Original Article

Community-based grain banks using local foods for improved infant and young child feeding in Ethiopia

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Abstract

The first thousand days of a child's life are critical for ensuring adequate nutrition to enable optimal health, development and growth. Inadequate infant and young child feeding (IYCF) practices likely contribute to Ethiopia's concerning malnutrition situation. Development partners in four regions of Ethiopia implemented community production of complementary food with women's groups processing local grains and legumes at grain banks to improve availability, accessibility, dietary diversity and timely introduction of complementary foods. The objective of this study was to establish the acceptability, perceived impact, feasibility and required inputs to sustain local grain bank interventions to improve IYCF. A subsidized barter system was used by mothers in the rural communities, and flour was sold in the semi-urban context. Purposive sampling guided the qualitative study design and selection of project stakeholders. A total of 51 key informant interviews and 33 focus group discussions ($n = 237$) were conducted. The grain bank flour was valued for its perceived diverse local ingredients; while the project was perceived as creating labour savings for women. The grain bank flour offered the potential to contribute to improved IYCF; however, further dietary modification or fortification is needed to improve the micronutrient content. Dependence upon external inputs to subsidize the barter model and the reliance on volunteer labour from women's groups in the rural context are the greatest risks to sustainability. This intervention illustrates how integrated agricultural and health interventions leveraging local production can appeal to diverse stakeholders as an acceptable approach to improve IYCF.

Keywords: nutritional interventions, complementary feeding, community-based, qualitative methods, infant and child nutrition, international child health.

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Introduction

Despite making many positive strides over the last two decades, Ethiopia's infant and under-five mortality rates remain among the highest in the world. Underlying the mortality and morbidity is unacceptably high undernutrition, estimated to contribute to 45% of child deaths (Black *et al.* 2010). Rates of stunting, wasting and underweight among children under 5 years of age are 44%, 10% and 29%, respectively (Central Statistical Agency (CSA) Ethiopia & ICF International 2012). Although there have been improvements over the last decade, Ethiopia has among the highest rates of malnutrition in sub-Saharan Africa (ICF International Inc 2013).

Complementary feeding practices in Ethiopia are generally inadequate, with only 4% of children meeting all World Health Organization (WHO) infant and young child feeding (IYCF)-recommended practices (Central Statistical Agency (CSA) Ethiopia & ICF International 2012). Late initiation of complementary feeding is one such challenge, with just over half of children 6 to 9 months of age receiving complementary foods (Central Statistical Agency (CSA) Ethiopia & ICF International 2012). Furthermore, 95% of infants and young children in Ethiopia do not meet the recommendations for dietary diversity, with mono-crop production and consumption for many households (Central Statistical Agency (CSA) Ethiopia & ICF International 2012; Aemro *et al.* 2013). The first foods

given are often thin and watery cereal-based gruels and cow's milk (Alive & Thrive 2010a,b; The Manoff Group 2014).

Interventions have shown mixed results in improving feeding practices and growth when reviewed under five broad categories: education alone; food alone; food and education; fortification; and increased energy density (Dewey & Adu-Afarwuah 2008). In the context of greater household food security, nutritional educational interventions that enable health workers in appropriate counselling and support for IYCF can impact child nutrition and growth (Guldan *et al.* 2000; Penny *et al.* 2005). Where household food insecurity is widespread, interventions with a combination of education and food provision have been more effective than either activity alone (Bhandari *et al.* 2004; Roy *et al.* 2005).

Global strategies to improve IYCF recognize the potential cultural, economic and social values of interventions that promote local foods, as well as the role of the agricultural sector in ensuring nutritious local foods are available for consumption (WHO & UNICEF 2003). Evaluations of small community-based interventions to process and provide local ready-to-use fortified supplementary foods suggest promise in increasing availability of nutrient-dense complementary foods but results on impact on growth are mixed (Ouèdraogo *et al.* 2009; Jilcott *et al.* 2010). Measured direct impacts of larger-scale agricultural interventions on child nutrition are not widely available in the literature, and the evidence base is inconclusive to the impacts (Ruel *et al.* 2013); however, projects are more likely to impact nutritional outcomes when they consider gender and invest in behaviour change nutrition education activities (Berti *et al.* 2004). The acceptability and feasibility of integrated nutrition-sensitive agricultural and

nutrition-specific health interventions to improve IYCF are not well documented.

The objective of this current study is to identify the acceptability, feasibility, required resources for sustainability and perceived potential for an intervention to improve complementary feeding in rural and semi-urban Ethiopia, in four regions with variation in food security, through local production of complementary food at community grain banks, using local grains and legumes as part of an overall IYCF strategy.

Methods

Intervention overview

As part of broader efforts to improve IYCF, the United Nations Children's Fund and Food Agriculture Organization with local universities and community leaders designed and initiated a pilot project in 2012 to establish local grain banks to produce affordable complementary food using local ingredients in four regions of Ethiopia. Following formative research, the pilot project was implemented with distinct management models for rural and semi-urban settings. In both cases, the product distributed was milled flour with a 3:1 ratio of grains to legumes blend, using locally available ingredients. Production of the complementary food at the grain bank required cleaning, roasting and dehulling of the cereals (maize, sorghum, wheat and teff) and legumes (broad bean, field pea, chickpea and kidney bean); mixing and milling of the cereals and legumes in 3:1 ratio; and addition of sugar.

