# PROBLEM FRAMING BRIEF: CHILD NUTRITION

## BACKGROUND

The given project brief at IDDS Zambia 2013 was improving nutrition of children in the region of Chitambala village in Mumbwa district. This is a small village 3 hours distance from Lusaka by car, with approximately 200 families. The selected problem framing was to improve the access to nutritional food by introducing solar dryers into the community because there is a surplus of mangoes in the months of December and January, but there is a lack of access to these and other fruits and vegetables in the rest of the year.

## PROBLEM FRAMING

The branches of the problem-framing tree presented in Figure 1 were assessed for areas, which had potential for technological innovation and community impact. A discussion on this assessment is presented following.

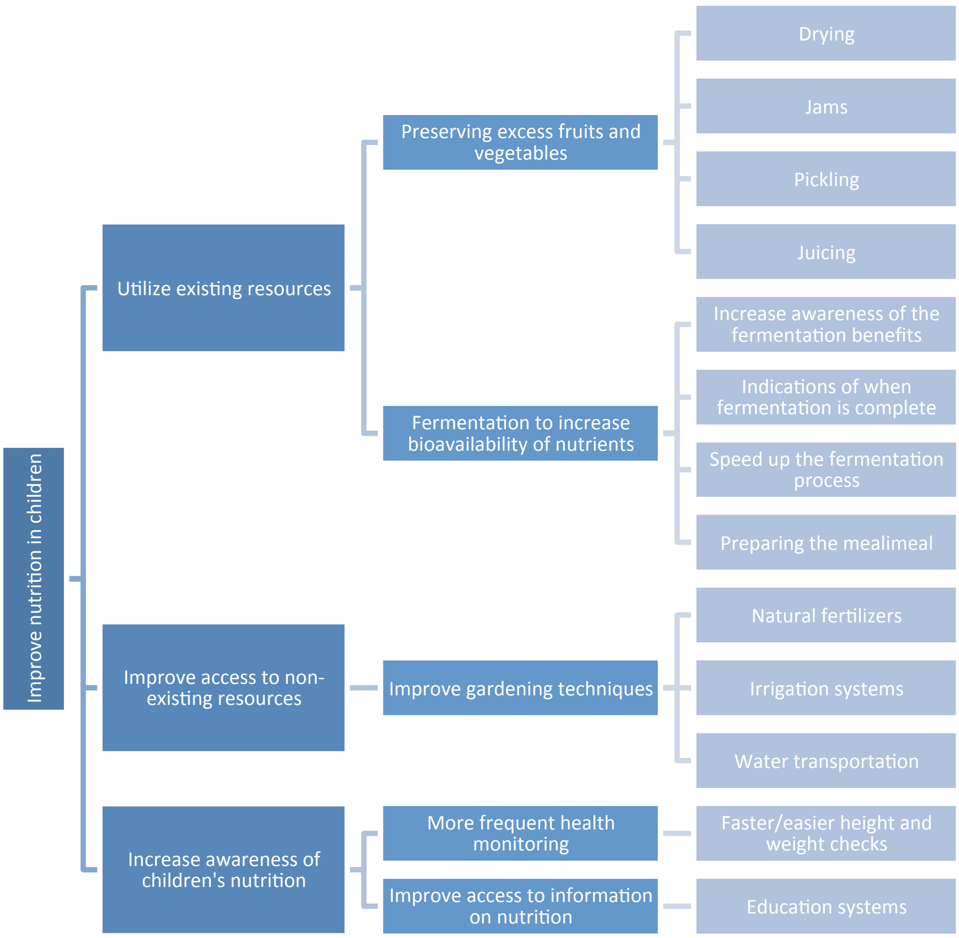


Figure 1: Problem framing tree for improving the nutrition of children in Mumbwa.

## MONITORING OF CHILDREN'S HEALTH

The monitoring process of children's health was not a concern that the community had raised or identified with during the interactions experienced. There are undoubtedly innovations in this area however not enough experience was obtained to identify them. The Health/ICT team at IDDS 2013 spent time investigating this issue more thoroughly and their project report would be a good point of reference for those interested in this area in more detail.

