 months across three districts and would have delivered 60,000 sachets in 25 months based on predicted estimates in Section 5.3. A direct comparison of costs would require us to estimate the CHP program cost at scale, for a single district which is similar to Namatumba in levels of anemia prevalence and nutritional deficiency among children. The challenge of this modeling exercise is that BRAC CHPs do not cover all the villages within one district and the scale costs will be non-linear. The MNP distribution time was also limited for us to estimate a rate of distribution at scale. In addition, limited sales data which explain the varied uptake across three districts outlined in Section 5.2, make comparisons difficult.

Besides, the most essential differences lie in measurement of opportunity costs, dosage recommended per child (CHP model recommended one dose every other day for 90 days whereas SPRING project recommended one dose every other day for 30 days), suppliers and coordination activities. An effective numerical comparison among the two studies will require additional data inputs to be valid, which is beyond the scope of this study.

The comparison of costs and activities enables us to identify key cost drivers which affect cost-savings at scale up.

1- Opportunity cost and incentive structure for distribution in the community

One of the key differences between the VHT and CHP delivery models is how MNP is delivered to households. The opportunity cost in the VHT delivery model and the incentive structure of the CHP model affect total program costs and change the incentives for delivering to the last mile. Since the VHTs are community volunteers and don't earn profits from the distribution of MNP, the opportunity costs to them are much higher. In comparison, CHPs earn a profit on every sale after 2 ¼ boxes, and they are further offered an incentive of USD 8 per month (equivalent to profits earned by selling 98 sachets of MNP) for reaching around 80% of the households in their village. This incentive cycle kicks in three months after the initial programme roll-out (as a result, it does not enter into our estimates of total program cost as MNP was delivered in this feasibility study). Thus, under the MNP model of delivery, the cost burden shifts from the volunteer to the households that purchase MNP for their use. This model of delivery is feasible as long as households are willing to pay for MNP.

Another key aspect in financial feasibility of the two models is the underlying difference between free distribution and purchase of the MNP product. VHTs model would result in higher coverage of under 5 children whereas the distribution for sale of MNP for CHPs might follow a non-linear trend conditional on the purchasing power of the communities being targeted.

2- Quantity, Country and supplier source of the MNP product

SPRING procured MNP from Fortitech premixes which is a US-based supplier. The unit cost of the MNP sachet was USD 0.025/sachet. In contrast, BRAC procured MNP sachets from South Africa at a unit cost of USD 0.035/sachet. Although both MixMe and Fortitech are manufactured by DSM, it may be possible to secure MNP at a lower cost from a different supplier or at a higher quantity. In addition, the country of supplier, nature of storage facility and existing organizational capacities to distribute the packets will affect total procurement costs. It is difficult to estimate how the procurement cost would vary if BRAC would have procured 277,396 sachets like SPRING. We assume that the costs per MNP sachet would go down as the quantity of procurement increases, however the exact estimates cannot be obtained to rightly compare the two projects. Similarly, logistics, personnel, freight and transportation costs would vary, the distributional trends for these costs are hard to predict and would require a considerable number of assumptions.

3- Context of distribution of MNP and the existing nutritional needs

The underlying prevalence of Anemia, demographic characteristics of the community including number of children under five, fertility rates, socio-economic status of the households will affect the cost-effectiveness of the two models. Table 3 exemplifies this point by outlining the disparities in sales among the 5 branches. As mentioned in Section 5.2, low levels of purchasing power of the households and community acceptance might be the key drivers for

low coverage in Bundibugyo and Nyahuka. However, additional data is needed to determine if household willingness to pay is a binding constraint on the feasibility of the CHP delivery model.

8. Cost evidence on MNP and discussion

This project costed USD 0.035 per MNP sachet compared to 0.025 per MNP sachet procured by SPRING. The World Food Programme (WFP) estimates the cost of procuring one MNP sachet is between 0.015 and 0.035 USD per sachet, depending on the quantity of sachets ordered, the composition of the mixture and the site of production (WFP, 2009).

