

Ergonomic considerations for a systemic approach: the millenium maize mills project in northern Mozambique

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Abstract. Malnutrition is a major problem for rural areas of Sub-Saharan Africa. Technology such as the maize mill, which alleviates the burden of pounding grain, also introduces opportunities and new challenges for improved nutrition. While there have been many technical studies of grain mills, and maize mills are in operation in hundreds of locations throughout Sub-Saharan Africa, the maize mill has not been studied from a socio-technical system perspective. This paper reports on the first phase of a study grounded on the hypothesis that mills can improve nutrition by exploiting their function as a social gathering point and providing both instruction and enjoyable healthful products. The objective was to identify those products that could be made available that customers at the mill would be willing to buy. Following observation of food availability, preparation, and consumption preferences within daily work routines, sample products were prepared and presented for cooking and consumption, along with some discussion at a district center mill owned by a local woman. The responses of customers and the mill owner were positive. Strategies for local manufacture and distribution of these products for sale and roles of the mill owner and the mothers are questions for future study.

Keywords: malnutrition, systemic design, social study, entertaining approach, food security, food seasonality, food preservation

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1. Introduction

Rural communities in many parts of Africa suffer from malnutrition resulting from seasonal availability of food and the unavailability and lack of knowledge of food storage techniques. This problem is compounded by time-consuming food processing activities, such as manual pounding of grains for cooking and long distance travel with heavy loads on foot or bicycle. Although several kinds of vegetables, cereals and fruits are available during the high season, in the lean season food products are scarce. During the lean season, farmers rely on preserved food products, especially grains, but many losses result from poor storage conditions thereby posing serious health threats. Furthermore, malnutrition exists even during the high season because people lack knowledge of a balanced diet.

The north of Mozambique, once one of the world's major producers of cashew, holds promise for high production of tropical fruits, such as mango, papaya, and banana, as well as ground nuts for oils, and legumes for feed. However, the energy requirements for building labor-intensive industries increase the dietary requirements of the people in the area. Thus a growing domestic food market must complement the global agro-industrial development. Since maize is the staple food in this region and in many parts of sub-Saharan Africa, the maize mill holds great promise for improving women's productivity.

Mills replace food pounding, bringing with it the opportunity for increased social interaction that is vital to knowledge transfer, particularly for nutrition and other areas of interest to the mill customers.

Although hundreds of mills have been located in sub-Saharan Africa, they have been studied from a technical perspective, particularly concerning food security and operability of the machinery [4, 5]. Nutrition has also been studied from a social scientific perspective. However, lacking is a study of the maize mill from a socio-technical systems perspective that would focus on the roles of people as actors interacting with technology to produce goods and services through work activities.

The success of the village-level maize mill depends first on its reliability in producing milled maize. The mill establishes its social function by being a popular place for customers to congregate and exchange stories as they wait for their sacks of maize to be milled. This social function may be exploited to enhance the mill's sustainability by becoming a supplier of supplementary products, i.e., a "Maize Mill Center", especially those products that enhance nutritional knowledge, basic food safety knowledge, and other services and goods that improve health and wellbeing. The objective of this study is to explore these assumptions by identifying and testing an introductory supplementary product of the maize mill that would be acceptable to the local community.

