FINAL REPORT

# IDENTIFICATION AND EVALUATION OF ALTERNATIVE INDICATORS OF FOOD AND NUTRITION SECURITY: SOME CONCEPTUAL ISSUES AND AN ANALYSIS OF EXTANT DATA

by

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## EXECUTIVE SUMMARY

The objectives of this report are two-fold: first, to identify nontraditional or 'alternative' indicators of food and nutrition security, and, second, to develop a conceptual framework in which to evaluate them.

Traditional indicators of food and nutrition security—household calorie adequacy from recall and preschooler anthropometric indicators, for example—have been found difficult to incorporate into ongoing monitoring and evaluation systems. Do any alternative indicators exist which are less expensive to collect—either because they already exist, or because they represent only two or three different values or categories—but are, nevertheless, valid and reliable in locating the food and nutrition insecure? Using information from seven data sets, representing four countries, we rank the ability—both singly and jointly—of several promising indicators from the literature to locate the food and nutrition insecure as defined by the more traditional indicators.

In addition, a conceptual framework for thinking about the utility of different alternative indicators is developed. A potentially useful indicator should be characterized by its costs of collection (which include costs associated with acting upon that information) and its costs of noncollection (or alternatively, the benefits foregone of

noncollection). Relative to the existence of no indicators, the initial indicator adopted should have the highest benefit per unit of cost of collection within budgetary constraints. Relative to a sophisticated but unsustainable monitoring system, simpler indicators should be adopted if the subsequent cost savings exceed the extra costs needed to maintain the effectiveness of the intervention in the information-depleted environment.

The central message of the empirical analysis is that relatively simple indicators perform well in locating the food and nutrition insecure. Comparable to more complex indicators, such as household income level and food expenditure, indicators such as the number of unique foods consumed, the household's dependency ratio, household rooms per capita, incidence of illness, vaccination status, age at weaning of the preschooler, and household drinking water and sanitation facilities—all coded with only two or three different values—were able, either singly or in combination, to identify households and preschoolers at risk of food and nutrition insecurity.

While we list an extensive number of indicators—classified into demographic, factor market, and proximate groupings—that perform well in locating the food and nutrition insecure in the data sets, we maintain that much better classification will likely be achieved in a location-specific setting, preferably in a participatory manner.

# IDENTIFICATION AND EVALUATION OF ALTERNATIVE INDICATORS OF FOOD AND NUTRITION SECURITY: SOME CONCEPTUAL ISSUES AND AN ANALYSIS OF EXTANT DATA

## 1. INTRODUCTION

Identification of valid and reliable indicators is a key task when developing a viable food and nutrition monitoring system. This lesson derives from the ten years of experience with nutrition surveillance (Tucker et al. 1989) when policymakers and implementors in developing countries found many of the traditional indicators recommended in the past difficult to incorporate into ongoing monitoring and evaluation systems.

The purpose of the present work is to identify "alternative" indicators that can be used in food and nutrition monitoring and evaluation systems.[1] The term "alternative"[2] is used because we are seeking indicators that are potentially easier to collect and analyze and less costly than the traditional indicators used to monitor food

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[1] This work builds on earlier work funded by the Office of Nutrition under the Agricultural/Nutrition Linkages project.

[2] Many of these indicators are what have also been termed 'Qualitative' indicators of development by McGranahan, Scott, and Richard (1990).

security and nutritional status such as household calorie adequacy and preschooler anthropometric measures.[3]

Some definition of terms is warranted before proceeding further. Food security, as used in this report, means the availability of sufficient food at all times for all people in order to ensure an active and healthy life. Sufficient food refers to both quantity and quality needed[4] for good health. The term 'food security' has been used at the national, regional, community, household, and individual levels (Maxwell 1990). For the purpose of this report, food security indicators are developed primarily for the household level.

Nutrition security, a less common term than food security, is defined as the appropriate quantity and combination of inputs such as food, nutrition/health services, and caretaker's time in order to ensure an active and healthy life at all times for all people. That is, food security is necessary, but not sufficient, for nutrition security. Nutrition security indicators are developed at the preschooler level.[5]

This report has two main objectives:

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[3] The conceptual and technical problems, for instance, of using anthropometric indicators for targeted food relief are well documented (Borton and Shoham 1989).

[4] A separate part of the work conducted under the food and nutrition monitoring project will evaluate the effects of policies and programs on micronutrient consumption. A piece of this work will identify types of "alternative" indicators that might be used to monitor and evaluate micronutrient consumption. This information will complement this report.

[5] A separate activity scheduled to begin in Fall 1991 will attempt to identify indicators for women's food security, health, and nutritional status.

1. Identification of alternative indicators of food and nutrition security, and,
2. Developing a conceptual and empirical methodology for the evaluation of these alternative indicators in terms of the costs and benefits of their collection.

These objectives are addressed: first, by developing a conceptual framework for indicator identification and evaluation; second, by reviewing the literature on indicators and, third, by analyzing extant data.

Section two develops a conceptual framework for the identification and evaluation of indicators in terms of the costs and benefits of their use. Section three lays out the rationale behind our selection of potential alternative indicators. We summarize the indicators' literature (a full literature review is provided in Appendix 1), describe the data sets used, and justify the empirical approach utilized in this report. A variety of statistical techniques are considered for application to data sets from Brazil, Ghana, Mexico, and two from the Philippines. We argue in favor of a simple empirical approach; what percentage of households with a given indicator characteristic (or combination of characteristics) are food insecure?

Section four provides the results of analysis of the data sets, comparing traditionally used indicators versus alternative indicators.

Section five summarizes the results of the analyses and the policy conclusions which derive from this work and discusses the type of

protocol that can be used to test the alternative indicators that have been recommended in a variety of field settings.

## 2. CONCEPTUAL CONSIDERATIONS

While it is fully acknowledged that the emphasis in the project on alternative indicators is very much on 'what works' in a particular location at a particular time (that is, on which variables serve as 'good alternatives' to the traditional but, possibly, less sustainable indicators of food and nutrition security), there is, nevertheless, a need for a conceptual framework to give the empirical work some context. Specifically, how do we identify and evaluate alternative indicators that 'work'? Before we develop a decision rule to guide us in addressing this question, we emphasize the conceptual limitations of working with cross-section data sets.

### 2.1 Different Food Security Definitions with Cross-Section and Time-Series Information

Food and nutrition monitoring and evaluation (FNME) systems have two important functions:

1. Identification of the food and nutrition insecure, and,
2. identification of those households or individuals that move in and out of this classification over time.

The two functions are, of course, interrelated, to the point that the definitions of food and nutrition security becomes contentious. For example, consider two households: Household 1 falls below the undernutrition line one-out-of-four times over a two-year period; and

Household 2, which does not fall below the line, but has a lower average calorie adequacy than Household 1. Which household should be considered the more food insecure?

If time-series information is available, the answer to this question depends on the definition of food security adopted. Table 2.1 describes three alternative definitions of food security: whether a household actually falls below an undernutrition threshold; the potential of a household to fall below that threshold; and the ability of a household to recover from falling below that threshold. Under the first definition, Household 1 is classified as more food insecure, but, under the second and third definitions, it is not classified as more food insecure.

However, if only cross-section information is available, only the first definition of food security can be utilized. Moreover, the classification of Household 1 as food secure or insecure will depend on its calorie adequacy at the time of the cross-section. These definitional considerations are extremely important in regions that experience severe seasonality.

An empirical example of the definitional differences and dilemmas that can arise is provided in Table 2.2. Households with higher average calorie adequacies fall below the 80 percent calorie adequacy threshold less often. Note, however, that only five households in the 80-90 percent average calorie adequacy range never fall below the 80 percent threshold. Are these households more or less food secure than the 37 households that have an average calorie adequacy of between 90-100

Table 2.1--Food security definitions of households 1 and 2 with time-series and cross-section information

| | Alternative Food Security Definitions | | | | | |
|---|---|---|---|---|---|---|
| | Fall Below Threshold? | | Potential to Fall Below Threshold? | | Potential to Recover From Below Threshold? | |
| | Household 1 | Household 2 | Household 1 | Household 2 | Household 1 | Household 2 |
| Time-series information | yes | no | yes | yes | yes | no |
| Cross-sectional information | yes or no | no | ? | ? | ? | ? |

Note: Household 1 falls below the food security threshold once in four periods. Household 2 remains above the threshold in all four periods, but has a lower average calorie adequacy.

Table 2.2--Mean household calorie adequacy and frequency with which household falls below the 80 percent calorie adequacy line: 448 households in Bukidnon, Philippines

| Household Mean Calorie Adequacy (Percent) | Number of Times Household Falls Below the 80 Percent Calorie Adequacy Threshold | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 60-70 | 0 | 0 | 4 | 21 | 10 |
| 70-80 | 0 | 4 | 41 | 38 | 7 |
| 80-90 | 5 | 39 | 43 | 10 | 0 |
| 90-100 | 27 | 37 | 16 | 1 | 0 |
| 100-110 | 26 | 30 | 3 | 0 | 0 |
| 110-120 | 25 | 12 | 2 | 0 | 0 |
| 120-130 | 22 | 4 | 0 | 0 | 0 |

Source: IFPRI-RIMCU Survey 1985.

percent, but fall below the 80 percent threshold one-out-of-four times? Or what about the 10 households in the 80-90 calorie adequacy range that fall below the 80 percent threshold three times: are they more or less secure than those 4 households that have average calorie adequacy of less than 80 percent, but only fall below that threshold one out of four times?

As only one of our seven data sets is not a one-shot cross-section, we do not explore these issues here. This does not, however, invalidate the other contributions of this paper: in the vast majority of cases, we only have one cross section to analyze, and furthermore, the methodology of estimating costs of noncollection is applicable to both types of data set.

## 2.2 A Decision Rule

Earlier, we posed the question: which variables serve as 'good alternatives' to the traditional but less sustainable indicators of food and nutrition security? The question now arises: what do we mean by a 'good alternative'? An indicator should be evaluated on a number of criteria that would include, we would expect, accuracy (validity and reliability) and ease of collection and processing (cost, timeliness, and sustainability). These criteria may be usefully characterized, respectively, as the **costs of noncollection** and the **costs of collection**.

The costs of noncollection are essentially the benefits derived from the collection of the alternative indicator. The benefits can be characterized in terms of the fewer calories required to achieve a given

nutritional objective when an alternative indicator is available compared to a non-targeted transfer. Noncollection costs will vary according to the society's sensitivity to its depth of undernutrition, as well as the nutrition objective that is to be optimized.

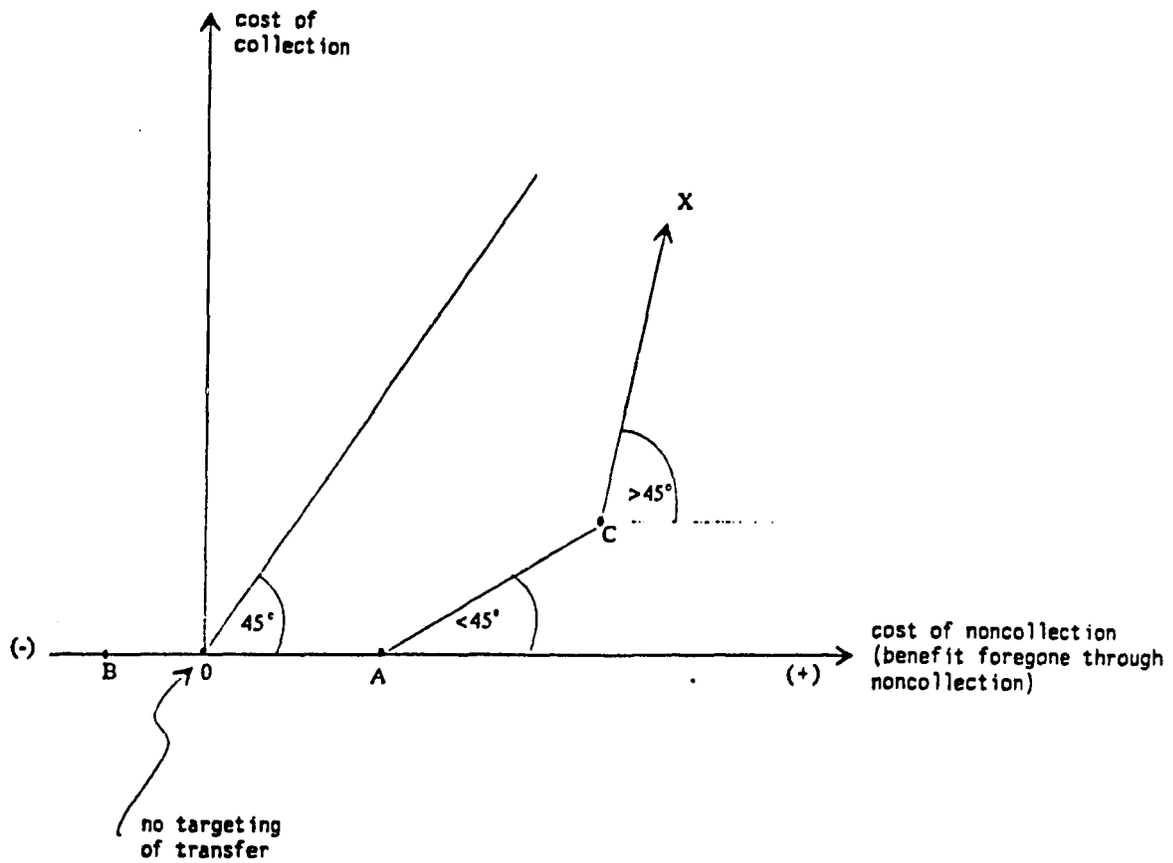
The costs of collection include fixed and variable costs associated with the design, collection, analysis, and sustainability of the data collection effort as well as the costs of acting on the data. These costs may well be subsidized by an external source.