Recipes were adapted to available grains and legumes and were designed to contain approximately 65% energy from cereals and 25% from legumes, and up to 10% from added sugar. The intention of the grain

Key messages

- High acceptability and pride associated with the grain bank flour was attributed to the diverse local ingredients
- The subsidized barter system was considered both a major motivator for rural women to participate in the grain bank project but also one of the greatest risks to sustainability of the programme model
- Women, especially in the semi-urban area, valued the time savings generated from receiving a processed grain bank flour for complementary feeding
- The project is dependent on external resources and substantial time commitment of women in both the urban and rural models; greater incentives are required to ensure their continued engagement

bank complementary food was to be an improvement over common diets of only one cereal by adding a variety of grains and legumes and also improving absorption of micronutrients through processing techniques to reduce the phytate content. By enabling mothers to make porridge with the grain bank flour, the project aimed to have timely introduction of complementary foods, a challenge in Ethiopia. The grain bank project was also designed to serve as an entry point for other IYCN interventions such as home fortification. Health extension workers (HEWs) recommended mothers add other available ingredients to the grain bank flour, including vegetables, fruits, oils and animal products when preparing complementary food, as the grain bank food alone will not cover all micronutrient needs to make recommended intakes from complementary foods. The project also included training and guidance on safe storage and processing of the ingredients and flour at the grain bank and safe and hygienic preparation at home (Addis Ababa University (AAU) 2010).

Mothers of children 6–23 months of age accessed the complementary food through purchasing in the semi-urban model and by means of barter in the rural areas. In both settings, the community provided the space to host the grain bank production and storage.

In the semi-urban settings, women's cooperatives were recruited to work at the grain banks in the production and selling of the complementary food. Initial inputs, resources, cereal stocks, legumes, milling equipment, mixers and packaging materials were provided to the women's groups. The price of the grain bank flour was based on purchasing power of the community, with guidance from the district administration and implementing partners.

The rural grain banks trained volunteer women from the community to process and produce the grain bank flour. In most regions, this contribution was unpaid or compensated with the grain bank flour. The bartering model required mothers to bring 2 kg of cereal or 1 kg legumes in exchange for 3 kg of the processed complementary food. The pilot programme provided the additional cereals and legumes needed to meet the 3:1 cereal:legume ratio and additionally cover approximately 1 kg of losses that occurs in the processing. The programme

financed milling equipment, transportation, firewood (for roasting), scales and simple packaging equipment. Women's groups processed the flour centrally in the *kebele* (village), while the collection of grain contributions and distribution of the processed complementary food and counselling on complementary feeding were performed at the health posts during growth monitoring and promotion (GMP) sessions. Key messages in the counselling focused on encouraging beginning complementary feeding at 6 months, how to prepare the complementary food and promoting the addition of available animal source foods and nutrient-dense fruits and vegetables into the prepared complementary food.

Eight rural grain banks were established (two per region) with an average participation of 92 children under 2 years (range 38–166) receiving the complementary food, with coverage of under 2s estimated from 27–86%. The grain banks operated for approximately 12 months and provided an average of 1258 kg of processed grain bank flour, averaging 13.7 kg per child total or 1.2 kg/child/per month. Consumption increased in later months as production efficiency increased in the grain banks. The women's groups volunteering at the grain had 10–15 participating women.

In the four semi-urban grain banks, on average, they operated for 8.5 months and sold 913 kg of grain bank flour to 533 customers, at a price of 17 Birr/kg. This worked out to 0.2 kg/child per month; however, there was a huge range in consumption in the semi-urban area as several users went once, whereas others were repeat customers. The monthly income of a grain bank was estimated to be 2425 Birr (Watanabe 2013).

Sampling

A qualitative study design enabled the exploration of the feasibility, acceptability and perceived impact of the grain bank project as a strategy to improve infant and young child nutrition. Relevant stakeholders and key behaviours were identified by the development of a project implementation pathway (Fig. 1), which guided purposive sampling of the various stakeholders within the project. We intentionally recruited participants and non-participants, who were those living in intervention communities who were eligible but did not

Fig. 1. Project behaviour change impact pathway to guide qualitative analysis. IYCF, inadequate infant and young child feeding.

attend grain bank or use the complementary food. From each of the four pilot project regions, two *woredas* (districts) were selected: one rural and one semi-urban, with two *kebeles* from each *woreda*.

Semi-structured interview guides and focus group discussion guides were developed for each target audiences along both the urban and rural project impact pathway (Table 1). Following pre-testing of the questionnaires, modifications were made to reflect the intent of questions. Regional research teams were made up of one supervisor and four interviewers, who were selected based on their experiences with qualitative methodologies and proficiency in local interview languages (Tigrigna, Oromiffa, Amharic and Somali). They received participatory training on qualitative interview skills and the intention of the questions. Refresher trainings were conducted by the regional supervisors. Data collection took place from August to November 2013 following the completion of the pilot intervention.

