A Nutribusiness Strategy for Processing and Marketing Animal-Source Foods for Children\textsuperscript{1,2}

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Abstract

Nutritional benefits of animal source foods in the diets of children in developing countries indicate a need to increase the availability of such foods to young children. A nutribusiness strategy based on a dried meat and starch product could be used to increase children’s access to such foods. The “Chiparoo” was developed at The Pennsylvania State University with this objective in mind. Plant-based and meat ingredients of the Chiparoo are chosen based on regional availability and cultural acceptability. Chiparoo processing procedures, including solar drying, are designed to ensure product safety and to provide product properties that allow them to be eaten as a snack or crumbled into a weaning porridge. Continued work is needed to develop formulation and processing variations that accommodate the needs of cultures around the world. J. Nutr. 137: 1115–1118, 2007.

For many years, the nutritional strategy for incorporating supplemental foods into the diets of weaning-age infants in developing countries involved large-scale commercial production and distribution of inexpensive weaning mixtures, often formulated from donated commodities. In the 1980s, the focus shifted to behavioral change and community-level initiatives to reduce childhood malnutrition by encouraging mothers to cultivate kitchen gardens and incorporate locally available fruits, vegetables, eggs, and meat into their children’s diets. The nutritional focus, however, remained on severely malnourished infants from very poor, rural households (1). By the early 1990s, it was recognized that malnutrition was also widespread in households that, in a search for employment, had relocated from rural villages to urban slums or rapidly growing periurban administrative and commercial centers. The nutribusiness strategy was designed to simultaneously address the nutritional, social, and economic conditions prevailing in rural areas and in rapidly urbanizing district centers in developing countries.

The goal of a nutribusiness is to enable rural women’s group members to elevate their own economic status while improving the health of infants, children, and other nutritionally vulnerable individuals in their own households as well as in periurban households without access to land for growing food (2). The nutribusiness concept is built on the premise that value-added food products processed and marketed by a women’s cooperative will be of high nutritional quality and made from animals and crops that are locally produced.

The nutribusiness concept differs in several key aspects from most other community-based approaches to the improvement of diets. A successful nutribusiness is intensely participatory in that it involves local women in every stage of the business from product identification and formulation to ingredient sourcing, product labeling, and marketing. Consequently, nutribusiness products reflect not only what women produce on their farm plots but also what they consider to be appropriate foods for young children or other nutritionally vulnerable individuals in their culture. The strategy of building on local knowledge and beliefs about feeding children also extends to other groups including pregnant women, the elderly, and those suffering from acute or chronic illnesses. Because an intense pride of product ownership develops, women shareholders in nutribusiness cooperatives become extremely knowledgeable about the nutritional benefits of their products and can effectively communicate their value in the diets of those with special nutritional needs.

Barriers to children’s consumption of animal-source foods

The diets of children in many developing countries are largely devoid of animal-source foods (ASF), a dietary component associated with improved growth, cognitive development, and physical activity (3–5). The rapid deterioration in safety and palatability that occurs within a few hours after game and meat animals are killed or fish are caught contributes to the lack of a
regular source of ASF in children’s diets. The problem of safely preserving meat, poultry, and fish in tropical climates, as well as some of the economic barriers and cultural practices that limit children’s access to ASF, might be successfully mitigated through a nutribusiness approach. Such an approach not only addresses children’s dietary quality but also addresses United Nations Millennium Development Goals that include poverty reduction, improved maternal and child health, and the empowerment of women (6). If current trends continue in the Sub-Saharan countries of Africa, none of these goals will be met by the target date of 2015 (7).

Processing nutribusiness products in rural developing country settings
A nutribusiness is built around a locally owned and managed food-processing facility. Both the economic viability and sustainability of the nutribusiness enterprise are dependent on the ability of the cooperative’s shareholders to profitably market the product(s) produced in that facility. A rural nutribusiness cooperative in developing country faces many of the same issues encountered by food manufacturers around the world, but local economic conditions, infrastructure, culture, and education may create special challenges. Leadership and ongoing financing for the nutribusiness cooperative need to be generated within a local community. However, financing the initial cost of constructing and equipping the processing facility would likely need to be externally subsidized by a grant or low-interest loan. Because maintenance and repair services are almost nonexistent in rural areas, and women's experience with technology is often limited, mechanical equipment of any sort must be simple and exceptionally robust.

The nutribusiness manufacturing process is designed to make minimal use of specialized equipment or tools, and the cost-effective production of its products relies on local access to inexpensive manual labor for relatively unskilled, gender-appropriate operations. Labor-intensive tasks such as washing, peeling, slicing, chopping, mixing, boiling, sieving, weighing, and packaging can be performed manually with simple, low-cost tools and equipment. However, women require adequate training to successfully operate and maintain more technologically sophisticated equipment such as a hammer mill, dehuller, or dryer.