Chambers, whose work in this area revolves around the principles of "optimal ignorance" (not trying to find out more than is needed) and "appropriate imprecision" (not measuring more accurately than is necessary for practical purposes), holds the position that the identification and collection of alternative indicators should embody these principles in order to maximize their usefulness (Chambers 1990). The 'cost of noncollection' concept embraces both these concepts because it is related to the collection of information with a purpose in mind, rather than to the collection of data for data's sake.

Figure 2.1 characterizes some indicators in terms of these two costs. Indicators, represented by points A and B, are collected outside the sphere of food and nutrition monitoring efforts; hence, they appear on or close to the horizontal axis. If their noncollection is likely to neither impede nor enhance attainment of nutritional objectives, we have a non-targeting case at the origin (point 0).

A forty-five degree line through the origin represents equality between the costs of collection and noncollection. If a country has a

Figure 2.1--A decision rule for the collection of different food and nutrition security indicators (A, B, C, X)



surveillance system already in place (at point X on Figure 2.1, for example), we can assume that the cost of collection of such data is outweighed by the perceived cost of noncollection. The question arises: are there indicators on the path between the points O and X that have lower collection cost/noncollection cost ratios (C/NC)? Moreover, if a country does not have a surveillance system in place, how sophisticated should its data collection effort be?

Variables such as dependency ratios, household size, land owned, wage rates, and value of assets, livestock, and so forth, are likely to be collected under a non-nutrition umbrella. How helpful are these variables in monitoring food and nutrition security? For example, let point A in Figure 2.1 represent factor market or demographic indicators: if these variables put us at point A, then the costs of noncollection outweigh the costs of collection.[6] If these variables 'move' well with the traditional indicators, then the costs of not collecting them will be high in terms of meeting nutritional goals. However, if these variables 'move' poorly with the traditional indicators, they can be represented as points closer to the origin. Note that it is possible for the costs of noncollection to be *negative* (point B). In that case, it would be better not to target at all. This alerts us to the fact that we are not involved in a zero-sum game.

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[6] However, there may be some costs incurred from a nutrition perspective because the data could be collected in a more nutrition-oriented way than if collected solely for a production-oriented survey.

Let the next node, C, represent the proximate or dietary indicators of food and nutrition security. Indicators such as number of foods consumed, number of meals, frequency of foods consumed, and meal consumption orderings within the family may well tell us all we need to know about the state of food and nutrition security, and so the costs of noncollection may be high. On the other hand, the costs of collection may not be high (especially when the processing, cleaning, and training components are taken into consideration).

The indicator with the lowest C/NC ratio should be the initial choice. However, note the trade-offs involved in terms of sequence of data collection. If some nutrition data collection resources had previously been devoted to collection of demographic/factor market indicators, we would now be drawing our 45-degree line from point A, not from the origin. The decision has to be reformulated based on costs already incurred and the gains to the collection of data that are ever closer to representing the 'true' food and nutrition picture.

In mathematical terms, where Q is the desired quality of data collected, and C and NC are the collection and noncollection costs, respectively, if

$$\delta C/\delta Q > \delta NC/\delta Q, \quad \text{or alternatively} \quad \delta C/\delta NC > 1,$$

then do not collect the additional information. This decision rule can be derived directly from collection and noncollection cost functions. If costs are a function of the desired quality of data collected and the income or nutrition level of the society or region (Y), then:

$$C = C(Q, Y) \quad \text{and} \quad NC = NC(Q, Y).$$

Furthermore, if Q is a function of Y, as in Q(Y), then a change in C, dC, can be thus decomposed:

$$dC = [(\delta C/\delta Q.\delta Q/\delta Y)+\delta C/\delta Y]dY + \delta C/\delta Q.dQ.$$

A change in NC can be similarly decomposed:

$$dNC = [(\delta NC/\delta Q.\delta Q/\delta Y)+\delta NC/\delta Y]dY + \delta NC/\delta Q.dQ.$$

Thus, the question is posed: for a given Y and Q, is dC greater than or less than dNC? In other words, is dC/dNC greater than or less than 1? An evaluation rests on the relative magnitudes of $\delta NC/\delta Q$, $\delta C/\delta Q$, $\delta NC/\delta Y$, and $\delta C/\delta Y$. All four terms are expected a priori to be positive, but how they balance out is an empirical question.

## 2.3 Measuring Costs of Collection and Noncollection

We have a decision rule, but how do we actually go about measuring the costs of collection and noncollection? The measurement problems with respect to the costs of collection side are considerable (see von Braun, Teklu, and Webb 1991; Horton 1990) and we will defer a detailed evaluation of these to the primary data collection phase of the project, which will facilitate a fuller control of the cost recording procedures. It is important to note, however, that the costs of collection should incorporate the costs of acting upon the indicator information and not simply the costs of collecting that information.

Costs of noncollection depend fundamentally on society's nutrition objectives and goals, and its sensitivity to undernutrition. Recent work in this area (see Ravallion 1989; Glewwe and Kanaan 1989; Haddad and Kanbur 1991) has focussed on gains from targeting when the objective

is to minimize undernutrition in the entire population. We adopt this approach in our conceptualization. For a given level of undernutrition reduction, we evaluate costs of noncollection of information as the calorie savings achieved using this information to target transfers, compared to an untargeted transfer. If targeting reduces undernutrition by more than an untargeted transfer, the value of that information is the amount of extra calories an untargeted transfer would have to deliver in order to achieve the targeted level of undernutrition.

It is important to realize that an improved appreciation of who is likely to fall below the undernutrition line, as compared to no information on this event, does not necessarily guarantee a reduction in undernutrition through targeting. This seemingly counterintuitive result deserves some exposition.

### 2.3.1 Targeting: Not Always a Positive-Sum, or Even a Zero-Sum Game

A brief discussion on the relative importance we assign to errors of exclusion (type I errors of false rejection of the null hypothesis of undernutrition) and errors of inclusion (type II errors of false acceptance of the null hypothesis of undernutrition) will help this counterintuitive idea of no targeting possibly being better than some.

Figures 2.2a and 2.2b plot the inclusion and exclusion errors for two different indicator eligibility cutoffs. Figure 2.2a portrays an indicator that shows no association with food insecurity. At the origin, no household is eligible for a transfer and, therefore, the exclusion error is 100 percent and the inclusion error is 0 percent.

Figure 2.2a--Errors of inclusion and exclusion, when the indicator and food insecurity have no relationship and the incidence of undernutrition is 33 percent

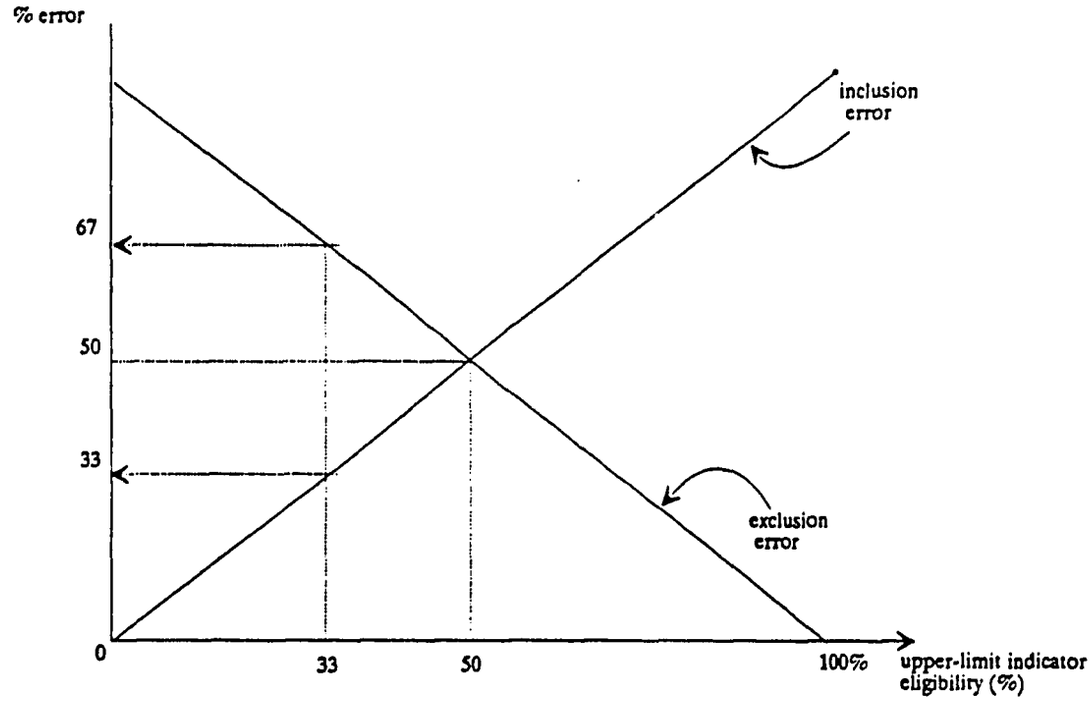
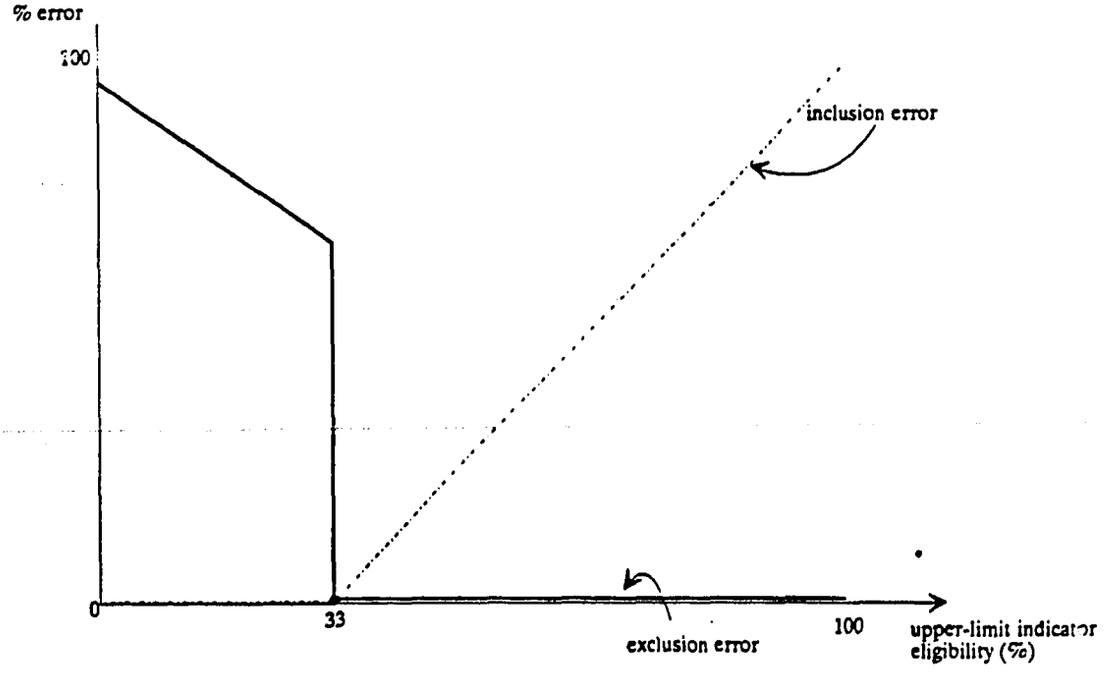



Figure 2.2b--Errors of inclusion and exclusion when the indicator and food insecurity have a perfect relationship in terms of ranks and the incidence of undernutrition is 33 percent



When all households are eligible, the inclusion error is 100 percent and the exclusion error is 0 percent. Eligibility rates between 0 and 100 percent give linear changes in the error rates. Figure 2.2b portrays a perfect indicator; one that accurately ranks households in terms of their food insecurity. If 33 percent of households are undernourished, at 33 percent eligibility, we have a perfect match: all households which are eligible are included and all households which are ineligible are excluded. Both errors are zero: no households are wrongly included or excluded. If eligibility were raised above 33 percent, errors of inclusion would rise, although error of exclusion would remain at zero since the eligible households were the first to be included in the scheme.