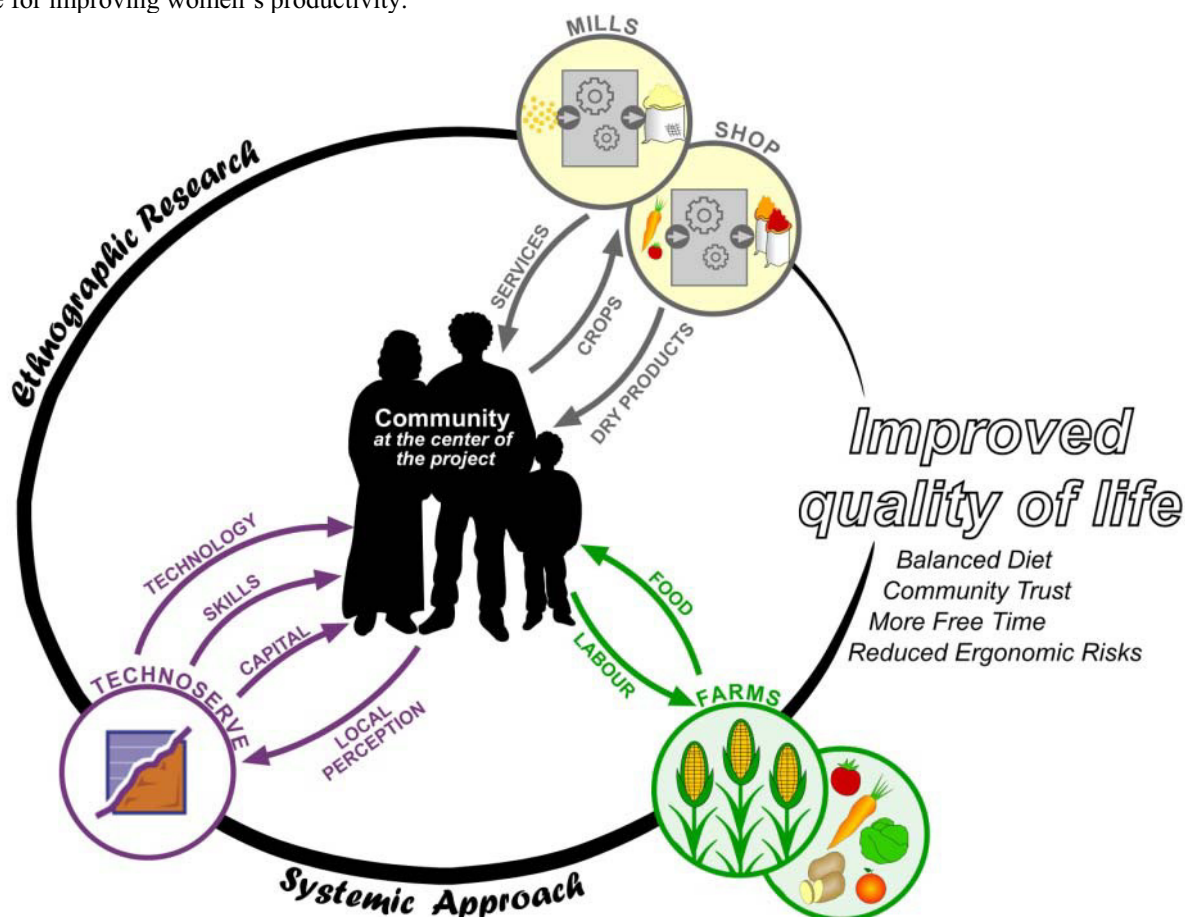


Figure 1. Systemic relationships within a rural development system

2. Conceptual Model and Study Method

2.1. Model for sustainable development

This study uses a demonstrated socio technical systems model, The Systemic Approach (Figure 1) “transforming the qualifications and motivational climate, supporting increased self-esteem and the pursuit of an upward spiral for the community” [1].

In this model, people in the community use knowledge resources of the change agent (the organization TechnoServe) to adopt a technological innovation (the Millennium Maize Mill Center), using resources and income provided through work in forestry related industries and household farming to improve the quality of their lives.

2.2. Method

Ethnographic study which “usually works best when conducted by an outsider with considerable inside experience”, is important to fully understand people’s needs ([2]: p.130). In this study volunteer consultants, comprising the field team, which was supported by the organization TechnoServe, lived with communities in the Ribáué district of the Nampula Province of Mozambique. This area was chosen for study because, as district center, Ribáué’s connection to the Province facilitates communication and growth potential, while also serving as a hub to remote areas that will be undergoing change as soy production and forestry activities commence. In this study, the field team was able to discover what kinds of goods and services customers at the mill want or need, and that are possible to make available. This was determined through interviews, observation of daily work activities, and conducting an event to demonstrate a product that was proposed from the needs and preferences revealed through the ethnographic study.

