5

Social Science Approaches to Including Nutrition Research in the International Sorghum/Millet CRSP

Kathleen M. DeWalt and Billie R. DeWalt

Research in southern Honduras as part of the International Sorghum/Millet Project (INTSORMIL) began in 1981. The primary task of University of Kentucky social scientists was to outline the socioeconomic constraints on production, distribution, and consumption of sorghum—an important crop grown on the Pacific coast of Central America. Conducted entirely by anthropologists and sociologists, this research was originally designed as a diagnostic study within the farming systems research (FSR) framework (B. DeWalt 1985; Shaner et al. 1981).

In this INTSORMIL study, significant components of the FSR "diagnosis" included the role of sorghum within the food system of southern Honduras, ways in which agricultural research could improve its role, and potential nutritional consequences of agricultural change. As fieldwork progressed between 1982 and 1984 it became evident that most farming systems research focused too heavily on production aspects of the food system. FSR needs to be supplemented by what we call "nutrition systems research" (K. DeWalt 1981, 1983; Richards 1932; Tripp 1982, 1984).

FARMING SYSTEMS RESEARCH FINDINGS

Since, the results of INTSORMIL's FSR work in southern Honduras have been reported in detail elsewhere (B. DeWalt and Alexander 1983; DeWalt and DeWalt 1982; B. DeWalt and Duda 1985; Stonich 1986), the main findings are only briefly summarized here in order to provide a background for describing the most important nutrition systems research components and findings.

From 1981 to 1984, research focused on three agrarian-reform communities of the coastal plains and six communities in two ecological zones of the highlands. We found that sorghum is an extremely important part of intercropping schemes in both lowland and highland communities.

These cropping systems have evolved primarily in response to regional rainfall patterns. Southern Honduras is marked by distinct dry (December to April) and rainy (May to November) seasons. However, the approximately 1,600 mm average rainfall masks considerable variation in actual rainfall from year to year. Also, a very distinct dry period called the *canícula* often occurs during the rainy season. Usually falling in July, the *canícula* poses an additional risk to cropping.

Maize is the basic food staple in southern Honduras, but it is a very risky crop because of the rainfall patterns noted above. To minimize crop loss, a maize with a very short growing season is raised. The main crop is planted in late April or early May for harvest during the *canícula* in July. If the rains begin late, or if the *canícula* begins early, this crop may be lost. Another maize crop is sometimes planted in August to take advantage of the rains after the *canícula*, but this crop is even more likely to fail. To minimize risk and ensure some sort of harvest, farmers intercrop sorghum with the early planting of maize. This system might appear to make little sense from an agronomic perspective because the plants compete for the same nutrients, but sorghum's greater drought tolerance is a distinct advantage. Sorghum stays in the field long after the maize has been harvested. Because photoperiod sensitive varieties are employed, sorghum does not flower until October and is not harvested until December. Cowpeas are also sometimes added to the intercropping system.

Sorghum is used for three purposes in southern Honduras: as a grain for making tortillas, the basis of the household diet; as feed for domestic livestock, especially pigs and chickens; and as a cash crop, large quantities of which enter the national marketing system, usually as livestock feed.

In southern Honduras, land is increasingly being converted to pasture for cattle (B. DeWalt 1983, 1986), and sorghum is becoming important within the cattle production system. During the lengthy dry season, cattle graze the sorghum residues. Late in the rainy season, landowners sometimes plant dense stands of sorghum; this forage sorghum is pulled up, bound into hands, and stored for cattle fodder during the dry season.

In the highlands, sorghum and maize are planted as part of a shifting cultivation system. Secondary forest is cut, and after two or three years of cultivation, the land is allowed to return to forest or is turned into pasture for livestock. In addition to the increased conversion of cropland into pasture, there is growing evidence that fallowing cycles are being shortened (Boyer 1983, Durham 1979). Also, soil fertility is declining, and soil erosion is becoming an ever-greater ecological threat (DeWalt and Alexander 1983; Stonich 1986). As a result, yields of basic grains in the region are dropping. In 1982, for example, the average yield of sorghum per hectare was only 540 kg; the comparable figures for maize and beans were 550 kg and 270 kg respectively.

The more productive lowlands are farmed mostly by large landowners who plant cash crops (e.g., sugarcane, cotton, melons) and, increasingly, pasture for cattle. A few agrarian reform communities were created in the lowlands during the late 1970s and early 1980s. In these communities, farmers often produce the same cash crops on land that is worked collectively (Adelski 1983), but usually each family is also allocated one or two hectares for cultivating grains for household needs.