An indicator that showed some, but not total, association with food insecurity would have error plots lying between these two extremes. How do we decide from these diagrams where the best eligibility cutoff is? This decision involves value judgements about the relative importance of errors of inclusion and exclusion. A common solution in the nutrition literature is to sum the errors, implicitly assigning them equal weights (Tucker et al. 1989). A more general solution is to use a measure of undernutrition that allows us to vary the severity of this trade-off through the choice of an appropriate 'sensitivity' parameter. One such measure is the Foster, Greer, and Thorbecke (1984) poverty measure, $P_\alpha$. The higher the value of alpha, the more a society cares about the depth of undernutrition. If $\alpha=0$, the $P_\alpha$ index is the head-count ratio, and if $\alpha=1$, it is the income-gap ratio. The index is defined as:

$$P_\alpha = 1/n \sum_{i=1}^{q}(1-y_i/z)^\alpha.$$

The calorie adequacy of the ith individual is ordered around a cutoff (for example, z=80 percent or 100 percent) and if q out of n individuals fall below the poverty cutoff, we have:

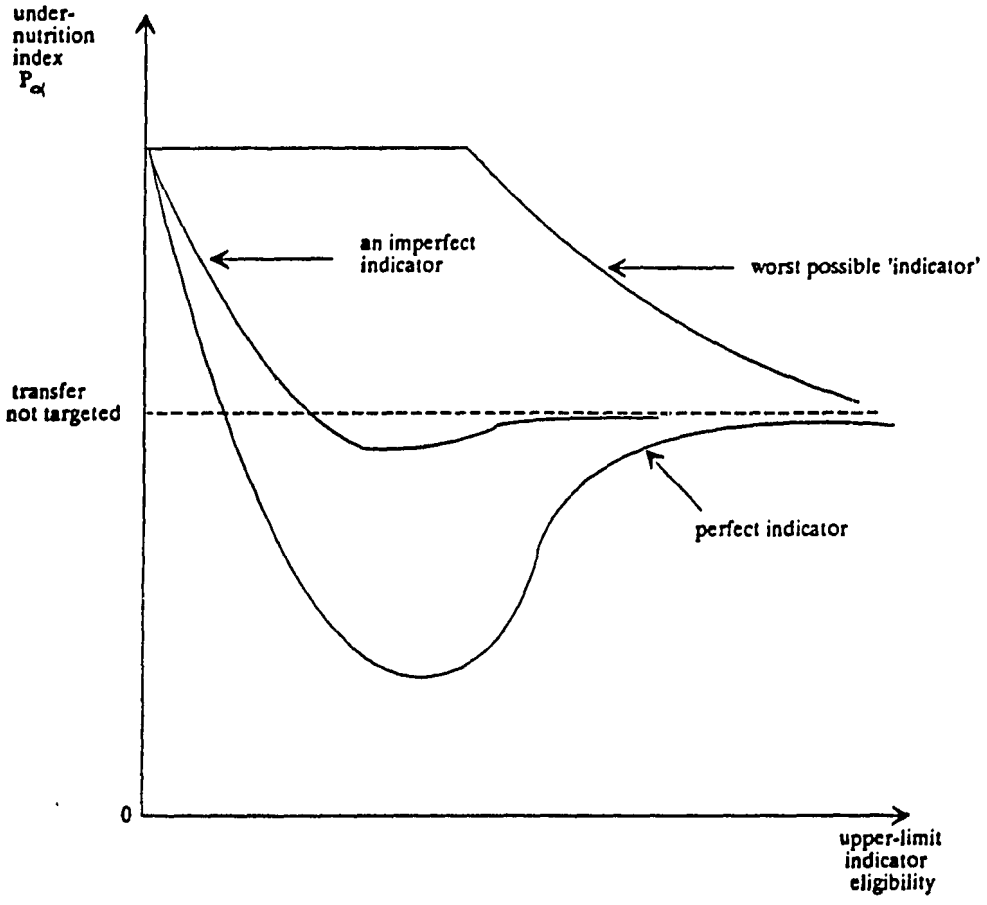
$$y_1 \leq y_2 \cdot \cdot y_q \leq z < y_{q+1} \cdots y_n.$$

Figure 2.3 presents a stylized representation of how we would choose the best alternative indicator cutoff point, given the objective of minimizing the $P_\alpha$ undernutrition measure. Our two key assumptions are that we have a fixed budget and that each eligible household receives an identical transfer. Thus, as more and more households become eligible for the transfer, the size of the transfer is reduced. As the upper-limit of eligibility rises, a u-shaped relationship between eligibility and undernutrition is likely.

As undernutrition declines, the transfer dilution effect (infra-marginal effect) of the additional households entering the eligibility net does not dominate the reduction in undernutrition of bringing in those extra households (marginal effect). Once the rate of undernutrition starts rising, the infra-marginal effect begins to dominate the marginal effect.

This is one representation of the trade-off between the error of exclusion and the error of inclusion. An incorrectly included household does not contribute to a reduction in the $P_\alpha$ undernutrition index; quite the contrary, it dilutes the transfer to the included eligible households. This dilution effect will be larger if we exhibit a greater

Figure 2.3--Targeting with upper-limit indicators



sensitivity to the depth of poverty. Therefore, at higher alpha values, errors of inclusion are given more weight and are taken more seriously by the undernutrition index. At higher alpha values, the weight given to the error of exclusion will be high if the excluded household is very undernourished or food insecure.

Depending on the depth of undernutrition, the size of the budget, and the alpha value selected, even a 'non-indicator'—one which has no association with food insecurity—may have a u-shaped $P_\alpha$ undernutrition line as eligibility increases. A perfect indicator (in terms of its ability to rank households from most food insecure to least food insecure) will, however, show a deeper curve than the 'non-indicator,' and the upward part of that curve will be steeper, reflecting the fact that there is no marginal impact but only the infra-marginal dilution effect beyond this point. For an imperfect indicator that is, nevertheless, correlated with food security, the marginal and infra-marginal effects will be stronger than for the 'non-indicator.' Hence, the undernutrition line for an imperfect indicator that is associated with undernutrition will lie between the two lines for a perfect indicator and a 'non-indicator.' An untargeted transfer is represented by the horizontal line to which all the undernutrition lines converge. A 'worst-case' upper-limit 'indicator' will have no impact on undernutrition until the first food-insecure household becomes eligible for the transfer, and by then, the transfer's impact will have been diluted by all the ineligible recipients.

Our earlier assertion—an improved appreciation of who is likely to fall below the undernutrition line does not necessarily guarantee a reduction in undernutrition through targeting—would be represented in Figure 2.3 as a failure of the imperfect indicator to break the horizontal line representing the untargeted transfer. The failure of the indicator to do this would depend on several factors: (i) the value of alpha; (ii) the nature of the budget division; and (iii) the loss function used to identify a potentially useful indicator.[7]

2.3.1.1 Value of Alpha

Kanbur (1989) has documented that the head-count index of undernutrition ($\alpha$=0) is responsible for some counterintuitive targeting results. Consider a simple numerical example for four households, presented in Table 2.3. The other factors mentioned above—nature of the budget division and loss function used—are controlled for, to a large extent, as the budget division closely matches the calorie shortfalls (even though it is an equal division). In this example, all the imperfectly targeted possibilities result in a worse nutrition outcome than the non-targeted transfer. A non-targeted transfer results in 100 calories going to each household and the head-count poverty index, $P_0$ becomes zero. A perfectly targeted intervention also results in $P_0$=0. However, none of the imperfectly targeted intervention can push $P_0$ below 0.25.

[7] This last point is by courtesy of Ravi Kanbur.

Table 2.3--When no targeting is better than some targeting: A numerical illustration

| | Household | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Initial calorie adequacy | 0.9 | 0.9 | 1.1 | 1.1 |
| Calorie requirement | 1,000 | 1,000 | 1,000 | 1,000 |
| Initial $P_0$ = 2/4 (head-count ratio) | | | | |
| (1) Non-targeted transfer (equal shares) of 400 calories, resulting in 100 100 calories to each household | 100 | 100 | 100 | 100 |
| (2) Post-non-targeted transfer calorie adequacy | 1.0 | 1.0 | 1.2 | 1.2 |
| (3) Post-non-targeted transfer $P_0$ = 0/4 (all households above 1.0 adequacy) | | | | |

| (4) Targeting scenarios | (5) Post targeted-transfer $P_0$ |
|---|---|
| Household 1,2 (perfect) | $P_0$ = 0 |
| Household 1,3 (imperfect) | $P_0$ = 1/4 |
| Household 1,4 (imperfect) | $P_0$ = 1/4 |
| Household 2,3 (imperfect) | $P_0$ = 1/4 |
| Household 2,4 (imperfect) | $P_0$ = 1/4 |
| Household 3,4 (imperfect) | $P_0$ = 2/4 |

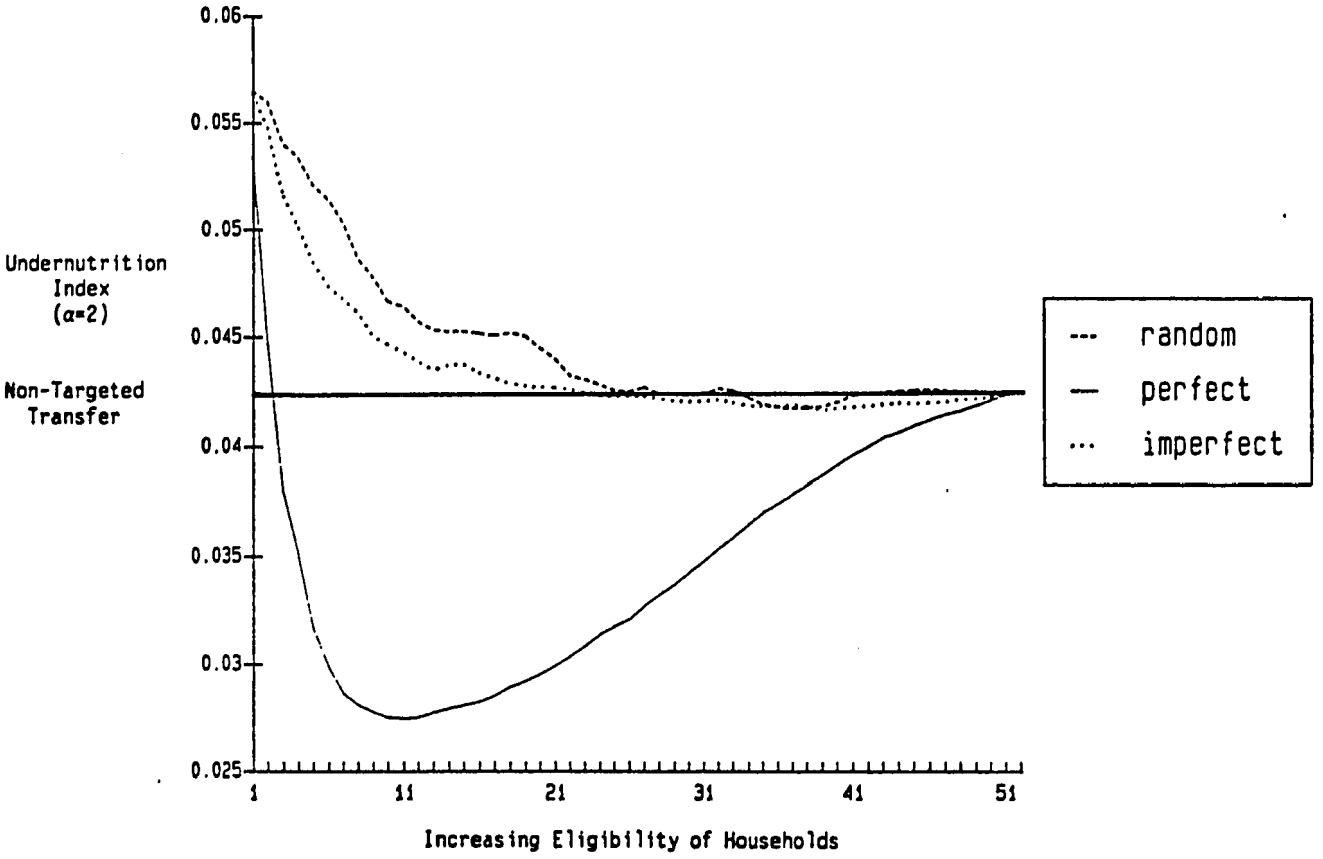
Targeting, then, even when there is some association between the indicator and food insecurity, does not always result in lower undernutrition for the whole sample, if we are only interested in a simple head-count measure ($\alpha$=0). This result is more likely to occur for populations close to the undernutrition line.

2.3.1.2 Nature of the Budget Division

A vector of household-specific transfers can always be found that reduces undernutrition more than a non-targeted transfer. Gains (or, at worst, no losses) can always be derived from tailor-made targeting even with $\alpha$=0, although it is unlikely that the household-specific transfers will be equal. However, when simpler and more operationally feasible budget division rules are used—equal division among eligible households, for instance—this gain might not always be realized, even for $\alpha > 0$. Figure 2.4 presents undernutrition lines for three indicators—perfect, imperfect, and random—based on the Bukidnon data. The random indicator is based on a variable that has no association with calorie adequacy (household ID number), and the imperfect indicator is based on food expenditure per capita. As $\alpha$=2 and food expenditure is a reasonable indicator of household calorie adequacy at both ends of the distribution, we are, to some extent, controlling for the other two factors responsible for the nonperformance of the targeting scheme ($\alpha$=0 and the nature of the loss function used).

Figure 2.4 shows the deep u-shape we predicted for a perfect indicator, but much shallower curves for the other two indicators. As

Figure 2.4--Targeted undernutrition-reduction based on three indicators: random, perfect, and imperfect, Bukidnon




Notes:

Undernutrition threshold = household calorie adequacy of 1.0.

Budget is 1 million calories.

expected, the imperfect indicator has a greater impact on reducing undernutrition than the random indicator, but not by much, especially at the former's minimum undernutrition point. More striking, however, is the failure to push the undernutrition line much below the untargeted transfer line.

2.3.1.3 Nature of the Loss Function

In their search for cost-effective indicators of poverty in Cote d'Ivoire, Glewwe and Kanaan (1989) noted that variables or sets of variables that showed the highest R-square values with actual consumption as the dependent variable did not always perform as the most efficient targeting instruments. This, they point out, is because high R-square values might be produced as a result of strong correlations at the upper end of the calorie adequacy distribution. We are interested in the lower end. More formally, linear regression minimizes the sum of squared residuals over the entire calorie adequacy distribution, but the $P\alpha$ measure does not use calorie adequacy information above the undernutrition line.