Ethical considerations

Ethical approval for the study was granted from the regional health bureaus in Amhara, Oromia, SNNPR, and Tigray and the Ethiopia Health and Nutrition Research Institute.

Data management and analysis

The transcripts were transcribed verbatim in local languages and then translated into English, with back translation on a selection of interviews for quality control. The overall analytical framework was guided by the theory of triadic influence and, more specifically, the three streams of influence: intrapersonal, social, and cultural–environmental (Flay *et al.* 2009). Transcripts were coded by three researchers to identify specific intrapersonal, social and cultural–environmental barriers and enablers for the key behaviours in the project impact pathway (Fig. 1). Individual, community and environmental factors affecting the experiences and perceptions around the grain bank intervention were identified. Overarching themes of acceptability, perceived impact, feasibility and sustainability were explored, with comparative analysis across regions, stakeholder groups and rural and semi-urban contexts. Other emerging unexpected concepts were also identified, and feedback and interpretation were given by field teams. The lead researcher checked for intercoder and intracoder reliability with a selection of interviews. Views and experiences generally represent those of the majority; however, when diversity of opinion was expressed, this is noted in the results.

Table 1. Selection of interview questions from focus group discussions and key informant interviews

Sample questions and selected <i>prompts</i>	Target audience
Who gives advice on how to feed your baby and what do they say? • Family, friends and health extension workers	Caregivers
What do you think of the idea of a complementary food or special food just for infants and young children?	Community leaders, health extension workers, agricultural extension workers, grain bank managers, caregivers
Tell me about how you were involved in the grain bank?	Community leaders, health extension workers, agricultural extension workers, grain bank managers, caregivers
What do you think of the grain bank project? • What do you think of the complementary food produced at the grain bank?	Community leaders, health extension workers, agricultural extension workers, grain bank managers, caregivers
Can you describe the barter system and what you thought of it?	Rural: community leaders, grain bank managers, caregivers
How would you describe the availability of the complementary food produced at the grain bank for the community?	Community leaders, agricultural extension workers, grain bank managers
What did you think of the amount of food produced by the grain bank and your access to the processed food? • What is the availability of the complementary food? • How did you obtain the complementary food? • What were challenges in getting the complementary food? • How did you find the location and hours of operation?	Caregivers
What did other family members think of attending the grain bank?	Rural caregivers
Volunteering at grain bank? The complementary food?	
Tell me what you have heard about the grain bank project?	Influencers, non-participants
Why did you purchase the complementary food from the grain bank? • Who encouraged you to purchase? • What did you think of price?	Semi-urban caregivers
How did you use the food from the grain bank at home? • Tell me about preparation, quantity, frequency, who consumed it at home, taste	Rural and semi-urban caregivers
How was the semi-urban grain bank managed? • Sales, marketing, promotion, price, hours of operation, finances	Semi-urban caregivers and grain bank managers
Who gives you advice on how to use the complementary food from the grain bank?	Rural and semi-urban caregivers
What advice would you give to someone implementing a similar project?	Community leaders, grain bank managers, agricultural extension workers, health extension workers, caregivers, influencers
What do you see as the main challenges to improving child nutrition? • What are the limits to the grain bank project? • What is the potential for grain bank project? • What is required for sustainability of grain bank? • What are the roles for agriculture and health? Integration?	Community leaders, agricultural extension workers, health extension workers
What advice would you give to someone implementing a similar project?	
Tell me what you have heard about the grain bank project? • What would you think about participating in the grain bank? • Who participated and who did not? Why?	Influencers, non-participants

Results

A total of 51 key informant interviews of the 58 proposed were conducted, and 33 of the 38 planned focus group discussions were conducted. Reasons for not conducting the interviews included staff turnover or informants unavailable. Focus groups were not discussed in two instances due to security concerns. The focus groups and key informant interviews lasted 45–60 min.

The focus groups ranged from 6 to 10 participants for a total of 237 participants. Information on the participants sampled is presented in Table 2.

Description of participation in the intervention

Women described the primary motivators for women to participate in the grain bank project were related to the favourable barter exchange rate and the time

Table 2. Details of sampling by region for the focus group discussions and key informant interviews for the Ethiopia grain bank infant and young child nutrition project