## Education on nutrition

The access to informational on nutrition did not seem to be the core challenge for nutrition in Chitambala: interviews and focus groups indicated that community members were aware of the concept of a balanced diet, but lacked the financial resources necessary for it to be put in place.

### New gardening techniques

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Community members expressed concern about the difficult to grow produce in the dry season and cited the cost of seeds, lack of fertilizer and lack of access to water as the main challenges. Organizations such as [1] are already implementing solutions to these challenges and the community members have been put in contact.

## Fermentation of foods to increase nutritional value

The lack of financial resources to obtain a balanced diet for the children caused an interest in ways to better utilize existing resources. There is research describing the benefits of fermented porridge as a more nutritious food because of the changes to complex carbohydrates during the process (World Health Organization, 1995), and the preventative and recovery benefits for diarrheal diseases (Sahlin, 1999). There are different ways to prepare the fermented porridge (which has also been referred to as sour porridge and, to a lesser extent, mutateka porridge) from maize: by fermenting the cracked kernels in water for 2 to 3 days until they ferment and afterwards making porridge from the resulting meal and liquid; making the porridge from mealie meal (maize flour) and leaving it to ferment; and fermenting the mealie meal and then cooking it to prepare the porridge.

Of those interviewed, no one mentioned disliking the taste of the fermented porridge. Rather, the taste was commonly cited as the motivation for making the porridge, as its sour taste is preferred over plain porridge. It is a practice traditional of the Western Province of Zambia, and so it is not well known in Chitambala. A fermented maize drink called munkoyo is popular in Chitambala, however, which may be similar to that shown in Tanzania to assist with recovery from diarrhea (Kingamkono, 2003).

### Preparing the mealie meal

In the process of grinding the maize into mealie meal, if the germ of the kernels are removed, protein and other nutrients are lost. This inspired the problem framing statement of techniques to prepare the mealie meal without discarding the germ and losing the nutrients, as can occur if processing of the kernels is done at sophisticated mills, used because milling by hand is a labor-intensive process. It was thought that community members could benefit from a device to speed up the milling process, which does not discard the germ.

We were later informed that the mills that the community members would take the maize to are not likely sophisticated enough that the germ is discarded, however further research into the loss of nutritional value, if any, undergone during this process is still necessary. In addition, schools in the area which were of particular interest because of their centralized impact on children's nutrition through their World Food Programme-assisted lunch program are provided with pre-processed mealie meal and would not currently benefit from such a device. As a result, this branch of the problem-framing tree was not focused on.

### Accelerating the fermentation process

The fermentation process can take up to four days if not using a method to accelerate the fermentation, such as starter cultures from a previously fermented batch, stored in the walls of fermentation vessels

[1] www.ideorg.org

such as gourds and clay pots. Warmth can further accelerate the process, and so there was potential for a technology in this branch to harness heat in ways other than the heat from leaving the gourd in the sun. It was found, however, that of the few who knew how to make the fermented porridge in the village, the time was not of concern as starting cultures were used. Consequently the concept of further acceleration through technological innovation was abandoned.

#### Indicating the completion of the fermentation process

It has been indicated by the literature (World Health Organization, 1995) the importance of not ending fermentation before the nutritional and food-safety benefits are achieved. An indication for when this time has elapsed was considered as a potential problem framing. It was found, however, that in Chitambala there is little awareness on the use of fermented porridge, and furthermore its nutritional advantages. As such, the first step is seen to be one in education, which would involve teaching the appropriate timings for the fermentation to achieve its benefits – it is not as if stopping the fermentation too soon is currently a problem. Furthermore, it would be expected that if schools, for example, were fermenting porridge for the benefits of the students, that they would adhere to these timings, and if they were to ignore them, an indication that this is so might not make any difference to their actions. As such, the porridge fermentation was not found to require a technological innovation at this stage, but education. If cases arise where, after such education, the fermentation is not being carried out correctly because of inability to time the process correctly, then a solution to inform when fermentation has been achieved may be considered a necessary part of the dissemination strategy, but this is not currently the case in Chitambala.