To illustrate this phenomenon, we apply the Glewwe and Kanaan (1989) methodology to our Bukidnon (Philippines) data set (Bouis and Haddad 1990). We calculate $P\alpha$ for the sample, for an untargeted transfer, and for a targeted transfer. The transfer is given only to households with predicted household calorie adequacy of less than 80 percent, where land per capita and some dummy variables for seasonality shifts are used in the predicting equation. This technique is useful when several

indicator variables are to be combined. With only one predicting variable, we are essentially choosing the land per capita cutoff as the value of that variable that predicts household calorie adequacy as 80 percent.[8]

As presented in Table 2.4, we find that $P\alpha$ for an untargeted transfer is less than $P\alpha$ for a targeted transfer. In this case, targeting with an indicator that tells us something about actual household calorie adequacy does less to move households across the 80 percent threshold than does a non-targeted transfer. This is due, in large part, to the ability of land per capita to locate the very food secure households, but not the very food insecure households. It is important to note then, that targeting can be a negative-sum game under certain circumstances. This possibility is illustrated in Figure 2.5 by the dotted line.

This rather long refutation of the idea that some targeting is necessarily better than none is simply to emphasize the point that the benefits derived from the collection of indicators identified as 'promising' in the following empirical analysis may not be greater than zero, let alone greater than the costs of collecting the indicators and acting upon them. In other words, the costs and benefits associated with the collection of indicator data will be extremely sensitive to the design and objectives of the intervention that the data serve.

In summary, this chapter has developed a conceptual framework for

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[8] There is no guarantee that this will be the same value as the undernutrition minimizing upper limit land cutoff.

Table 2.4--The potential ineffectiveness of targeting, Bukidnon data

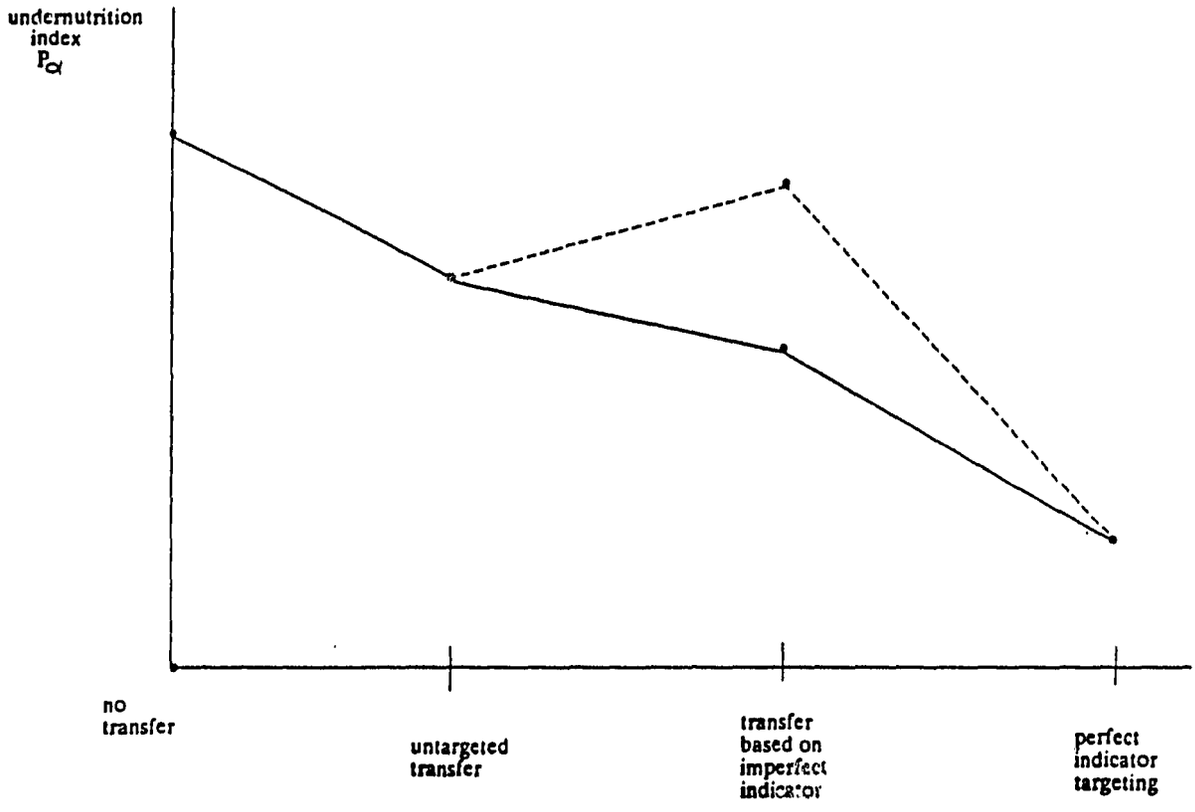
| Calorie Intervention | No Targeting $P_0$ | $P_1$ | $P_2$ |
|---|---|---|---|
| 100,000 | 0.3528 | 0.0677 | 0.0231 |
| 500,000 | 0.3220 | 0.0593 | 0.0200 |
| 1,000,000 | 0.2759 | 0.0502 | 0.0168 |
| 2,000,000 | 0.2014 | 0.0364 | 0.0119 |
| 4,000,000 | 0.1170 | 0.0194 | 0.0063 |
| | Imperfect Targeting (Based on Land-Cultivated pc) | | |
| 100,000 | 0.3571 | 0.0681 | 0.0232 |
| 500,000 | 0.3325 | 0.0618 | 0.0209 |
| 1,000,000 | 0.3030 | 0.0556 | 0.0186 |
| 2,000,000 | 0.2555 | 0.0476 | 0.0159 |
| 4,000,000 | 0.2186 | 0.0416 | 0.0136 |
| | Targeting (Based on Actual Household Calorie a Day) | | |
| 100,000 | 0.3381 | 0.0639 | 0.0217 |
| 500,000 | 0.2482 | 0.0443 | 0.0147 |
| 1,000,000 | 0.1675 | 0.0288 | 0.0093 |
| 2,000,000 | 0.0739 | 0.0125 | 0.0040 |
| 4,000,000 | 0.0166 | 0.0031 | 0.0008 |

thinking about indicators. For regions with sophisticated monitoring systems, if the cost-savings in terms of data collection and analysis from using alternative indicators outweighs the benefits foregone from the non-collection of the traditional indicators, then the alternatives should be adopted. For countries with no monitoring systems, the indicators with the highest cost of noncollection/cost of collection ratio should be adopted.

In addition, we have stressed the importance of indicator quality and that the adoption of an inappropriate 'indicator' can result in a worse undernutrition situation than if the 'indicator' was not adopted at all.

The conceptual analysis has resulted in a few simple messages: (1) potentially useful indicators will be strongly associated with the levels of food security exhibited by the most food insecure households and preschoolers; and, (2) even indicators that satisfy the above requirement may not always prove useful, at least for targeting purposes. Much depends on how the transfer is divided up, the costs of acting upon the indicator information, and the level of food and nutrition insecurity in the population.

Figure 2.5--Degree of targeting and impact on undernutrition



# 3. DATA AND EMPIRICAL CONSIDERATIONS

This chapter lays out the rationale behind our selection of potential alternative indicators, describes the data sets we analyze, and discusses the various measures of indicator performance that we employ. This report uses household calorie adequacy and preschooler anthropometry as traditional measures of food and nutrition security. Most data sets force the assumption that the traditional indicators provide a fair representation of true or actual food and nutrition security, and our data sets are no exception.

## 3.1 Identification of Alternative Indicators

Our selection of potential alternative indicators of food and nutrition security reflects a distillation of the literature and data availability. The organizational framework is presented in Table 3.1. Alternative indicators are usefully categorized into one of three groups: demographic, factor market, and proximate. The advantages and disadvantages of most of these indicators have been well-documented, but little empirical work on relative indicator performance has been undertaken so far. We seek to fill this gap.

Because we are silent on the costs of collection, we have to use potential alternative indicators that we are fairly confident will be less costly to collect than traditional indicators. Potential

Table 3.1--Traditional and alternative indicators: An organizational framework

| Level | Traditional | Alternatives | | |
|---|---|---|---|---|
| | | Demographic | Factor Market | Proximate |
| Household level (food security) | | | | |
| •Example | **Calorie adequacy** | **Dependency ratio** | **Land cultivated** | **Number of unique foods consumed** |
| •Advantages | Reflects food energy actually consumed, not just entitlements. | May already exist | May already exist | Relatively easy to collect and process and is linked directly to consumption. |
| •Disadvantages | Not very meaningful for specific households in a one-shot cross-section. Difficult to collect. | Age is often difficult to obtain, and establishing household membership is often not straightforward. | Difficult to obtain land size accurately; land quality is an important extra piece of information; difficult to establish land property rights. | Number of foods may reflect scavenging of wild foods. |
| Individual level (nutrition security) | | | | |
| a. Preschooler | | | | |
| •Example | **Weight-for-age** | **Birth order** | **Gender of household head; female contribution to household income.** | **Age at weaning (very early or very late)** |
| •Advantages | Only two component measures; relatively inexpensive. | Easy to collect; may already exist. | Easy to collect; information may already exist. | No measuring involved |
| •Disadvantages | Nutritional status has already worsened. | Usefulness will depend on mother's nutritional status. | Different ways of classifying headship; responsibility does not always equal power. | Depends on how gradual weaning is and the type of weaning food. |
| b. Adult | | | | |
| •Example | **Body Mass Index** | **Gender and age** | **Primary occupation** | **Order in which food eaten; number of meals eaten.** |
| •Advantages | No ages required; straightforward. | Information may already exist. | Information may already exist. | Likely to be less costly than full diet recall; no measurements. |
| •Disadvantages | Interpretation of values controversial and location-specific; pregnancy a factor. | Not useful if no intrahousehold inequality. May not be a useful first-cut of data. | Not useful if currently unemployed, underemployed; if former, quality of inputs may vary. | Adult may miss meal at home; common pot. |

alternative indicators that meet this condition include those that may already exist, or those that do not exist but are extremely easy to collect and use, that is, they only have two or three different values. An example of the former type of indicator is land cultivated per capita, and an example of the latter type of indicator is whether or not a preschooler has been ill in the past one or two weeks.

### 3.1.1. Potential Indicators Suggested by the 'Interaction of Poverty and Nutrition' Literature

The extensive nutrition economics literature, which focusses on the determinants of undernutrition (usually through regression analysis), provides a starting point in the search for potential alternative indicators. This literature is not as helpful as it might at first seem, for at least three reasons. First, because the very nature of regression analysis is an abstraction from reality—controlling for all other variables while shining a spotlight on one variable at a time—it is not especially helpful when one is looking for a combination of variables that might identify the food and nutrition insecure. Second, the magnitude of any significant coefficient (specifically the elasticity) will probably have to be large if the explanatory variable is to be of any use in identifying food and nutrition insecure households and individuals. Third, economic and nutrition researchers often omit 'outcome' variables from the right-hand side of their equations in an attempt to minimize biases. Often the variables of greatest potential in identifying the food and nutrition insecure

document a response to that insecurity (see, for example, Webb, von Braun, and Yohannes' [1991] classification of responses to famine conditions).

With these caveats in mind, we provide a summary of much of the work done on the nutrition-health-poverty nexus in Table 3.2. This is, in turn, adapted from Behrman (1990), and Behrman and Deolalikar (1988).

### 3.1.2 Potential Indicators Suggested by a Broader Literature

A much broader indicator literature exists, spanning a wide range of disciplines (anthropology, nutrition, sociology, geography, public health, and economics). This is described in detail in Appendix 1 and in summary in Table 3.3. Much of this literature focuses on changes in behavior—for example, migration, dietary changes, sales of land, livestock, and food—and we cannot address these issues with our data sets. Rather, we can identify risk characteristics of the food and nutrition insecure.

### 3.1.3 Potential Indicators Contained in the Data Sets

Whereas some variables are present in all or nearly all of the data sets, other variables are unique to a specific data set. Summary statistics of the core variables in the seven data sets are presented in Table 3.4. The next table, Table 3.5, lists traditional, demographic, factor market, and proximate indicators available by data set for both households and preschoolers.

Table 3.2--A summary of determinants of health and nutrition from the 'interaction of poverty and nutrition' literature

| Determinant of: | Determinant | Comments |
|---|---|---|
| Nutrient intake | Income | Level is usually examined; source, flow, control, and form are not. |
| | Total expenditure | Easier to measure than income, but still much controversy over the impact of measurement errors on estimated elasticities. |
| | Food prices | Calorie intakes are food price responsive, but many times in a positive direction. As the price of a preferred staple increases, calorie intakes increase due to substitution effects to starchy staples and an income effect that reduces the consumption of nonfoods. |
| | Women's wages | Hypothesized to raise household food security through higher and more diversified incomes, through greater female bargaining power, but concerns on the nutrition security side via less breast-feeding and less time in child care. |
| | Women's schooling | Hypothesized to raise food and nutrition security by raising female productivity inside and outside the home, and through greater bargaining strength within the household. |
| | Household size and composition | Difficult to assess the impact of household size without some knowledge of composition. Households with larger numbers of children and the very old relative to the individuals between 15 and 65 will suffer from labor shortages; however, large families in sub-Saharan Africa are usually older and are associated with wealth. |
| | Headship | Male or female, de jure or de facto, working or nonworking, cash or noncash; results are more complex than originally thought. |
| | Location | In many countries, location is often an excellent initial indicator of food insecurity. Either rural or urban, by administrative region, or by agro-ecological zone. |
| | Season | Seasons of scarcity and surplus arise in the absence of storage facilities at the household, community, or regional level. Also has impacts on intrahousehold allocation of health inputs. |
| Health | Parental height; weight | Often prove to be related to heights and weights of even very young children; most strongly through maternal weight gain during pregnancy. |
| | Household land | Ownership, cultivation, control over sale, control over crops grown; may be important in land constrained areas and not in labor-scarce areas. |
| | Parity | Maternal depletion syndrome, which remains controversial. |
| | Birth order | Usually has adverse effect on child weight-for-height; complex, though, because as birth order rises, households tend to be older and wealthier, but maternal depletion syndrome (the physiological toll pregnancy exerts) is more of a factor. |
| | Age | Could simply be measurement problems, but age seems to be important in determining nutrient intake for children, and height-for-age drops off quickly with age. Results for weight-for-age more complex. |
| | Sex | Some evidence to suggest female children have poorer health and mortality outcomes in south Asia, but evidence in Africa is very thin. More evidence to suggest that adult women are able to remain close to parity with men in terms of health and nutrition via heavier time burdens. |

Source: Adapted from Behrman (1990) and Behrman and Deolalikar (1988).