Region	Amhara	Oromia	Southern Nations, Nationalities and Peoples' Region (SNNPR)	Tigray
Key informant interviews				
Community leaders and grain bank managers (<i>n</i>)	5	4	4	4
Health extension workers (<i>n</i>)	2	3	2	3
Maternal child health nurses (<i>n</i>)	5	2	2	2
District agriculture head (<i>n</i>)	2	1	1	1
Development agent (<i>n</i>)	2	1	1	1
Non-governmental organization (<i>n</i>)	1	1	1	
Total interviews	17	12	11	11
Focus group discussions				
Participant mothers (no. of groups (<i>n</i> , age in years))	2 (15, 20–45)	2 (12, 22–48)	1 (9, 20–35)	2 (13, 22–38)
Non-participating mothers (no. of groups (<i>n</i> , age in years))	1 (8, 25–40)	2 (11, 19–32)	2 (18, 20–32)	1 (7, 22–40)
Grandmothers/mother-in-laws (no. of groups (<i>n</i> , age in years))	2 (16, 37–60)	2 (12, 35–60)	1 (10, 32–68)	1 (7, 22–40)
Fathers/husbands (no. of groups (<i>n</i> , age in years))	3 (22, 27–86)	2 (12, 22–42)	1 (9, 28–48)	1 (6, 42–60)
Health development army (no. of groups (<i>n</i> , age in years))	3 (24, 19–46)	2 (11, 22–40)	1 (9, 20–40)	1 (7, 30–41)
Total focus group discussions (no. of groups (<i>n</i>))	11 (85)	10 (58)	6 (55)	6 (39)

savings. In the rural settings, caregivers were happy with the initial exchange of receiving 3 kg of grain bank flour in exchange for 2 kg of grains, as they received a higher quality and cost product and more in return and moreover recognized that there were losses in processing.

I am happy by my participation in the grain bank. The bartering system is also good and interesting. Mothers can give 2 kilos of grains that she has in her home and take the processed product for 3 kilos. This system helps mothers by reducing their workload and she is getting more than she brings, as a result all mothers are very happy on the bartering system. Participant mother, Wolenso.

Most mothers in the rural setting in Amhara, SNNPR and Tigray had similar perceptions of the barter system as being favourable in economic return and labour savings. Although not universal, in some nomadic communities in rural Oromia, the concept of bartering was not culturally acceptable, thus limiting overall desire to participate:

In this culture it's not acceptable to exchange one kind of grain by selling or purchasing the other order to balance the diet, rather they eat what they produced on their farm and their children also eat what adult family members eat. Father, Biyyo Nagaya.

Sometimes, mothers did not feel they had enough extra grains to be able to participate. In other cases, there was confusion around what type of grains were acceptable. In Azedebo when a barter rate of 1:1 was tested, very few mothers saw the value in participating, even though an improved product was received in return. In most areas, mothers did not have legumes to contribute to the bartering system and relied on the project for legumes.

Some HEWs believed that caregivers did not want to participate in the grain bank nor purchase the food initially, because they expected it to be free based on donations from previous programmes:

At first the women didn't have the right awareness about the grain bank and when we asked them to bring the grain they were not willing to do so because there is dependency syndrome, but now they are aware. HEW, Wolenso.

Participation during the pilot phase was described as biased to those who were already engaged in community events and other formalized social networks or had greater access to the health system, as the grain bank was promoted through existing women's associations and social events such as group meetings, holidays, coffee ceremonies and public works events.

Participation was promoted by HEWs during routine health visits, vaccination campaigns, GMP sessions and at the health facility.

I gave birth to my first child at Tikur Anbesa hospital. They told me to give my breast milk for 6 months. Then they told me to go and get the flour at the grain bank because it is very good. Since it is very good I am feeding my child starting 6 months till now. Now he is 1 year 3 months old. Participant mother, Kone.

Some mothers who were not invited to participate but interested had felt unfairly excluded as a mother from Meley explained: 'They said it is over the limit and deprived me from participating, they didn't inform us, why we need this program'. Non-participant mother, Meley.

In the rural sites, the grain bank was most often located in the village centre, making the grain bank less accessible for those who lived in the outskirts of the kebele. 'Some of us are coming from distant areas and we are getting tired by traveling and we found this as a constraint.' Participant mother, Azedebo. The importance of accessibility as a potential barrier was described by fathers and grandmothers as well.

The grain bank is providing good service, if the bank is not available near to us our children will live in deficiency. No one travels far distance to buy complementary food. Grandmother, Chinakson.

The semi-urban grain bank customers were described as mainly civil servants who had greater socio-economic status. Many semi-urban caregivers were very satisfied with the price of the grain bank food, and in the Amhara region, where the grain bank flour costs 10 birr/kg, some were even willing to pay more as they feared for the sustainability of the project if the price remained low. Amhara had the lowest price at 10 birr/kg, while in the other regions, it ranged between 20 and 25 birr/kg. According to semi-urban caregivers, the price of the grain bank food was less expensive than other complementary food sold on the market and perceived to be of better quality. Mothers reported purchasing between 3 and 6 kg per month, but most would have liked to purchase more. 'The amount we buy depends on our finances, but what I use is 5 kilos per month; it is not enough.' Participant mother, Kone. Periodic supply shortages were reported by the women in urban and rural areas.

The complementary food is not always available for our kids due to different problems as others said and we take it as we get. So we take 3 kilos per week if it is available. Participant mother, Wolenso

Mothers described that there were not enough volunteers in the rural area to complete the processing of the grain bank flour, even though they had contributed grains. 'Sometimes, it is not grinded, for example during weekends you may not find it prepared'. Participant mother, Hatsebo.