3. Findings

3.1. Importance of the Village Maize Mill

Our field team visited the target area for planning and found that maize, which is nutritionally vital, is grown widely. However, this crop, used to produce several food products in the local diet, requires strenuous repetitive work to convert for consumption.

Women wake before dawn to pound grain manually (Figure 2) or travel to distant mills that are inefficient and unreliable causing several problems, like physical stress, and use of much time that could be useful for important purposes.



Figure 1. Manual pounding that requires effort and time (an entire morning for lunch or a whole afternoon for dinner). (Source: Couvinhas, field notes, Ribáué 2011)

Being the most frequently visited business within the rural village, the Ribáué maize mills become a community meeting place, with a great potential to improve quality of life of local people because it can provide opportunities for integrating other needed services. The mill serves remote areas and provides a prototype for more remotely dispersed mills with the potential of reducing travel time by foot and bicycle with heavy loads. Providing reliable, simple technology reduces pounding effort and time. These efficiencies allow for other important activities such as studying, household duties, attending to crops, and leisure.

3.2. The consumption of maize within the community: the social impact of Xima

The community consumes maize almost in all meals. It is cooked in three main ways:

- Wholegrain maize boiled with water and salt, is usually eaten by farmers during the lunch break however, frequently it originates digestion problems (mainly diarrhea);
- Pounded maize boiled with water, salt and beans or peanuts;
- Maize flour puree, named Xima (*'shee-ma'*), is the most popular dish, consisting of maize flour boiled in water without salt or other ingredients. Xima has an important role within the community, not only because is the most typical dish, but it is directly related with social beliefs. There are two versions prepared: Xima Celeste and Xima Branca. The former is made of maize flour that was milled with husks; the latter is made of hulled maize that produces a very white purée.

In rural areas, considerable social symbolism attaches to Xima; being able to make a very white Xima means that the wife has the virtues of being painstaking and meticulous. However, hulled maize brings about serious malnutrition problems since much of the nutritional value has been removed. The hulled Xima Branca is eaten mainly during the high

season. In the lean season, the available food products are so scarce that families are obliged to eat the less desired wholegrain Xima Celeste in order to have larger quantities of food.

The comment of a local resident illustrates this fact: “*Saco vazio não fica em pé*” (empty bag does not stay stand up: meaning that it does not matter what things people eat, they just need to feel the stomach full when hunger season comes).

All members of the family, even infants of just several months for whom the food is difficult to digest, eat Xima (Figure 3).

This diet is nutritionally inadequate and persists even in the more plentiful season, mainly because of the lack of knowledge about a balanced diet and the availability of adequate food preservation techniques. To overcome those problems the Millennium Maize Mills have the goal not only of milling maize, but teach people about a balanced diet and will have services to preserve maize and other kinds of food too.



Figure 2. Family, including babies, eating Xima (Source: Couvinhas, field notes, Ribáuê 2011)

3. Lack of food variety or lack of knowledge?

There are two main seasons in the north of Mozambique:

- The high season (from January to September) when, thanks to the rains, there are a variety of fruit, vegetables and cereals;

- The lean season, called the “hunger season” (from October to January) when there are very few fresh products. In this season, people eat what they were able to store, but the inefficient preservation techniques create serious health problems caused mainly by fungal growth and rodents.