A report from UNICEF indicates that a box of 30 sachets of 1g MNP would cost USD 0.55 (USD 0.018 a sachet) (excluding all programmatic and freight costs). The report argues that it would cost approximately USD 1.65 to provide MNP for one child in accordance with WHO's suggested guidelines of no more than 90 sachets per child over a six-month period (UNICEF, 2020). We estimate this cost to be USD 3.15 (USD 0.035*90) for this study upon excluding all programmatic implementation and freight costs. Including the programmatic implementation and freight costs, our estimated costs go up to USD 65 per child for treating one child every other day for 90 days. SPRING, 2016 estimated this cost to be USD 52.66 per child for one MNP sachet every other day for 60 days using the VHT model and USD 66 per child for the facility based model. However, due to reasons mentioned in Section 7.2 and different dosage, these estimates are not comparable.

9. Limitations and areas of further research

This costing study did not have an accurate estimate of the cost to store MNP at the district level. Once MNP leaves BRAC's offices in Kampala, it must be stored at the district offices until CHPs require re-supply. We assume minimal storage costs because MNP boxes are relatively small, occupy little office space and do not require refrigeration.

In addition, we are missing data on the opportunity cost for five external representatives from Uganda's Ministry of Health to participate in the MNP trainings and to advise on procurement (Ministry of Health officials received a travel reimbursement for their participation in the 2-day trainings).

As outlined in Section 5.3., our sales estimate for the remaining inventory of 52,935 MNP sachets is linear. In the absence of additional information to estimate caregiver willingness to pay, it is difficult to know how to model future sales. However, a careful study of caregiver's willingness to pay drawn from a representative sample of caregivers stratified by socio-economic status would help to fill the knowledge gaps discussed in Section 5.4. Relatedly, CHP's may experience greater opportunity costs as their travel and transportation costs increase when providing services to more remote areas. Without additional study it is difficult to know if recipient's needs are the highest in remote areas and to decide if BRAC should further

incentivize CHPs to reach beyond 80% of households in a village. An area for further research will be to assess the effects of contextual factors such as population density, market size, anemia prevalence, purchasing power of the households and diminishing returns to additional sales of MNP as CHPs' broaden their reach (Nyqvist, M.B. et. al. 2020).

SPRING, 2016 also assessed the feasibility of MNP in Uganda. However, it is difficult to compare the cost of the SPRING and BRAC MNP programs directly because the level of sales and program size are non-comparable. SPRING was implemented in a single district whereas BRAC was implemented in three. In addition, the categories of program cost do not appear to be directly comparable.

Also missing are data on caregiver's compliance with MNP consumption procedures and the use of the MNP by the community. Additional information on knowledge and uptake parameters can help us predict the relationship between sales and likelihood of uptake, and compliance with MNP.

As outlined in Section 6, the benefits of MNP distribution through the CHP model cannot be assessed at this stage. Since this study did not directly measure the health benefits of the intervention, future research can experimentally vary the price of MNP product and measuring the benefits to childhood anaemia and malnutrition at the caregiver level.

Detailed population level data is required to effectively understand district-level demand for MNP and to predict the cost to scale the program to the national level. It is not feasible to conduct a budget impact estimate because we lack population data needed to multiply the true "unit" cost of the intervention by the number of people affected (UDVA, 2020; Sullivan, 2014). While the UDHS 2016 includes data by region, district level data on population distribution and prevalence of child malnutrition is sparse. Similarly, although we know that CHPs visited 9600 households and sold 7065, we do not know the proportion of households with children under five nor do we know how many sachets each household purchased.

The inputs needed to replicate the CHP model in an adjacent district include an existing BRAC branch; the community's trust in the CHP; and data to estimate the needs of the nearby population. We expect scale costs to increase substantially with the cost to open a new BRAC branch (the estimated cost to open a similar Living Goods type branch was $19,000 in 2018).