Table 3.3a--Potential indicators of household food security from the broader literature

| HOUSEHOLD | INDICATOR | COMMENTS |
|---|---|---|
| **Demographic** | Household size/ composition | Household size/composition is not static, but changes with household biological life cycle (Caldwell, Reddy, and Caldwell 1986). Adjustment of household size/composition to recurrent food insecurity is a common strategy (Messer 1989a; Norris 1988; Nabarro, Cassels, and Pant 1989; von Braun and Pandya-Lorch 1991). During prolonged economic crisis, the trend is toward smaller consumption units (Seaman and Holt 1980; Taal 1989; Shipton 1990; Chambers 1989). Larger/extended households are more likely than smaller/nuclear households to be associated with greater diversification of assets, income sources and crop cultivation (Toulmin 1986; Taal 1989; Nabarro, Cassels, and Pant 1989), and less vulnerable to illness/death of breadwinners (Toulmin 1986; Lipton 1983a; Caldwell, Reddy, and Caldwell 1986). However, the poorest households tend to have large young families (Lipton 1983b). Households with female heads are often, but not always, disadvantaged (Peters and Herrera 1989; Kennedy and Haddad 1991; Louat, Grosh, and van der Gaag 1991). |
| | Migration | Distinguish between seasonal migration of able-bodied adults prior to/during peak agricultural labor periods and migration during dry season (de Waal 1988; Campbell and Trechter 1982; Autier et al. 1989). Rural Ethiopians could predict six months in advance whether household members would have to migrate in search of wage labor (de Waal 1988). Distress migration of whole families is usually the last in a sequence of household responses and a clear indication that other coping strategies failed (Corbett 1988; Watts 1983). |
| | Ethnicity/ region | Certain ethnic or caste groups may be historically or geographically more vulnerable to seasonal or chronic food insecurity (O'Brien-Place 1988). Welfare levels often vary distinctly by region (Haddad 1991). |
| **Factor Market** | Income sources | Smallholders spread risks through diversification of income sources, most notably off-farm employment (Downing 1988; Shipton 1990; Caldwell, Reddy, and Caldwell 1986; Merryman 1984; Reutlinger 1987). The riskier the environment, the more diverse the economic activities relied upon will be (Reardon, Matlon, and Delgado 1988; Staatz, D'Agostino, and Sundberg 1990). The distribution of income sources within a given community may be U-shaped, implying that income diversification has different purposes and consequences for the most and least vulnerable households (Castro, Hakansson, and Brokensha 1981; von Braun and Pandya-Lorch 1991). The source and/or control of income may be more important than total income in influencing household-level food security (Kennedy 1989). |
| | Changes in income/ income sources | Changes in petty marketing patterns of rural households may indicate anticipated food insecurity (McCorkle 1987; Cutler 1984). Increasing income within communities is associated with different diets but not necessarily improved nutrition (DeWalt et al. 1990; Behrman and Deolalikar 1987). The transition from subsistence to cash-cropping has been associated with increased vulnerability and increased malnutrition among children (Dewey 1981; Thomas, Paine, and Brenton 1989) and with increased household caloric intake (Kennedy 1989) or increased food expenditures (von Braun, Hotchkiss, and Immink 1989; von Braun, de Haen, and Blanken 1991). The effect of commercialization of semi-subsistence agriculture on food consumption and nutritional status of vulnerable groups has shown mixed results (von Braun and Kennedy 1986). |
| | Income flow | Income received seasonally in large sums will more likely be spent on lump-sum expenditures or consumer goods than on improved diets and other nutrition-related investments (Alderman 1986; Guyer 1980; Dewey 1979). |
| | Access to loans/credit | Nearly half of rural South Indian households took loans during a recent drought, and most felt these had been a considerable factor in maintaining minimum living conditions (Caldwell, Reddy, and Caldwell 1986). Access to traditional lines of credit through merchants collapses as collateral (for example, livestock) disappears during drought (Cutler 1986). |
| | Land ownership/ control | Number of different plots may be a more sensitive indicator than total acreage since households with fragmented landholdings can take advantage of different micro-climates more than households with larger but often less diverse landholdings (Dei 1990; Colson 1979; Paterson, cited in Castro, Hakansson, and Brokensha 1981; Dewey 1981; Downs 1988, cited in Shipton 1990). Access to seasonally flooded lowlands is an important buffering mechanism in drought-prone areas (Longhurst 1986). |

(continued)

Table 3.3a--Potential indicators of household food security from the broader literature (continued)

| HOUSEHOLD | INDICATOR | COMMENTS |
|---|---|---|
| | Land use practices | Intensification of land-use practices is one of the earliest responses in a sequence of adjustments to stress by Indian farmers (Jodha 1975, 1978). Intercropping, multiple seed strains with different maturation periods/resistance to disease, and broad mixtures of available cultivars are important diversification strategies of African farmers to minimize the risk of crop failure and enhance food security (Shipton 1990; Taal 1989; Smith 1986). Access to good-quality land and alternative employment sources may be more important in determining nutritional status of rural populations than choice of crop (DeWalt et al. 1990). |
| | Sales of land | Distress sales of land is a desperate measure and tends to occur much later in the belt-tightening process (Caldwell, Reddy, and Caldwell 1986; Corbett 1988). If land is a household's only asset, it will only be sold if there is no other way to survive; often the land is first mortgaged (Nabarro, Cassels, and Pant 1989). One of the more common reasons for land to come into markets in India was wedding and/or funeral expenditures (Srinivasan 1975 cited in Castro, Hakansson, and Brokensha 1981). |
| | Trees | Access to communal or private reserves of trees can significantly decrease the poor's vulnerability to contingencies (Chambers and Leach 1989; Chambers and Longhurst 1986). The percentage of cultivated land planted to tree crops can be used as a proxy for agro-climatic conditions, and was positively associated with child's height in Cote d'Ivoire (Strauss 1988). |
| | Livestock | Diversified herds with different pasture needs are less vulnerable to drought and infection than more homogenous herds that may produce more meat or milk (Colson 1979; Cutler 1986). The importance is not between small versus large herds, but between owning no animals at all and having at least some (de Waal 1988). Access to milk is indicated by having a female animal (de Waal 1988). Donkeys and mules are highly valued during famine because they help travel (Shipton 1990). Lack of access to resources, primarily oxen, makes women particularly vulnerable to drought in Ethiopia (McCann 1987). |
| | Sales of livestock | The ability to market livestock for grain commonly determines who will survive a famine and who will not (Shipton 1990). The sale of male animals before their optimum weight or of females before the end of their reproductive period is an indicator of insecurity (White 1986). Livestock sales occur normally, and do not necessarily imply a reduction of future productivity (Swinton 1988). Indicators related to livestock sales, prices or market demand/supply are difficult to interpret, and reliable data are hard to obtain in Chad and Mali (Autier et al. 1989). |
| | Sales of assets | Important to distinguish sales of key productive assets from sales of assets which are primarily forms of insurance/saving (Corbett 1988). Successfully surviving a drought depends upon a household's ability to retain intact all its productive assets (including family labor supply) solely by cutting back on ceremonial forms of consumption and by liquidating nonproductive assets (Jodha 1978). Poor people become poorer by disposing of productive assets (Chambers 1989). The income and assets owned by the richest and poorest quintiles is one of 20 suggested indicators of human welfare (Anderson 1990). |
| | Sales of food | The conversion of surplus food into durable valuables which can be stored and traded for food in emergencies is an important strategy for reducing vulnerability to risk (Colson 1979). The very poor in India cannot afford to consume their own home products and must sell them to obtain cash (Bhattacharya et al. 1991). |
| | Capital equipment | The number or diversity of assets may be a more useful indicator than net-worth of assets; households with low number and diversity of productive assets may be more vulnerable to external shocks and contingencies (Chambers 1989; Swift 1989). But low asset status is not necessarily synonymous with greatest poverty (Swift 1989). Some landless peasants in Tanzania actually owned tractors (which they hired out) and sewing machines (Pipping 1976, cited in Castro, Hakansson, and Brokensha 1981). Wells have become crucially important assets to Malian farmers for producing a regular grain surplus (Toulmin 1986). |

(continued)

Table 3.3a--Potential indicators of household food security from the broader literature (continued)

| HOUSEHOLD | INDICATOR | COMMENTS |
|---|---|---|
| | Consumer durables/ semi-durables | Determine whether household owns enough cooking utensils to avoid borrowing plates or pots from relatives or neighbors (Lewis 1951). Determine whether Indian women own more than one sari or blouse (Bhattacharya et al. 1991). |
| Proximate | Ill health | The main asset of most poor people is their bodies (Chambers 1989). All producers are vulnerable to sickness and disability (Toulmin 1986). Work-disabling accidents and/or morbidity of household breadwinners are often the pivotal events which impoverish households, making them useful indicators (Corbett 1989; Pryer 1989). |
| | Education | Few households with at least one educated member starve (Swift 1989). Women's schooling, even after adjusting for income, has a higher elasticity of nutrient demand than those for household size or income (Behrman and Wolfe 1984). Years of child schooling could be used as an easily-measured proxy for household living standards (Birdsall 1982; Anderson 1990). |
| | Food stores | Ability to store food post-harvest and availability of stored food pre-harvest are important indicators to monitor (Chambers 1989; Thomas, Paine, and Brenton 1989). Having two years household consumption requirements in store is seen as desirable in Sudan (Maxwell, Swift, and Buchanan-Smith 1990). Estimates of number of months stored grain will last are usually more accurate and culturally sensitive than asking farmers for volume estimates of stored quantity (Frankenberger 1985; O'Brien-Place 1988). |
| | Qualitative dietary changes | Shifts from preferred to lower status foods (starchy tubers or grain ground with stalks/ /husks/bran) and unconventional foods (wild foods, insects or game; poorer products, e.g., broken rice grains) are a normal occurrence in areas facing seasonal food deficits, but may also indicate anticipated stress (Ogbu 1973; Colson 1979; Cutler 1986; Caldwell, Reddy, and Caldwell 1986; Corbett 1988; Shipton 1990). Local sharing between families or households often intensifies when food is scarce (Shipton 1990; Maxwell, Swift and Buchanan-Smith 1990). The importance and intensity of wild food use depends upon severity and length of food shortages, the location of household with respect to wild food areas, and available household labor to collect them (DeWalt 1983; Zinyama, Matiza, and Campbell 1990). Households producing for auto-consumption are more likely to have greater dietary diversity than households producing primarily for the market (Fleuret and Fleuret 1980; Dewey 1979; Smith 1986). The correlation between dietary diversity and socioeconomic status is positive (Bentley 1987; DeWalt 1983; Schiff and Valdes 1990 b). |
| | Quantitative dietary changes | Fluctuation in consumption of main staple (Bhattacharya et al. 1991) or in meal patterns are indicative of food insecurity (Beck 1989; Taal 1989; Campbell and Trechter 1982; Oshaug and Wandel 1989; Galvin 1988). Food consumption reduction is part of a deliberate and early strategic household response (Corbett 1986; Cutler 1984; Shipton 1990). The number of meals per day was not found to be a useful indicator in Chad and Mali (Autier et al. 1989), and missed meals did not necessarily imply food unavailability in India due to frequent eating outside the home or at work (Bhattacharya et al. 1991). Most agrarians derive the bulk of calories from one to three grain staples which could easily be monitored (de Garine 1988, cited in Shipton 1990). There was a drastic reduction in consumption of pulses in India during the 1987 drought (Rao 1989). Determine if household has recently participated in food aid programs (Cutler 1986; Beck 1989; O'Brien-Place and Frankenberger 1988). |