FSR research conducted by INTSORMIL social scientists in nine communities in the region identified a number of food-crop production and storage constraints. The most important constraints were the erratic rainfall patterns and the declining productivity (and erosion) of the soil. In approximate order of importance, other constraints included postharvest storage losses to granary weevils and in-field losses to birds, plant disease, and insect damage (DeWalt and DeWalt 1982). These are all problems being addressed by INTSORMIL agricultural scientists. However, in our view, more important than the FSR findings are the constraints and recommendations identified by the nutrition systems research.

NUTRITION SYSTEMS RESEARCH

It is increasingly evident that several decades of technological modernization and economic growth have not significantly improved the nutritional status of marginal, rural populations. Consequently, there have been calls for a reevaluation of the potential for agricultural R&D projects directly to address nutritional problems among rural populations (FAO 1982; Pinstrup-Anderson 1981; Swaminathan 1984; USAID 1982a, 1982b, 1984a, 1984b). Arguments for the explicit inclusion of nutritional goals in agricultural R&D have followed two related lines.

The first is based on the realization that present approaches to improving the nutritional status of economically marginal rural people have not had, and are not likely to have, a positive impact. Nutrition programs are probably best suited for solving specific nutritional problems in small target groups at special risk (Beaton and Ghassimi 1979; Kennedy and Pinstrup-Andersen 1983, Pinstrup-Andersen 1981). Overall economic growth, where it has occurred, has frequently bypassed rural areas. The notion that the benefits of development will eventually "trickle down" to the nutritionally at risk in rural areas has not been vindicated (Selowsky 1979).

A second, related argument is that past failures to explicitly include nutritional goals in, or to anticipate the nutritional impacts of, the development of agricultural technology may have led to the deterioration of nutritional status among rural populations, especially small farmers. For example, in a review of nutrition, consumption, and agricultural development, Fleuret and Fleuret (1980) conclude that few programs to improve the productivity of small farmers have had a positive impact on family nutritional status. Some may even have contributed to a decline in nutritional status. Several studies of the impact of Plan Chontalpa in Tabasco, Mexico, show similar results (Dewey 1980, 1981a, 1981b; Hernández et al. 1974). There, productivity improved dramatically, but only the urban population's nutritional status was improved. Postmortems such as these have led to a growing realization that, while agricultural technology is not nutritionally neutral, the ways in which development projects and changing agricultural technology affect nutritional status are not clearly understood (Lunven 1982).

To tackle these issues, four areas must be addressed in agricultural research programs aimed at improving farm-family nutrition. These are: (1) targeting agricultural programs to those at greatest nutritional risk; (2) understanding utilization of crops and the potential impact of new crops or new varieties on overall diet, and predicting the impact of new agricultural technology on food consumption; (3) recommending ways in which agricultural R&D programs can improve the nutritional situation of those most at risk; and (4) monitoring and evaluating program impacts on food consumption and nutritional status. Each of these has somewhat different data needs and requires a different approach to data collection and analysis. Below, we illustrate these needs and approaches with INTSORMIL social science research in southern Honduras.

Targeting Agricultural Programs

Targeting agricultural research to groups at risk or to the nutritionally neediest is a crucial first step in incorporating nutrition into agricultural projects. As Reutlinger (1983) and others have pointed out, agricultural and rural development projects often fail to reach the people whose nutritional needs are greatest. Information necessary for targeting research and projects to such groups is thus quite important. Several approaches to targeting are discussed in Campbell 1985, Frankenberger 1985, Mason 1983 and 1984, and Mason et al. 1985. Joy (1973) and others (e.g., Valverde et al. 1981) have suggested an approach that includes identifying "functional classes" (that is, groups that are at risk because they share common problems, ways of making a living, resource constraints, and other factors) for whom a set of recommendations can be made. The notion of functional classification in the nutrition literature parallels the "recommendation domains" (Byerlee et al. 1982; B. DeWalt 1985) of FSR approaches to agricultural R&D.

The process and outcomes of targeting include the identification of specific nutritional problems, either through surveys or the use of secondary data; the selection of specific at-risk groups, defined in terms of their unique nutritional needs and the constraints they face in meeting these needs; and an analysis of the etiology of malnutrition. Through such research, targeting can identify crops and cropping techniques that can address those needs through agricultural research.