### Preserving excess fruits

In our research in the community, it was found that every house has at least one mango tree and in the rainy season these trees give so many mangoes that a lot of them go to waste because they cannot be eaten fast enough nor sold because of the saturated market. It was observed that people in Chitambala already dry some vegetables such as pumpkin leaves for matters of preservation throughout the year, yet they had not heard of the possibility to dry fruits, but were very receptive to the concept of dried fruit. Indeed there were many technical challenges identified in the process of safely making dried fruits available for enough time throughout the year to make an impact on nutrition, and so this was the path selected for the problem statement.

### Refined problem statement

To have all excess mangoes preserved for consumption throughout the dry season, using environmentally sustainable technology, with all stakeholders in the value chain benefiting.

## Solutions

The drying process can be divided into the stages outlined in Figure 2, with possible sub-stages also outlined. Each of these stages should be addressed in order for dehydrated food to be feasible, as if one is missing then the system, as a whole will not support the problem statement.

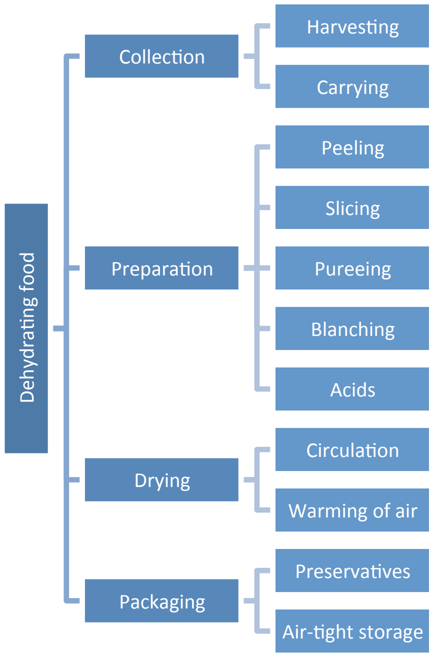


Figure 2: Challenges and possible sub-challenges of the food dehydration process.

## Collection Stage

The collection stage may consist of equipment to assist with harvesting produce such as nets to catch fallen fruits, and equipment to transport collected mangoes if large volumes are necessary.

Challenges in the collection stage may include the concept of ownership of trees, as it has been advised that trees may be considered communal and that there is no tree owner. How would the dynamics of the village change if mangoes were being taken by collectors and used for profit? Would there be enough supply of excess mangoes to last for the dry season?

## Preparation Stage

The preparing step consists of peeling, cutting the fruit into thin slices and coating it with things such as sulfur dioxide solution (not locally available, and dangerous to handle) or lemon juice to help to preserve it and maintain the color after it is dried. The lemon juice may be particularly of interest in this context because this is another fruit, which has been noted as being in excess during the rainy season. Fruit leathers may also be made by spreading puree onto a tray to dry instead of the slices. Mango crushing technology has been developed by D-Lab at MIT although the current status of the technology is unknown.

Potential challenges which have been identified in the preparation step include the accessibility of chemicals to treat the produce which may be of particular importance if the dried products are to be sold as a quality item in marketplaces where dried fruit exists, and the labor involved to peel and slice/puree large quantities of mangoes, as may be necessary at schools, for example. Food hygiene is integral at this stage to prevent premature spoilage of the food.

## Drying Stage

The speed of the drying stage depends on three factors: the relative humidity of the air (it must be lower than the food which is to be dried), the temperature of the air (warming the air increases its moisture absorbing capacity), and the speed of the airflow (the air must move fast enough to remove the saturated air from around the fruits). The drying process should be designed such that air which has absorbed moisture from the food is continually removed and replaced by air with more moisture absorbing capacity, which can be done with a circulation system. Consequently, two core components of a solar dryer are a circulation system which encourages the flow of air to replace 'used' air, and an air heating system to increase the moisture absorbing content of 'new' air.