## Table 3.3b--Potential indicators of preschooler nutrition security

| PRESCHOOLER | INDICATOR | COMMENTS |
|---|---|---|
| **Demographic** | Household composition | Family size and the number of young siblings are inversely associated with child health and nutrition in Nicaragua (Wolfe and Behrman 1982), but larger or extended households with grandparents and other relatives present can substitute as child caretakers to positively affect child welfare (DaVanzo 1984). Being a child of the household head in rural Gambian households has a positive effect on child height (von Braun, Puetz, and Webb 1987). |
| | Age | The prevalence of malnutrition is consistently highest during the second year of life, corresponding with the end of the weaning process (Akin et al. 1985; Strauss 1990; Carlson and Wardlaw 1990). The highest prevalence of stunting tends to be found in children between 18-48 months (Haaga et al. 1986), with a second peak in the fifth year (Carlson and Wardlaw 1990). |
| | Gender | Globally, there is little difference between male and female prevalences of child malnutrition, except in the case of wasting where male prevalence is somewhat greater (Carlson and Wardlaw 1990). Within countries and cultures, however, quantitative evidence of sex bias in patterns of child nutrition, health care and mortality have been observed (Kielmann, Taylor, and Parker 1978; Sen and Sengupta 1983; Senauer, Garcia, and Jacinto 1988; D'Souza and Chen 1980). Chen, Huq, and D'Souza (1981) found pronounced pro-male differentials in the food and health care received by Bangladeshi children. In India, sex differentials by birth order were far stronger than those by socioeconomic status (Das Gupta 1987a). Differences in child mortality by gender between North and South India were partially explained by variations in kinship systems and female autonomy between the two regions (Dyson and Moore 1983). In the Philippines, being male has a positive effect on calorie adequacy ratio but a negative impact on height-for-age (Senauer and Garcia 1991). Svedberg (1990) found less of a gender-bias in sub-Saharan Africa. Haddad and Reardon (1991) find zero boy-girl discrimination in Burkina Faso. |
| | Ethnicity | Ethnic origin was significantly associated with child nutrition status in Papua New Guinea (Shack, Grivetti, and Dewey 1990). Lower caste children and girls die more frequently in India, especially in the postneonatal period (Kielmann, Taylor, and Parker 1978). |
| | Region | The regional distribution of child malnutrition differs considerably depending on the particular anthropometric indicator being used (Carlson and Wardlaw 1990). Global prevalences of rural underweight and stunting are consistently higher than urban on average, but the prevalence of moderate to severe child malnutrition in certain urban slums may be much greater than in most rural areas (Carlson and Wardlaw 1990). |
| **Factor Market** | Occupation | Child mortality rates in Bangladesh and India were substantially higher in households whose members were employed in lower status occupations and who were poorly educated (D'Souza and Bhuiya 1982; Kielmann, Taylor, and Parker 1978). The increased energy needs of Brazilian men participating in sisal production adversely affected food consumption of other family members, resulting in some children only receiving about 50 percent of daily energy requirement (Gross and Underwood 1971). |
| | Income | Increasing household income through commercialization of semi-subsistence agriculture does not appear to have dramatic positive or negative impacts on children's nutritional status (DeWalt et al. 1990; von Braun and Kennedy 1986; Strauss 1990; Sahn 1990; Shack, Grivetti, and Dewey 1990), even though it raised household caloric consumption in Kenya (Kennedy and Cogill 1987). Income was not a major determinant of child mortality in Nicaragua (Wolfe and Behrman 1982). |
| | Income flow | The flow, content, and ownership of farm income may be more important to nutritional status than level of income; a steady, although low, source of income throughout the year may have a greater effect on nutritional status than intermittent lump sums from sale of production or wages (Babcock and Zalla 1984; Dewey 1981). |
| | Mother's work | The relationship between maternal work and child nutrition is more complex, or at least less consistent, than the relationship between maternal education and child nutrition (Leslie 1989). Where employment is found to have a significant impact on breast-feeding patterns, its effect depends, among other things, on both the type and location of women's work (Leslie 1989). In San Salvador, poor women preferred two part-time jobs to one full-time job in order to return home at lunch to breast-feed (Nieves 1979). A child's nutritional status may influence the mother's decision to work, as well as a mother's work affecting the child's nutritional status (Carloni 1984). Children of women working outside the home had significantly greater dietary diversity in Panama (Tucker 1989). Children with mothers working part-time in Zimbabwe had lower risks of malnutrition than those whose mothers either worked full-time or on a casual basis (Mazur and Sanders 1988). |

(continued)

11

Table 3.3b--(continued)

| PRESCHOOLER | INDICATOR | COMMENTS |
|---|---|---|
| | Land | Household access to land was the primary variable affecting nutritional status of children in Costa Rica (Rawson and Valverde 1976) and Guatemala (Valverde et al. 1977). Landowners and those cultivating more land in India have taller and heavier children and that these children consume more calories than children of agricultural laborers (Chernikovsky and Kielmann 1977). Access to even small amounts of land for landless households in the Philippines appears to appreciably improve preschooler nutrition (Bouis 1991). Rural households growing drought-resistant crops in eastern Kenya and local maize varieties in western Kenya had better child nutritional status than those mono-cropping or growing hybrid maize, respectively (Haaga et al. 1986). Size of landholding did not have an appreciable effect on preschooler calorie intake in the Philippines, but having access to a threshold of at least one hectare of cultivated land did have a significant effect (Bouis 1991). |
| | Housing quality/ status | The best predictor of child mortality in Bangladesh was floor area of the home (Chen, Chowdhury, and Huffman 1980; D'Souza and Bhuiya 1982). The effects of water quality and sanitation on child health/nutrition status is uncertain: Bangladeshi children from households lacking latrines had significantly higher risks of mortality (D'Souza and Bhuiya 1982) while improved drinking water supply did not improve child growth in Malawi (Lindskog, Lindskog, and Gebre-Medhin 1987). A greater degree of stunting and wasting was observed in peri-urban Zimbabwean children of parents who lodged rather than owned formal housing (Mazur and Sanders 1988). |
| Proximate | Morbidity | Growth of children in poor communities is strongly influenced by infectious diseases (Martorell and Ho 1984; Mata 1978, 1979; Chen and Scrimshaw 1983; Kennedy and Cogill 1987; Bouis and Haddad 1990). |
| | Birth order/ birth interval | The relationship between birth order and child nutrition status may be U-shaped, with low birth order children experiencing less sibling competition for child care or calories, and higher birth order children often benefitting from increased stability of older, more established households (Horton 1988; Behrman 1988; Senauer and Garcia 1991). However, high birth order children in households with unfavorable dependency ratios may be at greater risk of malnutrition. Short birth intervals contribute to higher risk of mortality due both to biological disadvantages of maternal depletion (low birth weight) and to between-child competition for care (Mata 1978; DaVanzo 1984; Pebley and Millman 1986; Palloni and Millman 1986). The most striking effects of birth interval occur in the post-neonatal period and with the very shortest of birth intervals (Winikoff 1983). |
| | Mother's age at birth | The relationship between mother's age at birth and child nutrition status may be an inverted U-shape, with young age reflecting maternal immaturity and old age associated with increased likelihood of birth defects. Babies born to Malaysian mothers less than 19 and older than 40 were more likely to die in infancy than other infants (DaVanzo 1984). |
| | Parental education | There is overwhelming evidence that maternal education is a major determinant of infant and child mortality in any given community (Mosley 1985; Caldwell 1979; DaVanzo and Habicht 1986; Ware 1984; Cochrane, Leslie, and O'Hara 1982; D'Souza and Bhuiya 1982; Borton and Shoham 1989). Even quite low levels of maternal education improved infant and child survivorship probabilities in Nigeria, without any increases in income or public health provision (Caldwell 1979). Urban Zimbabwean children of women who had at least some education had low degrees of wasting, in contrast to women with no education (Mazur and Sanders 1988). In Nicaragua, maternal education has a significant, positive impact on household nutrition in terms of calories and protein, but not necessarily significant for child health indicators (Wolfe and Behrman 1987), while male schooling is associated significantly with permanent, but not current, child health (Wolfe and Behrman 1982). Parental education has a positive impact on height-for-age of Filipino preschoolers (Senauer and Garcia 1991). In Latin America, literacy has a much greater influence on child mortality than on infant mortality (Palloni 1981). |
| | Breast-feeding duration/ frequency | When using breast-feeding as an indicator, one needs to distinguish between exclusive breast-feeding and mixed (bottle and breast) feeding (Leslie 1989). |

## Table 3.4--Summary statistics for core variables in the five data sets

| Variable | Brazil | Bukidnon | Ghana | | Luzon | | Mexico |
|---|---|---|---|---|---|---|---|
| | Rural | Rural | Urban | Rural | Urban | Rural | Urban |
| Number of households | 384 | 448 | 1,177 | 1,959 | 167 | 372 | 338 |
| Household calorie adequacy | | | | | | | |
| Intake | 1.20 | 0.91 | | | 0.70 | 0.78 | 1.08 |
| Availability | | | 1.24 | 1.35 | | | |
| Household size | 6.3 | 7.1 | 4.4 | 5.1 | 6.3 | 7.1 | 6.5 |
| Households with preschooler (percent) | 22 | 100 | 47 | 58 | 96 | 94 | 96 |
| Dependency ratio | 0.50 | 1.79 | 0.91 | 1.01 | 1.35 | 1.44 | 1.59 |
| Rooms per child | | | 0.57 | 0.53 | 0.33 | 0.42 | 0.47 |
| Land cultivated per child (hectares) | 8.2 | 0.4 | | | 0 | 0.4 | |
| Land owned per child (hectares) | | | 0.7 | 4.6 | | | |
| Number of crops cultivated | | 15%>2[a] | 2.5 | 7.2 | 0 | 1.62 | |
| Improved drinking water (percent) | | 20 | 88 | 30 | 87 | 9 | 81 |
| Improved sanitation quality (percent) | | 20 | 93 | 76 | 59 | 35 | 85 |
| Mother's education[b] (years) | | 5.70 | 0.55 | 0.43 | 0.59 | 0.29 | 6.07 |
| Father's education[b] (years) | | 6.24 | 0.45 | 0.33 | 0.47 | 0.19 | 4.99 |
| Adult male education (years) | 2.23 | | | | | | |
| Adult female education (years) | 2.06 | | | | | | |
| Food budget share (percent) | | 72.8 | 61.9 | 71.8 | 61.6 | 66.0 | |
| Number of unique foods consumed/ purchased | 10.6 | 7.8 | 24.7 | 22.3 | 22%>11[c] | 26%>11[c] | |
| Number of preschoolers | 139 | 778 | 534 | 1,152 | 342 | 751 | 308 |
| Z-score height-for-age | -0.94 | -2.04 | -0.95 | -1.42 | -0.08 | -0.08 | -1.35 |
| Z-score weight-for-age | -0.43 | -1.42 | -0.84 | -1.17 | -0.25 | -0.24 | -0.79 |
| Z-score weight-for-height | 0.21 | -0.49 | -0.42 | -0.60 | -0.12 | -0.10 | -0.54 |
| Age at introductory weaning (months) | | 5.3 | 15.7 (months breast-fed) | 18.1 | 4.95 | 6.04 | |
| Days sick (percent fever/week) as a percent of recall period | | 13 | 10 | 11 | 20 | 15[d] | |

[a] Fifteen percent of the Bukidnon households cultivated more than two crops.

[b] For Ghana, education figures represent the proportion of households which contain at least one individual who has completed primary education. For Luzon, education figures represent the proportion of households which contain at least one individual who has some high school education.

[c] For urban and rural Luzon, 22 percent and 26 percent of households, respectively, purchased more than 11 unique food items.

[d] For urban and rural Luzon, 20 percent and 15 percent of preschoolers, respectively, reportedly had a fever in the past week.

Table 3.5--Traditional and potential alternative indicators of food and nutrition security in the five data sets

| Traditional | Brazil | Bukidnon | Ghana | Luzon | Mexico |
|---|---|---|---|---|---|
| Household | | | | | |
| Calorie adequacy | | | | | |
| Availability | | | ✓ | | |
| Intake | ✓ | ✓ | | ✓ | ✓ |
| Micronutrient intake | | | | | ✓ |
| Preschooler | | | | | |
| Calorie adequacy - intake | | ✓ | | | ✓ |
| Micronutrient intake | | | | | ✓ |
| Z-score height-for-age | ✓ | ✓ | ✓ | ✓ | ✓ |
| Z-score weight-for-age | ✓ | ✓ | ✓ | ✓ | ✓ |
| Z-score weight-for-height | ✓ | ✓ | ✓ | ✓ | ✓ |
| Diarrhea | | ✓ | | ✓ | |
| Fever | | ✓ | ✓ | ✓ | |
| Day-sick | | ✓ | | ✓ | |

(continued)

Table 3.5--Traditional and potential alternative indicators of food and nutrition security in the five data sets (continued)

| Alternative: Demographic | Brazil | Bukidnon | Ghana | Luzon | Mexico |
|---|---|---|---|---|---|
| Household | | | | | |
| Dependency ratio | ✓ | ✓ | ✓ | ✓ | ✓ |
| Household size | ✓ | ✓ | ✓ | ✓ | ✓ |
| Gender of head of household | ✓ | | ✓ | ✓ | |
| De jure/de facto female head of household | | | ✓ | | |
| Gender balance of household | ✓ | ✓ | ✓ | | ✓ |
| Number of wives | | | ✓ | | |
| Percentage of males 0-5 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of females 0-5 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of males 5-11 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of females 5-11 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of males 11-17 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of females 11-17 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of males 17-60 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of females 17-60 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of males > 60 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Percentage of females > 60 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Age of household head | | ✓ | ✓ | | |
| Rural | | | ✓ | ✓ | |
| Urban | | | ✓ | ✓ | |
| Region | | | ✓ | | |
| Preschooler | | | | | |
| Age | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sex | ✓ | ✓ | ✓ | ✓ | ✓ |
| Relationship to household head | | ✓ | ✓ | ✓ | |
| Birth order | | ✓ | ✓ | ✓ | |
| Parity of mother | | ✓ | ✓ | (number of births) | |

(continued)