In the work of INTSORMIL social scientists, targeting research to the needs of the rural poor began with the identification of sorghum and millet as important crops for investigation. Like most of the CRSP commodities, sorghum and millet have been relatively neglected in terms of research, even though they form the subsistence base in a number of regions of the world experiencing nutritional stress. Furthermore, these crops are most likely to be used by groups at greatest nutritional risk. Improved availability of such crops therefore should differentially benefit those most at risk.

In order to identify those households at greatest risk of malnutrition in southern Honduras and to document the pattern of sorghum use in relation to nutritional needs in the region, we collected data on household nutritional status and dietary adequacy, with an emphasis on the use of alternative grains. Estimates of household nutritional status were based on anthropometric measurements of children 60 months of age and under. Length was measured in centimeters using an infantometer for children unable to stand unaided. For children able to stand, height was measured with a board in which a metal meter tape had been imbedded. A sliding headboard was used to read the height. Weight was measured to the nearest 100 grams, using a spring-type Salter scale for children under 10 kg. Children over 10 kg were weighed using a dial-face spring scale. Children's weight for age, height for age, and weight for height were calculated as a percentage of standard using the World Health Organization standards (WHO/FAO 1979).

Of all the children measured in the nine research communities, 65% were less than 95% of standard height for age (that is, stunted), but only 13% were under 90% of standard weight for their height (wasted). This pattern suggests that two-thirds of these children experienced undernutrition at some time in their first five years of life, but that acute undernutrition, as measured by low weight for current height, is less of a problem at any one time.

Dietary adequacy for all families was analyzed using estimates of food intake from 24 hour recalls of family meals, plus a food-use interview that focused on the week before the interview date. Amounts of energy and protein available to the household were calculated and expressed as a percentage of household needs. Protein and energy needs were calculated using WHO estimates of the requirements for individuals of the same age and sex as household members. These figures were then summed for the household.

On the average, families met 110% of their energy needs and 200% of their protein needs. However, these findings mask considerable variation, because 49% of the families did not meet their estimated energy requirement. In contrast, only 1% of families failed to meet their need for protein, thus indicating that calories are a much more significant limitation than is protein.

Although nutritionists in the Ministry of Health in Tegucigalpa and at INCAP (Institute for Nutrition for Central America and Panama) had reported that sorghum was not an important food for direct human consumption in the region, we found that this was not the case. Overall, basic grains, either maize or sorghum, provided 75% of the energy and 64% of the protein available to families. However, use patterns for the different grains varied among families, especially in the highland communities. Families in the poorest households—those of tenant farmers and sharecroppers and those headed by women—were much more likely than were landowners to use sorghum rather than maize, to use sorghum a greater percentage of the year, and to purchase sorghum for food (Thompson et al. 1985). They were also the families at greatest nutritional risk. Thus, improved availability of sorghum would more likely benefit the most nutritionally at-risk segments of the highland communities.

In the lowland agrarian-reform communities surveyed, the most interesting variation in sorghum use occurred between years. When lowland communities were originally surveyed in the summer of 1982, less than 3% of the families reported using sorghum. But a year-long drought began with the second planting season in 1982, and the second maize crop of 1982 and the first crop of 1983 failed. Resurvey of the lowland communities in 1983 showed that 25% of the families were using sorghum. While this was much less than the 68% of highland families using sorghum at the same time, it is a dramatic increase from 1982. The conclusion is that, for lowland communities, sorghum is most crucial in times of economic hardship.

Two specific questions regarding the nutritional problems of poor Central American communities had been raised by biological scientists. One was whether there was a need in the region for "quality protein" sorghum, i.e., sorghum high in lysine. The second question related to the finding by some INTSORMIL biological scientists that sorghum-based diets increase ascorbic acid requirements (Klopfenstein et al. 1981, 1983). This could be a critical limiting factor because some research has suggested that ascorbic acid may be a limiting nutrient in Central American diets (Futrell et al. 1982; INCAP 1969).

With regard to the first question, although the diets of communities in southern Honduras are poor, the limiting factor appears to be energy rather than protein. The need for high-quality protein is, of course, greater among small children than adults. We therefore surveyed children's diets separately and found that children are differentially fed high-protein foods, such as milk and eggs. Our conclusion is that, while quality protein sorghum might benefit groups with a *severely* limited diet, sufficient protein sources are available in southern Honduras and used so that the limiting factor contributing to protein-calorie malnutrition is energy.