If population density and anemia prevalence vary significantly, this model may fail to accurately predict. Population density of the district served may affect the average cost to deliver MNP. The cost driver of the increased cost to reach last mile households is the CHP's travel cost and visit frequency and whether households at last mile can afford to purchase the quantity of MNP needed to treat a child (at the needed dose or frequency). If CHP's are motivated to make a small profit, and it effectively costs them more to reach last-mile households, will they be able to sell the same number of MNP packages? Average cost (MNP) = (cost per branch * number of branches) / (population density * anemia prevalence * treatment coverage).

Ferris,2020 find that the pricing of MNP is a barrier to uptake and sales, with only higher income households purchasing the product. Findings where the community members asked credit from CHPs to buy MNP and proposed lower retail prices for the product for higher affordability, will have implications on the sale of MNP in the community and the costs of delivering the product at current prices.

Additional tracking of MNP product sales, and better insights into the purchasing power of the community will be key to helping BRAC determine the price needed to get more widespread community take-up.

10. Conclusion and recommendation

Conclusion

This study is among the first to explore the costs of providing MNP through an existing Community Health Promoter Program. It evaluated the total costs incurred by BRAC for delivering MNP through CHPs and assessed the costs to scale up the program to adjacent districts with similar population composition. The estimated total cost of training, procurement, transportation, and distribution of 60,000 MNP sachets is found to be USD 86,667. Costs per child treated for delivering MNP through CHP model are predicted to be USD 65, if all the 60,000 procured sachets were sold at the given rate. The cost per sachet sold would be USD 1.44.

The study estimates the cost to scale up the CHP model to adjacent districts in Uganda with similar levels of anemia prevalence, and with similar population densities to be USD 21,769 (for three districts) or about USD 7,265 per district. Care should be taken by policymakers while assessing the costs of expansion. This cost is subject to the district having an existing BRAC branch, established relationships of CHPs with the community and similar BRAC operations.

Comparisons across different modes of delivery for MNP distribution reflects greater costs of procurement, VHT opportunity costs and monitoring and evaluation costs if the Ministry of Health scales up the intervention on its own. To our knowledge, the only other cost estimate in Ugandan context comes from the SPRING 2016 study, which estimates a total cost of USD 6.48 per sachet sold and USD 52.66 per child treated using a VHT based delivery model, and a cost of USD 14 per sachet sold and USD 65.97 per child treated to deliver through a facility in Namatumba district. However, a direct comparison between two studies is limited because of variations in exclusion/inclusion criteria on programme costs, differences in scale of the intervention and sparse information on distribution of sales over time for expansion in district. The two models differ by varied opportunity costs among VHTs and CHPs and financial sustainability.

The study is limited to evaluate the budget impact and cost effectiveness of the intervention because of sparse data on population composition, purchasing power, CHP sales, compliance

of MNP and benefits of MNP consumption exists for the study. We leave these questions for future research.

Recommendation

This study has shed light on the costs of delivering MNP through BRAC CHP platform. The cost estimates can act as a reference for policy makers while implementing the MNP program in districts similar to the geography and population of the three districts included in this study. The research concludes that it may be less efficient for the government to deliver MNP on its own and it should carefully consider the costs of partnering delivery agents. While assessing the most suitable delivery mechanism for MNP, government should critically evaluate the opportunity cost and incentive structure of delivery agents, cost of supplier and source of shipment and context where MNP to be distributed.

It recommends using CHP model to distribute MNP because it is a cost-effective, sustainable, and community-owned option for promoting nutrition for children. Structurally, it is in align with related health policies for children' health and other health system plans in Uganda like CHP related policies. Similarly, to consider its roll out in other countries like Uganda, it might need to contextualize the learning of this project at every level of implementation cycles – landscape analysis of the country for MNP (Ferris 2019), feasibility assessment of MNP distribution through CHP (Ferris 2020), and operational guideline for MNP distribution through CHP including the information education and communication (IEC) materials (Ferris 2020)

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