Table 3.5--Traditional and potential alternative indicators of food and nutrition security in the five data sets (continued)

| Alternative: Factor Market | Brazil | Bukidnon | Ghana | Luzon | Mexico |
|---|---|---|---|---|---|
| Household | | | | | |
| Land cultivated per capita | ✓ | ✓ | | ✓ | |
| Land owned per capita | | ✓ | ✓ | | |
| Land sold/bought | | ✓ | | | |
| Percentage of land sharecropped | ✓ | | | | |
| Percentage of land cash-cropped | | ✓ | ✓ | | |
| Land tenure status | ✓ | ✓ | | ✓ | |
| Number of crops cultivated | ✓ | ✓ | ✓ | ✓ | |
| Main crop | | ✓ | | | |
| Value of assets per capita | | ✓ | ✓ | | |
| Ownership of farm assets | | ✓ | | | |
| Ownership of head of household assets | | ✓ | ✓ | ✓ | |
| Ownership of livestock | ✓ | | | ✓ | |
| Value of livestock per capita | ✓ | | ✓ | | |
| Any backyard production? | ✓ | ✓ | | ✓ | |
| Rooms per capita | | | ✓ | ✓ | ✓ |
| Floor quality | | ✓ | | | ✓ |
| Drinking water quality | | ✓ | ✓ | ✓ | ✓ |
| Sanitation quality | | ✓ | ✓ | ✓ | ✓ |
| Electricity | | ✓ | ✓ | ✓ | |
| Wall quality | | ✓ | ✓ | | |
| Education of household head | ✓ | ✓ | ✓ | ✓ | |
| Spouse | ✓ | ✓ | | ✓ | |
| Mother | | ✓ | | | |
| Father | | ✓ | | | |
| Literacy of household head | ✓ | | ✓ | | |
| Numeracy of household head | | | ✓ | | |
| Income per capita | ✓ | ✓ | ✓ | | |
| Number of income sources | | ✓ | ✓ | ✓ | |
| Occupation of household head | | ✓ | ✓ | ✓ | |
| Percentage of income own farm | ✓ | ✓ | | ✓ | |
| Percentage of income off-farm, agriculture | ✓ | ) | | ✓ | |
| nonagriculture | ✓ | )✓ | | ✓ | |
| Percentage of income from livestock | | | ✓ | | |
| Percentage of income from remittances | ✓ | | | | |
| Percentage of female income | | | | ✓ | |
| ~~Percentage of non-labor income~~ | | | | ✓ | |

(continued)

Table 3.5--Traditional and potential alternative indicators of food and nutrition security in the five data sets (continued)

| Alternative: Proximate | Brazil | Bukidnon | Ghana | Luzon | Mexico |
|---|---|---|---|---|---|
| Household | | | | | |
| Food budget share | | ✓ | ✓ | ✓ | |
| Percentage of food availability value: home production | | ✓ | | ✓ | |
| Percentage calorie availability: home production | | ✓ | | ✓ | |
| Number of unique foods purchased | | | ✓ | ✓ | |
| eaten | ✓ | ✓ | | | |
| Number of unique food groups purchased | | ✓ | ✓ | ✓ | |
| eaten | | ✓ | | | |
| Mother's nutrition knowledge | | ✓ | | ✓ | |
| Control of food purchasing decision | | | | ✓ | |
| Why food purchased? | | | | ✓ | |
| Is diet adequate? | | | | ✓ | |
| Missed meal? | | | | ✓ | |
| Preschooler | | | | | |
| Ever breast-fed? | | ✓ | ✓ | | ✓ |
| Currently breast-fed? | | | ✓ | | |
| Duration of breast-feeding | | ✓ | ✓ | | |
| Age at weaning | | ✓ | | ✓ | |
| Mother's food preparation for child | | ✓ | ✓ | ✓ | |
| Mother's illness | | | ✓ | ✓ | |
| Child vaccinated | | ✓ | ✓ | | |
| Child's illness | | | | ✓ | |

## 3.2 Description of Data Sets

The seven extant data sets analyzed for this research project are from the Philippines (two), Brazil, Ghana, and Mexico. The data sets were essentially selected to minimize project transaction and start-up costs. Each data set displays different strengths. The Ghana (urban and rural) data set is nationally representative and will permit an assessment of the importance of region of residence as an indicator of food and nutrition insecurity. The Mexico City data set is drawn from an entirely urban sample and has information on micronutrient adequacy that will permit us to broaden our traditional representation of food and nutrition adequacy. The Luzon, Philippine (urban and rural), data set contains some qualitative information on meal patterns and subjective questions that have recently been determined to be potentially important in defining hunger (Radimer et al. 1990). The Brazil data set is drawn from an unusually older sample of rural households (only 84 of 384 household contain preschool children), which will allow us to explore food and nutrition security in the context of different household demographic characteristics and dependency ratios. The rural Bukidnon, Philippine, data set is particularly strong on information on mothers and preschooler morbidity. The data sets are described in fuller detail below.[9]

[9] Of the seven data sets used here, only the Bukidnon data set has been analyzed for similar purposes (Kennedy, Peters, and Bouis 1990). However, the analysis undertaken here is of a greater breadth and does not duplicate that of the previous work.

### 3.2.1 The Ghana Data Set

The Ghanian data set comes from the 1987-88 Living Standards Survey, a national probability sample. The data have been analyzed most generally in Boateng et al. (1990) and Haddad (1991). Boateng et al. report that 65 percent of the population live in rural areas but contribute to approximately 80 percent to national poverty, based on per capita household total expenditure. This pattern is accentuated for the poorest of the poor (the lowest 7 percent of the population). Of the ten regions, Savannah and Eastern Volta contribute disproportionately more to expenditure-based poverty. Education enrollment and achievements are also substantially lower in the rural areas compared to the urban areas. Haddad (1991) also shows that literacy rates, preschooler Z-scores, and food budget shares consistently show Accra to be the best-off region and Savannah, the worst-off region. Clearly then, region is an important first-stage indicator of poverty and nutrition security.

Regression analyses using traditional food and nutrition security indicators as dependent variables have been undertaken for the same data set by Alderman (1990), who concludes that region and the pregnancy and lactation status of women are important targeting instruments.

### 3.2.2 The Bukidnon (Philippines) Data Set

The Bukidnon data set is a stratified (by crop and tenancy type) random sample of rural households in the southern Philippine island of Mindanao. It has been described in detail in Bouis and Haddad (1990).

Income and total expenditure were tightly associated with calorie consumption from both a 24-hour recall and food availability recall, although the true magnitude of the response is perhaps less than is generally considered conventional (Bouis and Haddad 1991). Mothers education was strongly and positively associated with household food expenditure, preschooler calorie intake, and preschooler height-for-age. Seasonality was a minor factor for preschooler Z-score determination, but was more important in determining household calorie intakes.

One of the most important determinants of preschooler anthropometric status, apart from age, was the mix of crops grown by the households. This mix of crops influenced the time allocation pattern of the mother, which then affected the child through maternal nutrition and time spent in breast-feeding in the post-birth period. Preschoolers of sugar-producing households got off to a better head start than their corn counterparts, but fell back to the level of the corn preschoolers by way of higher morbidity rates of the age of 2-3 years.

### 3.2.3 The Luzon (Philippines) Data Set

There have been no analyses of the Luzon data set to date. The urban sample is from Manila, while the rural sample is drawn from the surrounding areas.

### 3.2.4 The Mexico City (Mexico) Data Set

These data were collected in May 1978 as part of an evaluation of the CONASUPO milk subsidy program (Rogers et al. 1979). The milk

subsidy program serves the Mexico City area, and, in 1977, there were over one quarter of a million recipients.

The data are not thought to cover the poorest of the poor (for example, 86 percent of the households surveyed had televisions and the fathers had an average of 7 years of schooling), although values of preschooler anthropometrics are in the middle range of the seven data sets.

The data were further analyzed by Kennedy (1983). Preschooler standardized heights and weights proved to be difficult to explain by household income or family size, although the income did prove to be a significant explanatory variable of family calorie intake as the dependent variable. This lack of explanatory power is perhaps not so surprising in a population that is relatively food secure. An interesting additional focus would be on the quality of the diet rather than the calorie content. This is pursued in a complementary analysis under the Food and Nutrition Monitoring Project.

### 3.2.5 The Brazil Data Set

This data set consists of the final year of a panel covering the period 1979-84. It was collected in order to monitor the progress of the Integrated Rural Development Project (PRODEMATA) in the poor rural Zona da Mata of Minas Gerais Province in central eastern Brazil. This sample is unusual in that only 84 out of 384 households contain preschoolers. Nerlove, Vosti, and Basel (1990) report that product mix

and output concentration show substantial variation across farms, indicating a diversified agricultural sector.

Vosti and Witcover (1990) examine the role of multiple income sources in determining household calorie adequacy. The study sample of 384 households was not poorly nourished in terms of meeting calorie requirements, and neither were preschooler anthropometrics particularly poor. Variables such as farm size, female headedness of household, livestock income, and farm production pattern stability exhibited positive associations with food and nutrition security, whereas other variables, such as distance to nearest major market and off-farm income (particularly agricultural off-farm income), exhibited negative associations.

### 3.3 Potential Alternative Indicators: How to Measure Performance?

Chapter 2 put forward some conceptual considerations in attempting to answer the question "how well do factor market, demographic, and proximate variables 'move' with more traditional measures of household and preschooler indicators of food and nutrition security." As mentioned in Chapter 2, there are two steps in answering this question: (i) how strong are the associations between traditional and alternative indicators?; and (ii) how well do alternative indicators that show a strong association with traditional indicators perform in a situation in which they will be utilized, such as targeting.

The question we pose here is: which empirical measure of association is most appropriate to indicate the strength of 'movement'

between traditional and alternative indicators? Because there is no single measure of association that is sensitive to every type of association, we employ a range of measures: two-way tables, correlations in term of Pearson coefficients among variables, Spearman coefficients among ranks of variables, t-test tercile overlaps, factor groupings of observed variables, and ordered clusters of households and preschoolers.

### 3.3.1 Measures of Association

#### 3.3.1.1 Two-Way Tables

This technique identifies the food and nutrition insecure and then examines their characteristics vis à vis secure groups using variable means (see Kennedy, Peters, and Bouis (1991).

#### 3.3.1.2 Correlations: Continuous (Pearson) and Rank (Spearman)

The Pearson correlation coefficient is based on continuous variables and is quite sensitive to errors of measurement. The Spearman rank coefficients are correlations between the ranks of the variables, and are less sensitive to measurement error and may be more able to capture the spirit of qualitative inquiry. How far 'wrong' do we go comparing the two types of correlation coefficients for various alternatives? For both techniques, the stronger the association, the closer the absolute value of the coefficient is to 1.

### 3.3.1.3 Lower Group and Tercile Overlaps

This technique is used by Glewwe and van der Gaag to measure association among various poverty measures (1990). Essentially, the technique asks: what percent of households or individuals possessing a certain indicator characteristic are also food insecure households or individuals?

Table 3.6a presents a potential alternative indicator that shows a 33.3 percent lower overlap (the cell in the top left-hand corner) with a traditional measure. This potential indicator does not help locate the food and nutrition insecure households and preschoolers. The further above 33.3 percent the lower tail overlap is, the stronger the association with food insecurity; the further below 33.3 percent, the stronger the association with food security. Table 3.6b presents a potential alternative indicator that is a perfect predictor of the traditional indicator.

### 3.3.1.4 Errors of Misclassification (Exclusion and Inclusion)

These measures are defined by Tucker et al. (1989) and presented in Table 3.7.

These measures are useful when dealing with 2x2 matrices such as in Table 3.7, but lose some interpretation when there are more than two alternative and traditional indicator values. A 2x2 example from the Luzon data set is given in Table 3.8, with household size as the alternative indicator of food security and household calorie adequacy as the traditional indicator. Eligibility is initially based on small

Table 3.6a--An alternative indicator that shows no association with a traditional indicator of food security

| Alternative Indicator Food Security | Traditional Indicator Food Security | | |
|---|---|---|---|
| | Low | Medium | High |
| Low | 33.3 | 33.3 | 33.4 |
| Medium | 33.3 | 33.3 | 33.4 |
| High | 33.3 | 33.3 | 33.4 |

Table 3.6b--An alternative indicator that shows perfect association with a traditional indicator of food security

| Alternative Indicator Food Security | Traditional Indicator Food Security | | |
|---|---|---|---|
| | Low | Medium | High |
| Low | 100 | 0 | 0 |
| Medium | 0 | 100 | 0 |
| High | 0 | 0 | 100 |

Table 3.7--Measures of misclassification

| Food Security as Classified by Alternative Indicator | True Food Insecurity | |
|---|---|---|
| | Yes | No |
| Yes | a | b |
| No | c | d |

Source: Tucker et al. (1989).

Notes: a = Number of households or preschoolers classified as food/nutrition insecure by both the traditional and alternative indicators.

Sensitivity = a/(a+c).

Error of exclusion = c/(a+c).

Specificity = d/(b+d).

Error of inclusion = b/(b+d).

Positive predictive value = a/(a+b).

Negative predictive value = d/(c+d).

Table 3.8--Using selected household size cutoffs to identify households which have calorie adequacy values less than 80 percent, Luzon combined sample

| Household Size Cutoff | Sensitivity | Specificity | Positive Predictive Value | Negative Predictive Value |
|---|---|---|---|---|
| | | (percent) | | |
| Household total | | | | |
| ≤ 4 | 14.75 | 66.27 | 49.55 | 25.70 |
| ≤ 5 | 28.42 | 43.37 | 53.00 | 21.24 |
| ≤ 6 | 43.97 | 29.52 | 58.36 | 18.99 |
| ≤ 8 | 69.90 | 19.64 | 63.50 | 12.50 |
| ≤ 9 | 80.16 | 5.42 | 65.57 | 10.84 |

household size. When the eligibility cutoff is raised, more and more households are correctly classified as undernourished according to household calorie adequacy (high sensitivity) but fewer and fewer households are correctly classified as not undernourished (low specificity).