Dietary data for ascorbic acid are not yet analyzed, but we have documented the wide availability and use of fruits and vegetables with high ascorbic acid content. Qualitative data on the seasonal availability of fruits and vegetables suggest that wild or cultivated fruits are available almost year-round. During April, mangos and a wild fruit called *tiguilote* are available. In April and May 1983, highland households were also consuming approximately 200 wild plums (*jocote*) per week. The harvest of acerola (*nance*), a wild fruit with one of the highest-known ascorbic acid contents, occurs from May to the end of June. A second harvest of mango begins in August. These second-season mangos are of inferior quality and are often wormy; since they are not suitable for sale, they are more likely to be consumed within the household. Throughout the fall, a series of wild fruits is available until the rains end. During the dry season, some local citrus are available. At this time, too, households have more cash, and they appear to buy more of the staple vegetables, such as cabbage and potatoes. Most families eat cabbage several times a week, either cooked or raw in a salad. Market-basket surveys show that potatoes are purchased at least once a week by almost all families. At the end of the dry season, in February and March, cashew fruits ripen and constitute a favored snack food.

Our information on the availability and use of ascorbic acid-containing fruits and vegetables differs somewhat from other studies. We are tempted to conclude that because many of these foods are gathered from the wild and consumed casually, their use has been poorly reported in dietary surveys. The incorporation of ethnographic methods into our survey research allowed us to document the use of these foods. Whatever the final conclusions concerning the effect of sorghum consumption on ascorbic acid requirements, from our surveys there appear to be abundant sources of ascorbic acid available to families in southern Honduras. Thus, improving the production and availability of sorghum for human consumption need not focus on increased ascorbic acid requirements.

Understanding and Predicting Potential Impacts

The second area of investigation in the nutritional systems research framework is the utilization of crops or other foods that are to be introduced, improved, or made more available through agricultural research. For example, the introduction of new, more productive varieties of food crops would have little impact on local diets if such varieties lack the characteristics that make them acceptable foodstuffs or if they are nutritionally inferior. Acceptability is closely tied to methods of food preparation and the kinds of products that result. For example, the grain quality characteristics that produce an acceptable porridge may be different from those for an acceptable flatbread or fermented beverage.

Preparation techniques may, in themselves, influence the nutritional quality of food. The relationship between niacin availability and the alkaline treatment of maize has been recognized for some time (Katz et al. 1974). Where such relationships between indigenous preparation techniques and the nutritional quality of a food are unknown, introducing new food crops without anticipating the effects of preparation may impair dietary adequacy. An analysis of the acceptability and important organoleptic properties of food crops must also include an understanding of food beliefs and preparation practices relating to the crops.

Sorghum has probably been a part of southern Honduran diet for about 100 years. The *criollo* (landrace) grains used have been selected for their appropriateness as a food as well as for their agronomic qualities. A wide variety of products are made from sorghum, many of which are sorghum equivalents of foods also prepared from maize.

For example, sorghum tortillas are prepared using essentially the same method as for maize tortillas. The grain is "nixtamalized" by heating in an alkaline solution of ashes or lime. The hot mixture is then allowed to sit for several hours or overnight. In the highlands, ashes are preferred in preparing sorghum tortillas because the pericarp of sorghum reportedly peels more easily than when lime is used. In the coastal lowlands, the available firewood leaves a salty ash that is said to be unsuitable for preparing tortillas; here, lime is always used. Cooking time for sorghum is roughly one-third the time for maize, or only about 10 minutes versus 30. Some women say the shorter the cooking time, the better and whiter the appearance of sorghum tortillas. It is also claimed that sorghum tortillas equal maize tortillas in quality if the sorghum is not overcooked. Overcooking is said to produce a less acceptable, darker tortilla. After cooking and soaking, the grain is washed and the pericarp removed. The grain is then ground in a hand mill and reground on a stone quern. The resulting *masa* is formed into flat rounds and baked for several minutes on a griddle. When some maize is available, it is preferable to prepare tortillas using half maize and half sorghum to stretch the maize.

While the tortilla is the most common and important product made from sorghum, a number of other foods are also prepared. *Rosquillas* and *rosquetes*, hard cookie-like products, are made from either maize or sorghum masa to which ground fresh cheese, sugar, and other ingredients are added. During the winter months, popped sorghum is formed into balls using honey, to make *albarotes*. A soft drink, *agua fresca*, is made from ground sorghum mixed with water and sugar. Sorghum masa cooked in water or milk produces an *atole*, or thin porridge. In the past, a coffee substitute was prepared by roasting sorghum that is first soaked to prevent popping and then ground to a coffee-like consistency. This could be used alone or mixed half-and-half with coffee beans.