Access to the grain bank flour was partly determined by operating hours in the semi-urban areas; yet there was a diversity of opinions and experiences among the mothers across the regions. A mother from the semi-urban area in Wolenso described irregular and unpredictable shop hours as barrier:

The grain bank does not have its own manager who works all the time, so we get the food from the person who is assigned and since they have other jobs, they aren't available all the time. This is a problem to get the product as we want.

For some women with good relationships with the women of the semi-urban grain bank cooperatives, they described having the grain bank food delivered to their home or office: 'We get it whenever we want but if we can't get them there; they will bring it to our house'. Participant mother, Kone. Many fathers suggested that they would like to see additional distribution sites.

Acceptability of grain bank flour and perceived impact of intervention

The grain bank flour was highly valued for two attributes of the ingredients: diversity and being locally grown in both the urban and rural settings.

There was pride in the perceived quality of the food and satisfaction that it came from local products, especially in comparison with donated foods that have been promoted through previous initiatives. One HEW from Chinakson describes:

about the complementary food, what the community is saying about the grain bank product it is very good because the raw material for the complementary food is the grain that is produced in the area and it doesn't have

fluctuation in cost to get the raw material and to be produced. They can just bring together whatever they produce in their land. Because of this and other things they are very happy about the grain bank.

The pride was associated with the local products both for cultural value of the food and the economic potential of using local agricultural inputs over purchased imported foods or donated foods.

The HEWs and Health Development Army (HDA) themselves described having participated in the grain bank or having purchased the grain bank flour. They appreciated the time savings of not having to go to the mill and also felt the flour was produced safely:

Concerning the quality of the complementary food, it is very good quality, and I give it attention because it is my job and you do not see any dirt, and the milling machine is clean and they do not use it for other crops. HEW, Adilo.

The main attribute that generated pride by all stakeholders was the concept 'grown in our own land', which was perceived as an indication of quality and freshness.

In semi-urban areas, women compared the grain bank flour with other commercially processed complementary foods and suggested that the improved labeling and packaging would improve the appeal of the grain bank flour.

It has to be like Axum's containing 12 different cereals; it has to add more food than Axum's and the foods mixed in the complementary food should be written on the packages. Participant mother, Mahibere Selam.

Willingness to pay in the semi-urban area was primarily driven by time savings of producing the flour from a variety of local grains:

The composition of the complementary food is more than 17 types. We don't have time to wash and crack and so on. Before the grain bank was opened I bought the flour from Woldiya, 15 birr for half a kilo. Now when they sell it for 10 birr a kilo I am always confused about how it is profitable for them. So it is good. Participant mother, Kone.

Time savings to preparing the many grains was also recognized in the rural setting:

The government brought this to save our energy, because we are mothers of children, we don't have time to do it. So when we bring the grains and take the flour, our energy will be saved. Caregiver, Woyni Durbete.

Some non-participating mothers in rural and semi-urban sites benefited from training on the preparation of the grain bank flour and made the flour themselves at home. In Oromia, semi-urban mothers who were preparing the food at home intended to use the grain bank in the future to save time.

Mothers who had used the grain bank food were motivated to continue giving it to their children based on perceived benefits to their child's health: 'We have seen the health benefits of the complementary food on our children. Our children are gaining weight and look bright and relaxed.' Participant mother, Azedebo.

Feasibility of intervention to improve IYCF

The concept of complementary feeding was not part of the traditional IYCF practices within these communities. This was identified by health workers as one of the greatest challenges to ensuring that sufficient quantities of the grain bank flour were given to infants and young children as part of overall efforts to improve complementary feeding practices.

Although the term complementary feeding was known, it was primarily recognized in areas where HEWs have performed promotion and outreach. However, the understanding of complementary feeding was often perceived as equivalent to 'balanced diet' and in some cases as 'supplementary feeding'. The concept of giving specific foods to children in the complementary feeding phase (6–23 months of age) was non-existent prior to the grain bank project and in many areas without the active presence of HEWs.

We eat whatever we get at home. Injera. I give to my child mostly milk. We see how people who are in our surroundings take care of their children and how the child grew up. We do exactly what we see from people. Mother, Fugnan Ijiba.

In areas where the HEWs have been more active, women were aware of the recommendations of exclusive breastfeeding (EBF) until 6 months of age and introduction of complementary foods:

They tell us to give only breast milk until 6 months. We are told not to give even water for children before 6 months. After 6 months we must feed them by making porridge which is made from different cereals. Mother, Meley.

However, HEWs explained that awareness of recommendations was not followed by practice: 'There are no separate foods for the babies; they were eating just what the adult family members eat in the house...As a result it's difficult to harmonize the differences.' HEW, Biyyo Negaya. They described additional challenges in promoting the addition of fruits, vegetables and animal source foods to the complementary foods.