Commonly used methods for the air circulation include: natural convection by utilizing the fact that hot air moves upwards, and devices such as chimneys and exhaust fans to encourage used air to be removed from the system.

The heating of new air can be performed by methods such as directly heating the air by sunlight, warming the air by passing it by materials heated by the sunlight, or heating the air through mechanisms requiring non-solar fuel sources, such as excess heat from a stove as was explored by the Waste Management team at IDDS 2013.

Direct sunlight solar dryers heat the air inside the fruit drying chamber by exposure to sunlight, which will also reach the fruit itself and can cause loss of nutrients. Indirect solar dryers heat the air which will dry the fruit in a separate chamber, protecting the fruit from the sunlight. A combination of these methods allows for faster air warming.

A prototype was developed to combine direct and indirect heating methods in one device to make the drying faster, as moist fruit left for days in warm humid conditions presents food safety concerns about micro-organisms and mold growth, highlighting the need for the process to be as fast as possible without cooking the fruit. For better use of the heat of the sun, a chamber of wood was made, covered with clear plastic so the sunlight can enter, the walls were covered with aluminum foil for enhanced heating of the air. For the use of air circulation, the same chamber had a black plastic bottom to try to heat air and make some air circulation to the top. Other attachments which were produced were a wind-powered exhaust fan made of plastic water bottles that could help the air circulation, a chimney made of water bottles for the same reason, and an aluminum foil solar cooker for warming air in a tube made of water bottles for natural convection. These prototypes were developed to gain first-hand experience in the concepts, but afterwards it would be necessary to change the materials for local resources.

The core challenge in the drying step for dehydrating fruits is reducing the time required such that food safety is not a concern and to increase the throughput. A dryer must therefore have sufficient air-warming and circulation capabilities, dependant on the context. Key challenges in the drying stage are environmental challenges presented in Mumbwa such as dust and animals which attack the drying food, and particularly in the rainy season the potential low sunlight availability and high humidity of the air. Environmental challenges to consider in the design/selection of a dryer itself also include the rain, strong winds, termites and constant solar radiation if solar dryers are to be used. Monitoring of the drying process may be a challenge to ensure that food being stored has adequately low moisture content.

### PACKAGING STAGE

For the packing, some people already have the knowledge to make airtight plastic bags for selling groundnuts, sealed with fire. The only concern could be on the strength of the bag because it is needed to store the dried fruits for months, in this time the bag could open or be attacked by rodents.

In general the challenges in storage are protection from humidity which can cause the food to re-hydrate, and protection from rodents and other pests.

## NEXT STEPS

- Selection of the most appropriate context: large-scale dryers for schools, dryers for household personal consumption, or dryers for use in businesses.

- Research into the most appropriate dehydrator (solar or otherwise) design for the given context.
- Research into relevant business model case studies.
- Pilot study for community acceptance of the dried products.

It was found that there are a lot of established technologies in drying, and even in Lusaka where IDDS 2013 was hosted there is the Light of Hope model co-created by D-Lab from MIT. It is therefore recommended that rather than building new devices and processes for drying, research into how and if these existing practices fit to the conditions of Chitambala in meaning of scale, manufacture, environment and price.

A pilot for introducing the drying process to the village could be performed using a community women's group that shares knowledge on how to grow food, better methods of processing them and other things. Of particular interest is that this group maintains a communitarian peanut butter machine, where they charge a usage fee for the machine for community members and use the profits to maintain the machine and club. This group seemed most open to accepting the use of drying machines, so training them on how to use it could be easier. After a cycle of rainy and dry season, the community would see value of the dried mangoes as a source of nutrition and even in the selling of some dried mangoes on the market for a higher price at the time where mangoes are unavailable or expensive. After using this channel to spread the value of dried fruits, the villagers could be more open to having smaller scale drying machines on their homes together with some training on how the process works and what they need to do so that the fruits last longer, creating a new market for a business in training people to build, sell and operate dehydrators such that fruit is available throughout the year for improving children's nutrition.

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