All the products mentioned above were recognized in all the communities surveyed. In all areas, maize was preferred over sorghum for tortillas and most other products. When we began our research, the extent of the use of sorghum as a food was unclear. Consumption studies carried out by INCAP (1969) did not mention sorghum, and the staff of the national nutrition planning commission reported that it was an insignificant part of Honduran diets. These omissions and misconceptions probably arose from people's reluctance to admit to consuming sorghum, and from poor probing by interviewers unaware of the extent of sorghum use. Such findings reflect the generally low prestige of sorghum.

However, the perceived acceptability of sorghum as a maize replacement differs from area to area and from time to time. In general, sorghum is more acceptable in highland communities, where it serves as an insurance crop in the subsistence farming system. In the lowlands, commercialized agriculture results in a diet that is more likely to be purchased; when funds permit, maize is preferred. In INTSORMIL's first survey of lowland communities, few households reported making tortillas from sorghum. Women generally stated that, during the two or three weeks of the year when maize was unavailable, they would use sorghum. They claimed that the "hill people" were sorghum users, not they. The second survey followed two cropping cycles of drought. During the drought, resources were much more limited in the lowlands than in the highlands. Because it was cheaper than maize, sorghum was purchased far more frequently in the lowland communities; responses concerning its acceptability as a human food became much less negative.

In sum, the most important grain-quality characteristics of sorghum are those contributing to high-quality tortillas. The most acceptable sorghums are those that produce the lightest colored tortillas. Shorter cooking time and ease of pericarp removal are also important. These desirable food-quality characteristics, however, need to be balanced against other important aspects of sorghum production. Postharvest storage loss to granary weevils is a significant constraint on sorghum availability. However, the most weevil-resistant sorghums may not be the best food-quality ones. Several of the "improved" varieties of sorghum previously released in the region are more susceptible to weevils than are the criollo varieties. While this does not affect the desirability of the grain when it is grown as a cash crop for sale immediately following the harvest, many people felt that the "improved" varieties were not suitable for home storage and consumption.

A second area of sorghum acceptability has to do with a very different "quality." In Latin American food classification systems, foods (as well as illnesses and medicines) are classified as having an essential quality that can range from hot to cold. Sorghum is ranked as "cooler" than maize, which is considered neutral. Although not everyone still follows the traditional hot/cold food classification system, some people report that nursing mothers should not eat sorghum tortillas because the coolness could sicken their infants. Some nursing women will therefore prepare sorghum tortillas for their families and maize tortillas for themselves. For children, however, all sorghum-based foods are considered appropriate.

Even when they are considered appropriate and acceptable, sorghum tortillas are believed to be less filling than are maize tortillas. A frequently reported formula holds that five sorghum tortillas are as filling as four maize tortillas. This observation may relate to the controversy surrounding the digestibility of sorghum protein and its effect on human nutrition. Studies of children recovering from malnutrition show poor digestibility of sorghum protein in a product made from whole ground sorghum (McLean et al. 1981). However, digestibility appears to be affected by processing methods. Sorghum that has been decorticated and heat-extruded has been found significantly more digestible (McLean et al. 1981). To date, however, there has been little testing of sorghum prepared in traditional dishes, in contrast to the well-known finding that the preparation of maize for tortillas alters the availability of a number of nutrients, including niacin and several amino acids.

Since our research in Honduras, several INTSORMIL technical scientists have begun to investigate the digestibility of sorghum products prepared by indigenous techniques. For example, in experiments with young pigs, Serna-Saldívar et al. (n.d.) have demonstrated that protein digestibility of pearled sorghum cooked in a lime solution is roughly equivalent to that of similarly prepared maize. The digestibility of protein in several African dishes where sorghum is cooked in an acid medium is similar to other staple grains (Kirleis n.d.). Further testing of sorghum products prepared with traditional techniques such as nixtamalization would be an important addition to understanding potential nutritional problems in sorghum-based diets.

Recommending Ways Agricultural Research Can Improve Nutrition

A set of tentative recommendations emerged from our farming systems and nutrition systems research. These were discussed formally and informally with biological scientists, especially the plant breeder who has led INTSORMIL's efforts in southern Honduras since late 1981. Input from both social and biological scientists resulted in a set of goals that have guided further sorghum R&D in the region.