The economic development goal of a nutribusiness enterprise is to establish a cooperative that creates low-skill employment in a rural community to generate supplemental income for rural women with limited employment opportunities while providing training for them to successfully perform more complex mechanical and managerial tasks. The nutribusiness enterprise creates a market for women’s seasonal agricultural produce that might otherwise be lost to spoilage and adds value to their staple crops. A profit is returned to the women shareholders through the sale of distinctive, nutritious, convenient, culturally acceptable food products that are made available in regional markets.

Nutribusiness operations involving the drying of meats, blanched vegetables, and ingredients such as cooked beans require particular care to minimize the possibility of product contamination or spoilage. Solar dryers are one option to produce safe, shelf-stable products under controlled conditions. A solar dryer design for a nutribusiness facility was created by Stephen Kieras, a Food Scientist, and George Okoth, a Mechanical and Processing Engineer. Two dryers with this design were fabricated and installed in 1999 by the Kenya Industrial Research and Development Institute (8). Thirty-six steel mesh trays, each ~3 ft square, were constructed to hold the various materials to be dried. The design features of this dryer include 2 external thermal collectors fitted with dark wool carpeting to help remove dust from the incoming air. An electric circulating fan is powered by solar panels that also provide sufficient current to operate a bag sealer and a single light bulb (Fig. 1). Dryer design drawings are available upon request to E. Mills at ewm3@psu.edu.

Kieras found that the dryer located in Ndanai, a rural community in the Rift Valley Province of Kenya, was able to maintain a temperature of 55°C for up to 9 h/d (9). These drying conditions were subsequently employed in the Meat Laboratory at Penn State to process a novel animal source food product called a “Chiparoo,” designed especially for children. Use of a solar dryer can, we believe, support the safe drying not only of blanched vegetables and cooked beans but also of an ASF such as Chiparoos in sufficient quantity to sustain a small-scale commercial food-processing venture in a rural community.

Sanitation concerns are of prime importance in any nutribusiness operation and are heightened in a warm environment, especially when production involves considerable handling of ingredients during manufacture, the finished product contains an ASF, or the food is intended for consumption without further cooking. Because refrigeration is nonexistent in most rural areas, the finished product must be shelf-stable. Stability is achieved principally by reducing moisture through rapid drying, but in some cases, ingredients may need to be added to lower the pH or the water activity of the product. Sturdy plastic packaging is needed to protect the finished product from contamination or rehydration. The packaging materials should be heat sealable and preferably resealable.

The biggest challenges in establishing and sustaining a nutribusiness cooperative are to create and maintain the necessary technical and managerial expertise within the local community. Local universities, government laboratories, or nongovernmental organizations may be helpful in developing and implementing the community manufacturing procedures, but maintaining local technological expertise over time can be a daunting task. In communities where HIV/AIDS and other diseases are claiming many adults, much practical knowledge is lost before it can be effectively transferred to others. A community-based approach is more likely to succeed in preserving knowledge because multiple people learn the same techniques, thus providing some redundancy of knowledge. Additionally, a community-based nutribusiness approach provides efficiencies of scale and economic incentives that can lead to excess production of crops and small animals. This excess increases the volume of finished product available for cash sale. Our group has described a model for development of a nutribusiness enterprise involving rabbit

Figure 1  Solar dryer at the nutribusiness facility in Ndanai, Kenya (left) and 1 of 36 trays in the solar dryer (right).
production by multiple households in a community with half of the animals being used directly for food in the home and the others being processed along with sweet potatoes into Chiparoos for cash sale (10). The model could be applied equally well to poultry or other small ruminants and is the strategy most likely to result in the regular consumption of meat by children residing in poor, rural households.

The products produced by a nutribusiness cooperative should be those that can be safely processed using locally appropriate technologies and locally available ingredients. They should be culturally acceptable, nutritious and safe for consumption by the intended audience. Such products may be animal source foods, like the Chiparoo, or, like various nutribusiness porridges, may contain a mix of plant-based ingredients.

**Plant-based nutribusiness foods**

Plant-based foods contribute most of the energy consumed by the rural poor in much of the developing world. Cultivated crops including millet, sorghum, rice, and other starchy grains and tubers are supplemented with beans or lentils as a source of protein. The diet is often complemented with cultivated vegetables and fruits as well as plant foods gathered from the bush. Nutritious foods can be developed by creating appropriate blends of plant-based ingredients, as has been demonstrated through nutribusiness ventures established in Kenya and in Northern Namibia where a cooperative has been established to manufacture an “oshikundu” (porridge) mix comprised of 2 parts pearl millet flour to 1 part cowpea flour. The ingredients used in “Bascot,” a family porridge mix manufactured in Gatanga, Kenya, are beans (cooked to inactivate antinutrient factors), bananas, maize, pumpkin marrow, and/or carrots and pumpkin and/or amaranthus leaves. “Tupcho,” the family porridge mix produced by the nutribusiness cooperative in Ndanai, Kenya contains flours from maize, beans, finger millet, pumpkin marrow, pumpkin leaves, carrots, and amaranthus. In a feeding trial conducted in a Kenya nutrition rehabilitation center, the feeding of Tupcho porridge to malnourished children resulted in a greater weight gain than did the porridge regularly used by the facility (11).