As the grain bank flour was perceived as high quality, it was given to other vulnerable groups including elderly, pregnant women, lactating women and the sick. For many families, the concept of giving it just to the child was not fully accepted and sharing with other family members was common, even though families understood the child to be the intended beneficiary: 'All the family, me and the child consume the food. But most of the time we pay attention to the child'. Participant mother, Kone.

Advice and support for complementary feeding

Health extension workers received training on complementary feeding and felt it was their role and responsibility to inform the community about child nutrition and the grain bank project including teaching mothers about the use of the grain bank flour. They also described that the existence of the grain bank helped them in their goal to reduce malnutrition. Most HEWs considered the promotion and participation of grain bank activities as part of their assignment. GMP sessions and individual visits were cited as opportunities to discuss complementary feeding. They engaged the HDA volunteers in outreach, including educational demonstrations and health talks with mothers' groups.

The community respected the HEWs' advice, and caregivers described them as the most trusted source of health information. As one nurse in SNNPR described: '...there is intimacy between the health extension workers and the mothers'. The majority of HEW and HDA were confident in their capacity to change mothers' complementary feeding practices. They felt that their closeness put them in a good position to refer mothers and promote the grain bank flour: 'Mothers listen to us better than others, comparatively and they also show interest to change what we tell them into action, and they come back and ask us'. HEW, Azedebo. In contrast, the volunteer HDA suggested that they did

not experience the same level of respect, and their advice was not as valued by mothers compared with the HEWs.

Health extension workers believed in the potential social and nutritional benefits of the grain bank project and took on roles in distribution at GMP sessions and sometimes delivered to women's homes. Most HEWs felt motivated and committed to the grain bank project, even though it increased their workload as one HEW explained:

I feel very good on my participation in the grain bank because the grain bank is helping the community well and the grain bank is contributing to the wellbeing of the community by minimizing the prevalence of malnutrition. HEW, Chinakson.

In most settings, but especially where organized women's groups were absent, informal social networks of family and neighbours were most influential in child feeding. Grandmothers, specifically mother-in-laws, were a major source for advice and influence on complementary feeding, and they took pride in this role. Although described in both settings, their influence was strongest in the rural areas, where they had more contact with daughter-in-laws. Many grandmothers described changing their opinions and perceptions of the importance of IYCF after participating in events and campaigns with the HEWs. Where grandmothers were aware of the grain banks and directly informed of its existence, they advised their daughters and daughter-in-laws to participate: 'We and the HEWs tell mothers to participate in the program telling the benefit they may get from the grain bank when we meet at "Edir"'. Mothers-in-law, Degakedida. However, when grandmothers were not directly informed about the grain bank, they did not have an equally positive perception of the project and felt excluded.

Health extension workers' role in encouraging recommended IYCF practices was made more challenging when mothers received conflicting advice at home:

... when you advise them they may not accept our advice because they have their own knowledge from their elders or traditional values. Some mothers absorb what we advise and implement it, but others may not take our suggestions because their level of awareness is not the same and they

are highly influenced by traditional advice. HEW, Biyyo Negaya.

Importance of engaging fathers/husbands

Although not the primary source of advice around complementary feeding, husbands were involved in deciding whether a woman could participate in the grain bank barter system using family grains, volunteer at the grain bank or, in the case of the urban settings, participate in the grain bank cooperative and purchase the grain bank flour. Some were targeted with messages on complementary feeding at village agricultural meeting, but very few fathers had been directly targeted with information about the grain bank project.

We couldn't get information about how to prepare the flour and from what kind of grains it is prepared, since we weren't involved in any meetings. But now if we get awareness about complementary food we will discuss about it and advise our family and also encourage them to participate in all meetings. Father, Wolenso.

For many households in rural and semi-urban sites, decisions about household food purchasing were made by the mothers through discussions with their husbands. Most mothers felt that they could convince their husbands on what was necessary for the family, and they faced little resistance currently, compared with the past. Contributing grains harvested by the family for the barter system would traditionally have been a decision made by men. In most regions, joint decision-making was described as a positive change for the current generation of parents: 'During our mothers' time, who decides and buys was the husband only, but these days we are able to decide together'. Participant mother, Kone. However, in SNNPR, although mothers discussed with their husbands, many respondents said that their husbands made the final decisions: 'The husband makes the decision. You cannot decline his decision. Therefore my husband decides, I accept.' Mother, Azedebo. In rural SNNPR, some husbands feared gossip if their wives were to participate in activities such as the grain bank.

Engaging husbands was an enabler to women's participation in the grain banks, as husbands were concerned of the time commitments:

Before it became clear for us, we were considering our wives as if they were wasting their time on nonsense when they were coming to the grain bank. But now we have realized that the grain bank is meant for the benefit of our children and ourselves. Father, Degakedida.

Fathers saw value in both time savings and the barter ratio:

It is very good and helps the mother by reducing the work load and it helps her because she gets 3 kilos for 2 kilos; that put her on top and benefiting her family. Her baby is fine and she can invest her time on other productive work in the house. Father, Wolenso.