First, it was decided that a sorghum improvement program in the region would be valuable because sorghum is differentially utilized by the poorest members of the population. The most resource-poor farmers grow the crop, and the most resource-poor families include it more frequently in their diet. Thus, improved sorghum production, especially by small farmers, would likely improve nutrition for those most at risk.

Second, it was determined that the photoperiod sensitive varieties of sorghum grown in the region are uniquely adapted to the ecological circumstances. Early-maturing hybrids are suitable only for commercial farmers in the lowlands. Targeting research results to those most in need would be better achieved if local varieties were improved. Furthermore, double-cropping sorghum in the lowlands could greatly increase pest problems because a suitable habitat for these pests (especially the sorghum midge) would be present for a much longer period of the year. Therefore, breeding goals have focused on improving criollo sorghum varieties in southern Honduras. Some work on hybrids will be carried out, but only as a secondary goal.

Third, improved varieties resulting from the breeding program should fit within existing cropping systems and the Honduran government's relatively resource-poor seed distribution and extension programs. Unlike hybrids, varieties do not require an elaborate extension infrastructure because they can be passed on from farmer to farmer. Farmers already engage in such trading of germplasm. In addition, landrace varieties are already fairly high-yielding given the conditions under which they are grown. The greatest hope for improved yields may lie in a dwarfing gene to reduce the height of current varieties, thus allowing the plants to put more energy into seed production and less into the stalk. Furthermore, reduction of height likely could be accomplished without reducing the value of sorghum for livestock. The tall sorghum stalks are so woody that they are not very palatable for cattle. Reducing the height while keeping leaf biomass high is the goal.

A fourth advantage of working primarily with local varieties is that they already have several important grain-quality characteristics. For example, their hard pericarp provides some protection against granary weevils. The "best" existing varieties (in terms of their acceptability as a human food) were identified, and breeding goals centered on enhancing these food-quality characteristics.

Fifth and finally, it was determined that there was no real need to build a quality-protein component into the breeding program. The limiting factor in the region is calories, so improved yields and grain quality are more important goals for biological research.

Monitoring and Evaluating Program Impacts

As research continues and improved varieties are created, we feel strongly that their acceptability to farm families in the region must be assessed. The data we collected were useful not only for project planning, but also for social science monitoring and evaluation of the effects of INTSORMIL R&D. We hoped that during the course of the project we could continue to collect anthropometric and household economic data to determine whether the benefits of INTSORMIL research were in fact reaching and assisting those for whom they were most intended, but the social science component of INTSORMIL has since been eliminated. Consequently, further monitoring under program auspices will not be possible. Nevertheless, we hope eventually to use the baseline information that we gathered to conduct a meaningful evaluation of the impact of this CRSP research program on communities in southern Honduras.

SUMMARY AND CONCLUSIONS

The inclusion of a nutrition systems approach in farming systems research in southern Honduras allowed us to directly address a series of questions important for guiding and implementing biological agricultural research in the INTSORMIL CRSP. Information generated by social scientists has had an impact on the research priorities of sorghum breeders and other scientists working on issues of grain quality and utilization.

We have argued strongly for targeting research to meet the constraints of small farmers, especially those who rent land. At the same time, consumption data suggest that much of the sorghum eaten by such families in southern Honduras is purchased. Hence, an increase in sorghum availability in local markets with a decrease in price is likely to differentially benefit those at greatest nutritional risk.

Information on sorghum acceptability and utilization has highlighted the need to investigate indigenous methods of preparation, both to understand the grain-quality characteristics necessary to produce acceptable foods and to evaluate the nutritional significance of processing techniques. Finally, an understanding of the place of a single commodity such as sorghum in the diet as a whole is necessary in order to evaluate the importance of the nutritional characteristics of alternative varieties in establishing breeding priorities.

REFERENCES

Adelski, M. Elizabeth. 1983. The Role of Cotton in the Agricultural System of Southern Honduras. *Practicing Anthropology* 5(3):14, 18.

Beaton, George, and Hossein Ghassemi. 1979. *Supplementary Feeding Programs for Young Children in Developing Countries*. New York: UN Children's Fund.

Boyer, Jefferson. 1983. Agrarian Capitalism and Peasant Praxis in Southern

Honduras. Ph.D. dissertation, Anthropology, University of South Carolina.