A key nutritional limitation of cereal-based porridges is the high viscosity resulting from gelatinization of the cooked product. A thick porridge is difficult to swallow for infants and those suffering from the effects of AIDS. However, adding sufficient water to produce a thin, easily swallowed gruel results in a product with an energy content of considerably <4 kcal/g and a correspondingly low nutrient density. Adding natural enzymes from malted grains can alleviate this dilution problem by reducing the viscosity of a cooked porridge from a thick paste to an easily swallowed liquid while increasing its palatability through the conversion of starch to sugar. PowerFlour is dried barley malt that is distributed free of charge by the PowerFlour Action Network (12). PowerFlour has been shown to be a valuable addition to the starchy gruels fed to infants and young children in developing countries and is now being used to help maintain the nutritional status of individuals with HIV/AIDS.

**Animal-source nutribusiness foods**

While the Kenya nutribusiness project was engaging women in the formulation and processing of unique, shelf-stable plant-based porridge mixes for regional markets in the Rift Valley and Central Provinces, researchers in Embu, Kenya were assessing the benefit of adding supplemental meat to the diets of school children (13).

In response to the need for culturally and nutritionally acceptable ASFs that could be made regularly available to infants and children in rural areas, we began to investigate the possibility of using the solar dryer designed for producing plant-based porridge mixes to process an ASF for children that could be manufactured by a nutribusiness cooperative.

Simple dehydration is an effective means of preserving food in regions with a warm, dry climate. When applied to meats, however, this technique leads to a very hard, chewy product that is not suitable for young children or older adults because of the difficulty in chewing it. The addition of cooked potato or other starchy material to the raw meat before the drying produces a crisp, crumbly product that is easily rehydrated. Penn State’s Chiparoo is such a product composed of roughly equal proportions of meat and potato. Good process control is essential for assurance of microbiological safety and product quality. The PSU group demonstrated that a combined meat (rabbit or chicken) and potato “Chiparoo” could be manufactured safely using drying conditions achievable in the nutribusiness dryer (55°C for 9 h) (14). In that study, a 5-log reduction was achieved for each of 4 pathogens (Listeria monocytogenes, Salmonella typhimurium, *Escheria coli* O157:H7, and *Staphylococcus aureus*) inoculated into the raw product.

Chiparoos fit into a continuum of foods with meat jerky at one extreme (very chewy) and potato chips at the other (easily crumbled). They are more crumbly than jerky but more durable than a potato chip. For best utility, a Chiparoo should be able to be eaten as a snack by school-age children or be easily crumbled into a weaning porridge for younger children. The properties of Chiparoos may be influenced by manufacturing procedures. Chiparoos manufactured with raw meat of differing particle size up to 4.8 mm did not exhibit much change in drying rate, color, or texture. However, Chiparoos cut to greater thickness, up to 6.3 mm before drying, were slower to dry, exhibited less red color, and were harder to crumble after drying.

In another effort to improve the Chiparoo process, Harper utilized a manufacturing procedure that included an initial water cooking step before slicing and drying the Chiparoos (Fig. 2) (15). This procedure enhances the microbial safety of the process because the batter is fully cooked before the slower drying process. This work also investigated the development of lipid oxidation in Chiparoos during storage. Lipid oxidation or oxidative rancidity commonly leads to pronounced flavor and color changes and production of injurious peroxide or free radical compounds (16). In this project, 2 meat species, rabbit and chicken, were compared along with the use of 3 levels of added sodium phosphate (0.2, 0.3, and 0.4%) to help control lipid oxidation. Phosphate level had little effect on the physical properties of the Chiparoos and only slightly reduced lipid oxidation as measured by the thiobarbituric acid test. However, meat species affected several properties of Chiparoos. Rabbit

![Figure 2 Chiparoo slices from cooked chub (left) and strips of raw batter (right).](image-url)
Chiparoos had a lower cook yield and pH while demonstrating an increased ease of rehydration, greater ease of crumbling, and greater lipid oxidation. In light of these findings, work is planned to investigate the properties of Chiparoos made from several other meat species.

A nutribusiness strategy that improves child and family nutrition and promotes economic development may be applicable in impoverished communities around the world. The food products manufactured by the cooperative can be adapted to locally available ingredients and cultural considerations of the foods offered to children. The first Chiparoos were developed for Kenyan communities using native sweet potatoes and small animals (chickens and rabbits) that, unlike beef, are not considered to be “adult” or “men’s” foods. Those Chiparoos also used locally available lime juice for increasing acidity and improving microbial safety. In other countries or regions Chiparoos could be made from other local meat sources and possibly fish. The starch or carbohydrate for Chiparoos may derive from various potatoes, other tubers, or grains. For successful operation of the nutribusiness cooperative, the manufactured products should use locally available ingredients and be acceptable within the local culture.

**Literature Cited**