“*A partir de Setembro até Fevereiro não temos caril para comer com a Xima*” (From September to February we do not have *caril* – tomato sauce with meat or dry fish - to eat with Xima)

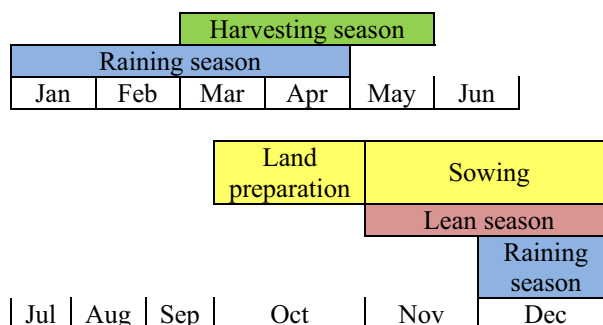


Figure 3. Seasonality in the north of Mozambique (Source: USAID)

If people were able to preserve food, there would be a lower incidence of malnutrition during the lean season. However, malnutrition is also present during the high season too because:

- The inadequate nutritional content of Xima Branca and
- The farmers’ lack of knowledge of the importance of a balanced diet of foods.

“*Só vario a alimentação quando estou farto de comer algo que tem sempre com o mesmo sabor mudo, por exemplo, de feijão para folhas de mandioca*” (I only change the type of food when I am tired of eating something that has always the same taste so I change, for example, from beans to cassava leaves).

Farmers’ lack of knowledge about growing produce is also a factor. Although farmers produce large amounts of fruit and vegetables, they frequently do not consume these in part because of custom and in part because they can often be sold for cash. They prefer to sell all products; but unsold produce may not be collected even for home consumption, if they do not have buyers or the price is too low, since the food quality is lacking as a result of lack of knowledge about growing produce for commerce. Understandably, farmers prefer to spend time and effort planting the food that they can sell or else consume instead of growing larger volumes of crops that no one will buy or eat.

4. Systemic approach: an investigation of social and cultural factors related to nutrition

4.1. The social context

An intervention is needed to understand the social dynamics related to nutrition in order to fight malnutrition. However, this intervention must take into consideration people’s perception and beliefs in order to be well accepted rather than being construed as an imposition. Without this initial study of this social context, any proposed intervention would have little

positive or possibly even a negative impact on social behaviors.

4.2. *The culture of food*

Food acceptability in the north of Mozambique is directly related to the aesthetic appearance of the food and the sensation of satisfaction from fullness in the stomach. Some examples are the preference for a dark-colored Caracata (cassava purée) and a pure white Xima. These preferences are likely rooted in the suitability of the food for consumption, i.e. inhomogeneous and coarsely processed Xima is not as digestible and may have food impurities such as insects and fungus, whereas improperly processed cassava can be toxic.

The standard for food adequacy is the perception of fullness in the stomach with a good taste. Fruits and vegetables fail to provide this feeling of fullness and require further processing. Food preparation involving several ingredients increases the energy requirements for processing the food. Thus starchy food such as maize and cassava are economical, whereas vegetables require additional preparation.

Knowledge of foods is learned from the previous generations and passed on to the younger generations in initiation rituals where adolescents also learn standards for acceptability in domestic partnerships. For example, if a young boy cannot create as productive a maize farm as the other boys who participate in the same initiation ritual, his risk of losing his wife to another man is higher. On the other hand, if the wife does not know how to pound and cook a fine Xima with the maize that her husband provided (after so many working hours in the farm under the sun) she can lose her spouse. Each member of the family has a specific role in food provision.

4.3. *The Challenge for Intervention*

Creating the national possibility of industrial growth necessitates increasing the energy levels and overall health of workers and students. People have increased nutritional needs and therefore must learn new ways to meet these needs. Introducing easy-to-use new food products that are similar to the ones that are eaten now, but have a higher nutritional value, is one way to intervene. But the challenges faced by any intervention strategy, as outlined above, are in summary:

- (i) Working within social values and practices while using novel approaches as the vehicle for changes in food preparation and consumption behaviors;
- (ii) Educating on related nutritional issues in acceptable, engaging ways;
- (iii) Addressing the issue of food storage in ways that preserve nutritional value, for situations

where formal storage facilities are not available

- (iv) Developing a local capacity for sustainability, for when the project is over.

5. An intervention emerges

After several food preparation experiments within the community, a proposal to address the impoverished nutritional value of these traditional foods emerged.