Byerlee, Derek, L. Harrington, and D. L. Winkelmann. 1982. Farming Systems Research: Issues in Research Strategy and Technology Design. *American Journal of Agricultural Economics* 64:897–904.

Campbell, Carolyn. 1985. Rationale and Methodology for Including Nutritional and Dietary Assessment in Farming Systems Research/Extension. Bean/Cowpea CRSP Working Paper 85.3E. Cornell University: Bean/Cowpea CRSP. Mimeo.

DeWalt, Billie R. 1983. The Cattle Are Eating the Forest. *Bulletin of the Atomic Scientists* 39:18–23.

———. 1985. Anthropology, Sociology and Farming Systems Research. *Human Organization* 44:106–114.

———. 1986. Economic Assistance in Central America: Development or Impoverishment? *Cultural Survival Quarterly* 10:14–18.

DeWalt, Billie R., and Sara Alexander. 1983. The Dynamics of Cropping Systems in Pespire, Southern Honduras. *Practicing Anthropology* 5(3):11, 13.

DeWalt, Billie, and K. M. DeWalt. 1982. Socioeconomic Constraints to the Production, Distribution and Consumption of Sorghum in Southern Honduras. INTSORMIL Farming Systems Research in Southern Honduras Report No. 1. Lexington: University of Kentucky College of Agriculture.

DeWalt, Billie R., and Susan Duda. 1985. Farming Systems Research in Southern Honduras. In Fighting Hunger with Research. Judy F. Winn, ed., pp. 184–192. University of Nebraska: INTSORMIL.

DeWalt, K. M. 1981. Diet as Adaptation: The Search for Nutritional Strategies. Federation Proceedings 40:2606–2610.

———. 1983. *Nutritional Strategies and Agricultural Change*. Ann Arbor: University of Michigan Research Press.

Dewey, Kathryn G. 1980. The Impact of Agricultural Development on Child Nutrition in Tabasco, Mexico. *Medical Anthropology* 4(1):21–54.

———. 1981a. Nutritional Consequences of the Transformation from Subsistence to Commercial Agriculture in Tabasco, Mexico. *Human Ecology* 9(2):151–187.

———. 1981b. Agricultural Development, Diet and Nutrition. *Ecology of Food and Nutrition* 8:265–273.

Durham, William. 1979. *Scarcity and Survival in Central America: The Ecological Origins of the Soccer War*. Stanford: Stanford University Press.

FAO. 1982. *Integrating Nutrition into Agricultural and Rural Development Projects: A Manual*. Nutrition in Agriculture No. 1. Rome: FAO.

Fleuret, P., and Ann Fleuret. 1980. Nutrition, Consumption and Agricultural Change. *Human Organization* 39:259–260.

Frankenberger, Timothy R. 1985. *Adding a Food Consumption Perspective to Farming Systems Research*. Washington, DC: USDA, Nutrition Economics Group, Technical Assistance Division, Office of International Cooperation and Development; and USAID, Bureau for Science and Technology, Office of Nutrition.

Futrell, Mary, Robert Jones, Louis Blum, and Eunice McCulloch. 1982. Socioeconomic and Nutritional Factors Relating to Grain Sorghum Production and Consumption in Southern Honduras: Preliminary Summary of 1981 Field Research. Starkville: Mississippi State University. Mimeo.

Hernández, M., C. P. Hidalgo, J. R. Hernández, H. Madrigal, and A. Chávez.

1974. Effect of Economic Growth on Nutrition in a Tropical Community. *Ecology of Food and Nutrition* 3:283–291.

INCAP . 1969. *Evaluación nutricional de la población de Centroamérica y Panamá: Honduras*. Guatemala City: INCAP.

Joy, Leonard. 1977. Food and Nutrition Planning. *Journal of Agricultural Economics* 24:165–192.

Katz, S. H., M. L. Hediger, and L. A. Valleroy. 1974. Traditional Maize Processing Techniques in the New World. *Science* 184:765–774.

Kennedy, Eileen, and Per Pinstrup-Andersen. 1983. Nutrition-Related Policies and Programs: Past Performances and Research Needs. Washington, DC: IFPRI.

Kirleis, Allan. n.d. Personal communication to Kathleen DeWalt.

Klopfenstein, Carol, Elizabeth Varriano-Marston, and Carl Hoseney. 1981. Effects of Ascorbic Acid in Casein vs. Sorghum Grain Diets in Guinea Pigs. *Nutrition Reports International* 24:1017–1028.