However, husbands in rural settings were less convinced of the benefit of women volunteering their time: 'We have arguments at home about payment. They say to me, why you work for free when people in the kebele are paid.' Participant mother, Azedebo. Some other community members held this same view: 'Some neighbors say: why do you go there leaving your children and your cattle and home for nothing?' Participant mother, Azedebo.

Semi-urban husbands viewed the grain bank flour to be of good value:

My husband supports it, they say it's great, go on it is very good, it is very good when I told them that one kilo is sold 10 birr. They say: how could they be profitable? Participant mother, Kone.

Perceived sustainability of the model

The concept of sustainability is on the minds of implementers, grain bank volunteers and community members.

Caregivers who volunteered in the grain bank processing in rural settings had expectations of financial incentives and compensation for their time. One of the participating mothers in rural SNNPR stated this clearly while most other mothers were more subtle in their responses: 'We mother participants need to see the grain bank much developed. We would also need to get some incentives'. Participant mother, Azedebo.

In some semi-urban grain banks, incentives were initially provided, but there were gaps in payments before the grain banks were profitable:

We are not getting any benefits for ourselves but we are making our community better off. We are not getting any income but previously we used to get per diem. We were paid 35 birr when we were roasting and preparing but it has been about six months since we have been told to be self-sufficient. Currently even if we do not get benefit, we decide to continue our service for one or two years not to hold back the community. GBM, Hatsebo.

In the rural area, there was division over whether capacity building, material incentives, free complementary food or financial incentives were most appropriate. The current motivation for the grain bank managers and women's groups was primarily social recognition and pride in contributing to community well-being:

We don't have salary, we are working for free. I said don't you think that if we work this for our home we would be profitable? I said if we work hard for today and pay the sacrifice we will be examples for others. GBM, Kone.

Many community leaders and grain bank managers described a sense of ownership for the project.

In a context where several NGOs are working and some previous initiatives were perceived as short-lived, mothers felt reluctant to participate as they questioned the long-term commitment of the project: 'We thought this one (project) would not continue because there were some which started but did not continue.' Non-participant mother, Adilo. An HEW said these perceptions created challenges for engaging communities in a new project: 'Some of the non participants community members have no positive thinking on the grain bank, and think it is a hopeless project and may not continue in the future'. HEW, Adilo.

In Amhara, SNNPR and Tigray, the agricultural and development agents felt that there were adequate amounts of grains and pulses produced in the communities to sustain the grain banks, but the costs varied and legumes were not always locally available:

There is no problem of accessibility of grains in the kebele since grains are produced in the kebele but there is a problem for legumes which are imported from other places. Due to shortage of legumes the production of food is disturbed

and mothers who come to the grain bank may lack the food as they want. District Agriculture Head, Chinakson.

In order to assure the supply and overcome the scarcity of legumes and some grains, the grain bank managers and community leaders felt that external support and improved mechanisms for domestic trading of legumes from other parts of Ethiopia were needed.

Despite implementation challenges, the project had support from both the agricultural and health sectors, was seen as a key example of cross-sectoral integration and was frequently described as 'a key strategy to improve food security'. Agricultural agents saw the grain bank project as an opportunity to train farmers on crop diversification and saw potential for market expansion by selling produce to the grain bank:

We have discussed to enable farmers use the opportunity created by supplying the crops where there is scarcity. For instance, they could sell to the grain bank beans, barley, peas etc. It is even better to sell it because the food is prepared for their children. We are trying to work on that currently to make farmers sell their crop to the grain bank. DA, Adilo.

Resources required for grain bank

The grain bank managers, community leaders and participating women all felt that additional refresher training or supervision would be helpful in supporting the grain bank processing:

Without continuous training and practices it could be forgotten. If you train today and don't apply it practically, it will be forgotten through time...I think training is useful to motivate. GBM, Hatsebo.

The semi-urban women's cooperatives mentioned the need for additional support and expertise to promote and market the grain bank flour, develop and manage a sustainable business, and navigate legislative issues around selling processed food, in addition to more of the food safety training they were receiving. One grain bank manager compared the flour demand with a commercial product but explained the constraints:

We'll sell it like Axum. But we don't sell at shops because it is not legal. We processed so much to make it legal and we spent much money. But the worda could not accept it. GBM, Mahibere Selam.

Cooperatives also wanted support with packaging and labelling to make the product more appealing. One group found creative ways to generate demand by providing 'taster' introductory samples, while others developed a local branding named 'Edget Lehistanat almi migib' (Nutritious food for child growth).

Discussion

This qualitative study reports on the internal, social and environmental influences that shape stakeholders perceptions of the acceptability, perceived impact, feasibility and resources required for sustainability of a community grain bank project to contribute to improved complementary feeding using locally produced ingredients.

The grain bank flour was valued by communities for the inclusion of a diversity of local grains and pulses and specifically by beneficiary women for potential labour savings. With the engagement of both the health and agricultural sectors, the use of local crops provided a key opportunity to link the agriculture sector to this nutrition-specific IYCF project. Whereas the need for more evidence for agricultural interventions to impact micronutrient nutrition remains (Berti *et al.* 2004; Lutter *et al.* 2013; Arimond *et al.* 2011; Ruel *et al.* 2013), this qualitative assessment of the Ethiopia grain bank project suggests a high potential for acceptance of food produced for complementary feeding, labour saving for women and multi-sectoral engagement.