5.1. *Fortification powder*

While the maize is being milled, it would be possible to fortify the maize with nutrients powder already available from a local processing company. That would improve the health and energy of the community for work without changing the color of Xima Branca.

“O sabor é natural e característico, a Xima Branca não pode ter um cheiro nem um aspecto diferente do normal” (The taste is natural and characteristic, the White Xima can not have a smell nor a different appearance).

5.2. *Dehydrated local products*

Since people do not have adequate storage conditions, access to dried food would alleviate some of the burden of poor nutrition, (Figure 5).



Figure 4. Some products that can be transformed into powder form without nutritional loss

5.3. *Colored Xima*

From the systemic social study of households it was possible to see that a promising way to sell the dried vegetables, fruits and cereals that could fortify food would be in powder form as an additive to the Xima. Xima is already often mixed with dried fish to impart some flavor. If the sensation of energy and satisfaction is maintained, and consumer interest is attracted, adding tastes could bring a diversification to the diet, improving its value while potentially altering the social perception of the superiority of white Xima.

The team conducted several “at home” experiments with corn meal to test acceptability and willingness to prepare or purchase. Baked forms of corn meal were found to be a pleasing alternative; however, the cost of preparing the foods were beyond what people were able to pay on a regular basis. The field team purchased vegetables currently in season and used drying techniques in a controlled environment to create several varieties of products.

During private experiments, consumers’ reactions were very positive. They liked the innovative colors and tastes. The possibility of food additives created from locally produced vegetables emerged as a promising option for testing at a public event, (Figure 6).

Food testing is just the beginning of this project that aims to introduce a change in the society - modest but innovative –based on creating enthusiasm for change among people. In fact, the practical challenge is to give the idea that colored Xima is “fun”, not only healthy. In this way, our nutrition intervention will be able to reach people more easily.

5.4 Public cooking demonstration

This *innovative way to eat* Xima, with the potential (but also challenge) to change the perception that white Xima is better, was tested at a public cooking demonstration held at the maize mill. Labeled packets of dried vegetables were displayed and samples of cookies and cake baked with the dried vegetables were distributed (Figure 7). Then the Xima cooking demonstration took place. When colored ingredients were added to maize flour at the public event, they gave the Xima pleasing colors, such as orange (from carrots), green (spinaches, drumstick leaves, cabbage), red (tomato), yellow (pumpkin), etc.(See labeled packages in Figure 8)

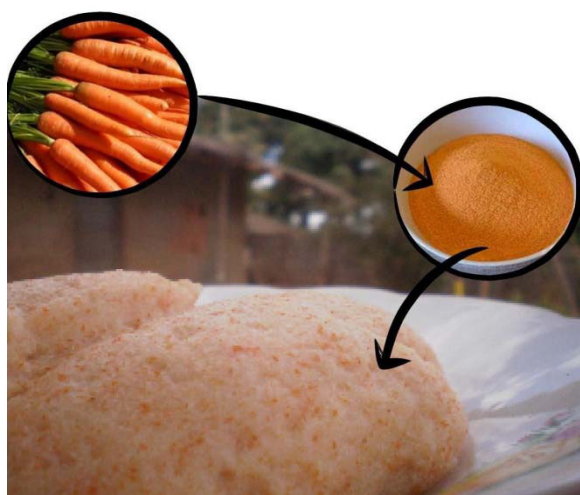


Figure 5. Xima made with dried carrot powder - as promoted at the public event.

“Esta Xima – Colorida – tem um bom sabor! Até quando não tem caril se come com gosto!” (This Xima – Coloured- has a good taste! Even when we do not have *caril* (tomato sauce, sometimes used with meat or fish) it tastes good!).



Figure 6. Dehydrated foods displayed at the public event.



Figure 7. Public event where women learned how to make Colored Xima and the importance of a balanced diet.

In this way people could have fruit and vegetables in their diet all year, and at the same time be able to sell their fresh products during the high season.