Klopfenstein, Carol, Carl Hoseney, and Elizabeth Varriano-Marston. 1983. Effects of Ascorbic Acid in Sorghum-, High Leucine-, and Casein-fed Guinea Pigs. *Nutrition Reports International* 27:121–129.

Lunven, Paul. 1982. The Nutritional Consequences of Agricultural Development and Rural Development Projects. *Food and Nutrition Bulletin* 4(3):17–22.

Mason, John. 1983. Minimum Data Needs for Assessing the Nutritional Effects of Agriculture on Rural Development Projects. In Nutritional Impact of Agricultural Projects, Papers and Proceedings of a Workshop Held by the United Nations Inter-Agency Subcommittee on Nutrition. J. Muscat, ed., pp. 24–40. Rome: IFAD.

———. 1984. Data Needs for Assessing the Nutritional Effects of Agricultural and Rural Development Projects: A Paper for Project Planners. Nutrition in Agriculture No. 4. Rome: FAO.

Mason, John, Marito García, Janice Mitchell, Karen Test, Clarence Henderson, and Hamid Tabatabai. 1985. Nutritional Considerations in Project Planning: A Case Study of Assessment Methods. *Food Policy*, May:109–122.

McLean, W. C., et al. 1981. Protein Quality and Digestibility of Sorghum in Preschool Children: Balance Studies and Plasma Free Amino Acids. *Journal of Nutrition* 111:1928–1936.

Pinstrup-Andersen, Per. 1981. Nutritional Consequences of Agricultural Projects: Conceptual Relationships and Assessment Approaches. World Bank Staff Working Paper No. 456. Washington, DC: World Bank.

Reutlinger, Shlomo. 1983. Nutritional Impact of Agricultural Projects: Conceptual Framework. In Nutritional Impact of Agricultural Projects, Papers and Proceedings of a Workshop Held by the United Nations ACC Subcommittee on Nutrition. J. Muscat, ed., pp. 1–16. Washington, DC: IFAD.

Richards, Audrey. 1932. *Hunger and Work in a Savage Tribe*. London: G. Routledge and Sons.

Selowsky, Marcelo. 1979. Balancing Trickle Down and Basic Needs Strategies: Income Distribution Issues in Large Middle-Income Countries with Special Reference to Latin America. World Bank Staff Working Paper No. 335. Washington, DC: World Bank.

Serna-Saldívar, S. O., et al. n.d. Nutritional Value of Sorghum and Maize Tortillas. College Station: Texas A&M University. Mimeo.

Shaner, W. W., P. F. Philipp, and W. R. Schmehl. 1982. *Farming Systems Research and Development: Guidelines for Developing Countries*. Boulder: Westview Press.

Stonich, Susan. 1986. Development and Destruction: Interrelated Ecological, Socioeconomic, and Nutritional Change in Southern Honduras. Ph.D. dissertation, Anthropology, University of Kentucky.

Swaminathan, M.S. 1984. Nutrition and Agricultural Development: New Frontiers. *Food and Nutrition* 10(1):33–41.

Thompson, Karen S., Kathleen M. DeWalt, and Billie R. DeWalt. 1985. Household Food Use in Three Rural Communities in Southern Honduras. INTSORMIL Farming Systems Research in Southern Honduras Report No. 2. Lexington, KY: University of Kentucky Experiment Station.

Tripp, Robert. 1982. Including Dietary Concerns in On-Farm Research: An Example from Imbabura, Ecuador. CIMMYT Working Paper. El Batán, Mexico: CIMMYT.

———. 1984. On Farm Research and Applied Nutrition: Some Suggestions for Collaboration Between National Institutes of Nutrition and Agricultural Research. *Food and Nutrition Bulletin* 6(3):49–57.

USAID (United States Agency for International Development). 1982a. AID Policy Paper: Nutrition. Washington, DC: USAID.

———. 1982b. AID Policy Paper: Food and Agricultural Development. Washington DC: USAID.

———. 1984a. Nutrition Sector Strategy. Washington, DC: USAID.

———. 1984b. Africa Bureau: Nutrition Guidelines for Agriculture and Rural Development. Washington, DC: USAID.

Valverde, Victor, William Vargas, Philip Payne, and Anne Thompson. 1981. Data Requirements and Use in Nutrition Planning in Costa Rica. Food Policy Feb:19–26.

WHO/FAO. 1979. Measurement of Nutritional Impact. WHO/FAO 79.1. Geneva: WHO.