Acceptability stemmed from the value that community leaders, agricultural workers, health workers, mothers, husbands/fathers and grandmothers attributed to the grain bank flour for its diversity of local grains and legumes and preferred it to imported donated supplementary foods. The cultural value of local food and biodiversity to support nutrition is critical to the acceptance of this intervention (Johns & Sthapit 2004). Demand often exceeded the availability with the sharing of the grain bank flour to other family members, a practice also observed in programmes with donation of supplementary foods (UNHCR/WFP 2009). Sharing is perhaps greater in this context without a local conceptualization of complementary feeding. Like in many other settings, grandmothers were identified as

an important influence in what foods were fed to young children (IYCN: The Grandmothers Project 2011); however, grandmothers were not targeted directly with behaviour change interventions on IYCF, emphasizing an opportunity for future interventions.

The grain bank flour produced in this intervention has the potential to increase the nutrient composition of diets and modestly improve dietary diversity by ensuring children get a variety of cereals and legumes and also enable timely introduction of semi-solid foods. Processing of complementary foods has improved the nutrient content and can reduce compounds that inhibit absorption of minerals (Oumarou *et al.* 2005). The grain bank flour fell short of increasing the food diversity beyond the two food groups, namely grains and legumes, and meeting micronutrient needs (World Health Organization (WHO) 2008). In food-secure contexts, the grain bank food could be further enriched by adding available nutrient dense foods, including animal source foods which are known to be important for child growth (Marquis *et al.* 1997). In food-secure contexts, interventions have improved child diet growth through promotion of diverse local foods (Dewey & Adu-Afarwuah 2008; Shi & Zhang 2011). However, in the context of this intervention in Ethiopia, small-scale or home fortification is required to further improve the dietary quality and bring infants and young children closer to meeting their recommended micronutrient intakes, as has been demonstrated in an intervention in Zambia with locally produced enriched foods (Gibson *et al.* 2011). The grain bank flour complementary food can serve as an entry point for home fortification and other dietary modification. The level of production would need to increase beyond that of the pilot project phase to increase the amount per child and also compensate for sharing.

Beyond nutritional benefits, the grain bank intervention was highly valued by women for the potential time savings for those who exchanged grains for processed flour in the rural areas or those who purchased the processed flour in the semi-urban setting. Agricultural interventions with the potential for labour savings for mothers have been credited with potential for positive impact in the first thousand days (Hertforth *et al.* 2012). However, it will be important to ensure fair compensation for women who spend time and energy on processing and producing the grain bank flour. A

business model with job creation for women could offer added benefits.

Feasibility of implementing the project at scale to have a potential impact on improving a child's nutrition depends on a guaranteed supply of legumes, grains and labour. The subsidy in the rural barter model used in this project was a motivator for women to participate in the project and generated support from their husbands in most regions; however, it is not sustainable without external inputs and economic resources from donors. This project offers an alternative implementation model to food donation and food subsidy programmes, which have been described as expensive and often un-targeted (Barrett 2002). The rural grain bank model here is unique in that it is a food subsidy of raw ingredients to the grain bank, primarily sourced from the local production, rather than cash or donated foods. Whereas the semi-urban business model, based on selling the processed flour, could be a sustainable employment opportunity for women; the rural model relies on extensive volunteer contributions from a small group of women in the production and processing and, based on our results, is unlikely to be sustainable without fair compensation or incentives. These incentives for women are a necessary investment for this to be a sustainable food source for children's diets.

The current study is qualitative in nature and does not measure impacts on dietary change or growth; future studies will evaluate these elements. Comparative cost-effectiveness data is also needed to assess the relative potential of the intervention. The potential for response bias may exist in any qualitative study if researchers are perceived as affiliated with the project; however, the diversity of positive and negative opinions expressed suggests that this was minimal here. Many results cannot be generalized beyond the four Ethiopian regions included in the study; however, several concepts and themes are applicable to other developing country settings.

In summary, community grain banks are accepted and valued by local community members for using local agricultural inputs and offering labour savings for women. The grain bank flour was perceived as having potential to improve infant and young child nutrition; yet greater quantities of production are needed to have an impact, and other sources of micronutrients are needed through further dietary modification and fortification to feasibly

improve child nutrition at scale. Integrated health and agricultural interventions leveraging the local biodiversity have potential to be highly accepted at the community level and may be embedded within broader efforts to contribute to improved child growth. As currently designed, the intervention depends on maintaining external inputs, especially in the rural context. The sustainability of such interventions should be considered, and additional micronutrients will be required; documented examples and best practices are much needed.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

Contributions

MLR drafted the manuscript, provided overall guidance in study design, data analysis and interpretation. SJMO, AAA and ALT contributed to study design

and data interpretation. BS contributed to data analysis and interpretation. All authors reviewed and approved the manuscript.

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