6. Discussion and critical evaluation

6.1 Different mixes

The dried products can be mixed in many different ways, creating national pre-cooked products that will fight malnutrition. Some examples are (Figure 9)

- Instant soup (“Sopa instantânea): potato, carrot, tomato, cabbage, onion, pumpkin, spinach, maize;
- Food for baby (“Papas para bebés”): milk, maize, papaya, banana, carrot;
- Tomato sauce (“Preparado para refogado”): onion, tomato, green pepper.



Figure 8. Different mixes of dried products (as shown in a promotional brochure).

These and many other food products could be sold in different ways, for example:

- In maize mills to the farmers: when people go to the mill their maize, *natural Mozambique-produced food-powder* can be added to their flour. In addition, it would be possible to buy there small packages of dried food, especially baby food (to avoid feeding babies with *Xima*);
- In the supermarkets of the big cities of Mozambique: instead of buying imported pre-cooked products, it could be possible to manufacture nationally with nationally grown products. In this way consumers are helping their own country to have a greater development and for both targets will be possible to save time and effort. This has been found to be a popular option with nationally grown poultry,

6.2 Enhancing the value of the mill to the community

Buying fresh products from the local farmers, drying the produce, and then selling the products at the Millennium Maize Mill Center will add value to the current function of the mill. There can be several lessons on nutrition and sales of products to improve wellbeing, such as soaps made of natural local products and maize. The potential for these Mills to become centers for social and cultural exchange, at the same time promoting health and wellbeing depends on the relationship that the mill owner develops over time with her customers.

6.3 Challenges to Changing Food Processing and adoption of technologies

To solve the local problem of seasonality a process is needed for collecting, preserving and making dried produce available particularly in low food production seasons.

Since people do not have good storage conditions access to dried food would alleviate some of the burden of poor nutrition. Drying their products at home is difficult since food spoilage and drying conditions are not easily controlled at the household level. However, there are drying facilities within the country that are in operation producing dried mango and pineapple. Contracting with these organizations on a large scale is one possibility. Building local drying facilities using the same control processes and modified technology is a second possibility.

Buying dried food is also problematic. Farmers may not have the money to purchase when the product is available even if they have sold their produce during the high production season. One mechanism could be an exchange program for qualifying raw materials bought from local farmers; some payment could be made in the form of dried, well-preserved food.

TechnoServe is considering these issues in its next steps for a regional system development program that addresses change at these several levels.

6.4 Trust

Living within the society and making several experiments within it revealed several aspects of trust. Nutrition education projects have come and gone in this region. The voluntary consultants risked being perceived as being involved with “just another one”. Such projects organize ad-hoc groups that are trained to address problems in nutrition and sanitation as they arise. Uneven supply of material and technology make these activities unsustainable.

What underlies successful projects can, to a large degree, be boiled down to a single idea: create genuine trust [3]. In the case of nutrition, the capability to address food preservation is essential. The maize mill uses electricity and also is at risk of breaking down. The design of these mills must be evaluated jointly with the mill owner and community. The mill must pay its electric bill and must provide sanitary conditions for the maize, keeping the mill itself free of fungus and bacteria. If the mill owner and operators are perceived as unreliable, untrustworthy, or negligent, the mill will fail because of lack of trust. On the other hand, trust can become over-reliance that becomes a problem. For example, if a credit-providing organization over extends credit, either to mill owners or to consumers.

Finally, trust is embedded in products; all supplementary products offered in the mill must be consis-

tent in their quality and truthful in their claims. The relationship of the mill owner to the community is of primary importance. The relationship of the mill owner to the supplier (of knowledge and of resources) is also important for trust. Trust at each node in the network of resource flow is what permits the flow of information and resources for problem solving, error avoidance and the prevention of system failures. This also extends to the customer who having purchased the improved food product, uses it to provide a meal for the family which the family has grown to anticipate. Thus the consumption and enjoyment of the product enhances family relationships while changing food consumption behavior.

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