Figure 3.1 plots these two types of error. Summing sensitivity and specificity as a measure of indicator performance, the use of small household size as an indicator is worse than using a random indicator (for which the sum would be 100 percent). Small households are associated with better household calorie adequacy. A more appropriate indicator, therefore, would be to make large households initially eligible. This produces a plot of specificity plus sensitivity such as in Figure 3.2, from which it can be seen that the best household cutoff is all households with at least five household members. These larger households are at greatest food insecurity risk.

3.3.1.5 Factor Analysis and Cluster Analysis

These two data techniques attempt to find homogeneity in a sea of heterogeneity. Factor analysis attempts to group variables in terms of common variances, or the strength of their relation to the underlying dimensions within the data. By trying to represent the (total) variance of a series of indicator variables in terms of underlying qualitative dimensions or factors, we can examine whether our traditional measures of food and nutrition security (which, presumably, are highly correlated with a qualitative factor called 'hunger') are bracketed together with

Figure 3.1--Errors of inclusion and exclusion when household size is used as an indicator of food security: Luzon combined sample

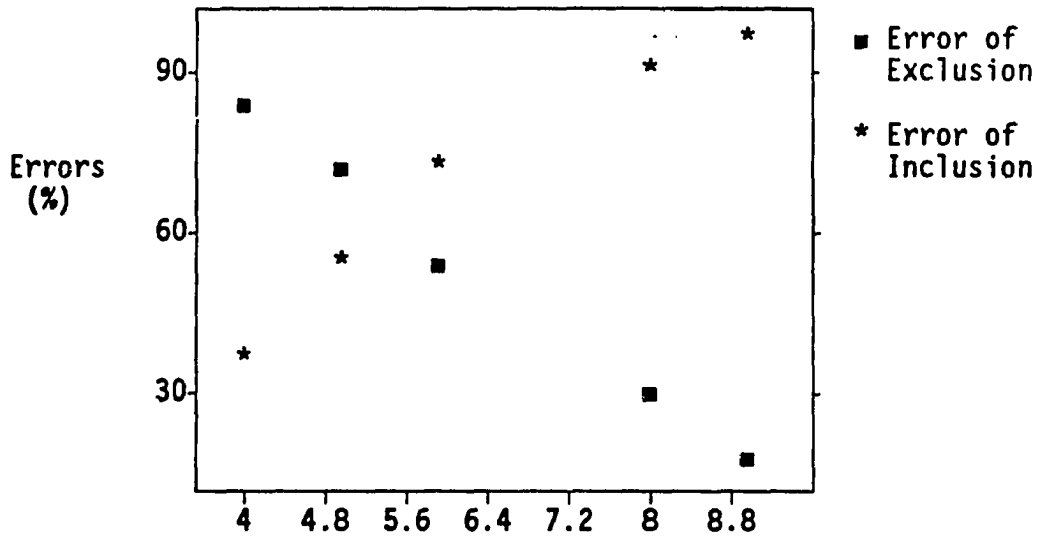
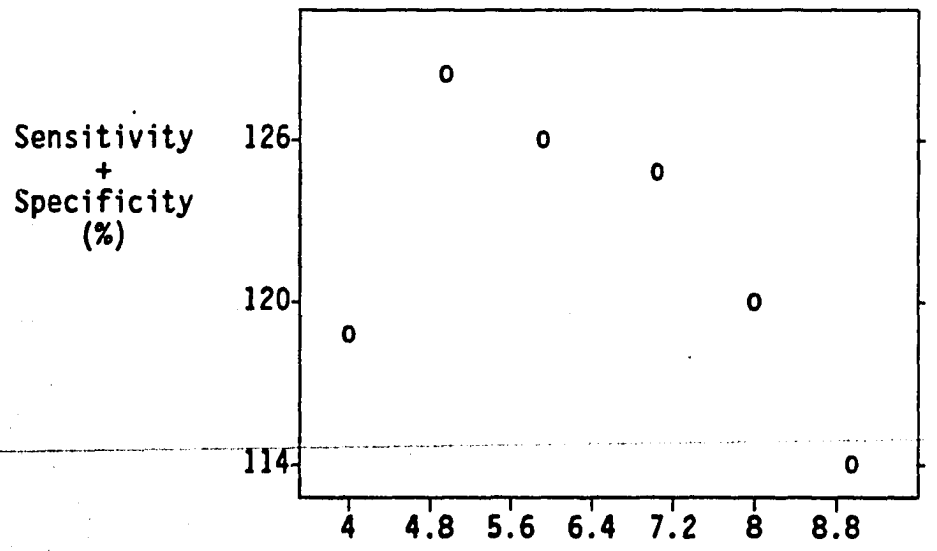



Figure 3.2--Sensitivity plus specificity when household size is used as an indicator of food security: Luzon combined sample



any other variables. The identity of these companion variables would be of considerable interest.

Cluster analysis attempts to group individuals or households in accordance with the characteristics they possess. In trying to group households or individuals according to their similarity across a series of indicator variables, we can examine the different calorie adequacies of the members of different clusters and then look at their profiles in terms of the remaining indicator variables.[10]

### 3.3.2 Preferred Method of Association

Our preferred technique is the overlap analysis: what percent of households or preschoolers in an indicator group are food or nutrition insecure? The other techniques described—two-way tables, correlation coefficients, classification analyses, factor analyses, and cluster analyses—were used in a supporting role in our analysis. Each technique in the search for useful indicators suffers from crucial flaws. For example, in the case of two-way tables, the investigation of the characteristics of households classified as food insecure is suggestive, but it begins with the premise that these households have been located. For instance, the knowledge that 40 percent, 30 percent, and 20 percent of households in the lower, middle, and upper calorie

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[10] Both of these techniques are available in SPSS and are very different from the type of data analysis typically used to study these issues. Typically, dependence techniques, such as regression, are used instead, where one or a small subset of variables is defined as the endogenous dependent variable which is to be explained by a set of independent or exogenous variables.

adequacy terciles respectively have unimproved drinking water suggests that this is a useful indicator, but we have to make the further calculation that 44.4 percent of households with unimproved drinking water are food insecure. In other words, it is difficult to rank indicators from these tables.

Correlation coefficients are subject to extreme values. This can be corrected to some extent by looking at correlation of ranks. Nevertheless, high correlation coefficients could arise due to association at the upper end of the calorie adequacy distribution.

Because chi-squared statistics are calculated across all nine cells in a 3x3 table, a highly significant test statistic could arise because of association at the upper calorie adequacy range. Reclassifying indicators into 2 groups for a 2x2 table would remedy this, but we would lose precision and the ability to detect nonlinearities in terms of middle tercile groups showing stronger associations than the upper or lower groups.

Factor and cluster analysis techniques do not work well with categorical values or continuous variables that are not normally distributed. For variables such as household size, income, food expenditure, and calorie adequacy, factor and cluster analyses are useful in identifying common variances (Factor) and common characteristics (Cluster). Cluster analysis is especially useful in identifying outliers and small distinct subgroups, although again the technique is sensitive to measurement error.

The overlap analysis is not without problems either. The Venn diagrams in Figure 3.3 provide an illustration of the way in which an indicator group can have a high percentage of households which are food insecure yet cover only a small percentage of those at risk (indicator C). Similarly, some indicators will be so general that they will contain all the food insecure households but the food insecure households will only represent a small percentage of the households with that indicator value (indicator D).

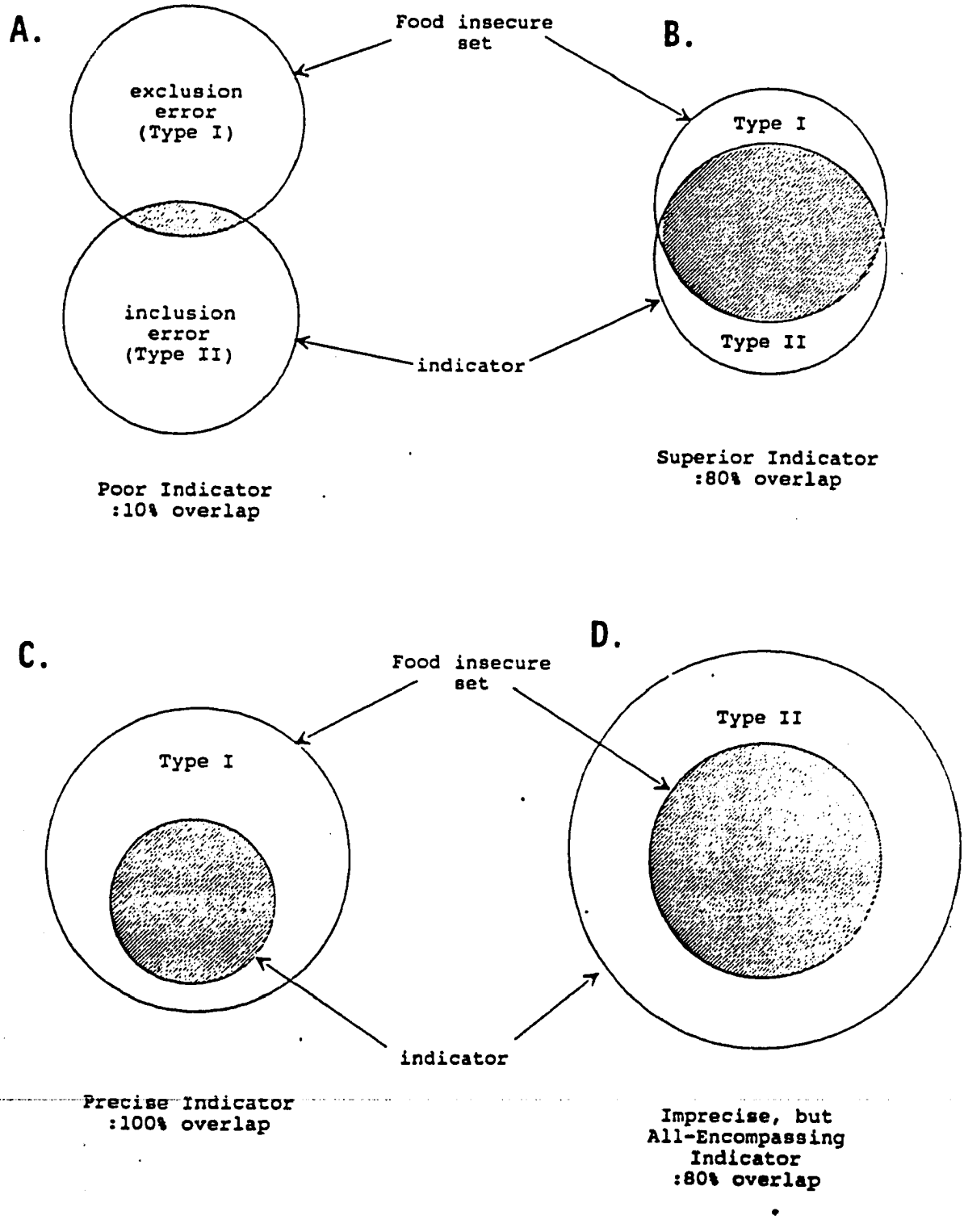
### 3.3.3 Estimation of the Costs of Noncollection

Figure 2.4 in Chapter 2 demonstrated the difference in undernutrition impact between a transfer that was not targeted and a transfer that was targeted by random, imperfect, and perfect indicators. The real value of this analysis is in attaching a calorie savings figure to the improvement due to imperfect targeting. This is achieved by comparing the impact of the imperfect targeting effort to that of a non-targeted transfer. In other words, how many extra calories ($B_e$) does an untargeted transfer (B) need in order to have the same impact on undernutrition as the targeted transfer? Mathematically this can be expressed as the value of $B_e$ that satisfies the equality:

$$P_{\alpha,\ \text{no targeting}}\ ((B+B_e)) = P_{\alpha,\ \text{imperfect targeting}}\ (B)$$

Preliminary results from Bukidnon, using food expenditure per capita as an indicator for calorie adequacy, show that 68,000 calories (6.8 percent of the initial transfer), approximately valued at 1,600 pesos, were saved through targeting. This low figure is probably because we

Figure 3.3--Venn diagram representation of exclusion and inclusion errors for four different indicators of food insecurity



used a high undernutrition cutoff (calorie adequacy equal to 100 percent) which effectively raised measured undernutrition in the sample and, therefore, reduced the usefulness of targeting and increased the efficiency of non-targeted transfers: now the vast majority were eligible for a transfer.

## 4. RESULTS OF DATA ANALYSIS

This chapter presents results for the strength of association between traditional and alternative indicators of food and nutrition security in the seven data sets. Initially, we identify single indicators that are strongly associated with food and nutrition insecurity, then we interact some indicators, and, finally, we calculate the costs of noncollection for a few of the more promising indicators.

Before doing so, however, it is worth pointing out the limitations of the empirical analysis. First, we have no cross-country longitudinal data and so we are dependent on a very restrictive theoretical definition of food security (see Chapter 2). Second, we are restricted in operationalizing this definition of food security by having to use the traditional indicators as a benchmark against which to test the alternatives. Hence, we have no independent benchmark against which to compare the ability of the traditional and alternative indicators to locate the food and nutrition insecure. Ideally, adult weight changes over a fixed time period or biochemical measures of nutrient levels would serve as a benchmark (see Lanjouw and Stern (1991) for a discussion of this benchmark of triangulation issue with respect to household income). Third, we would like to have more variables appearing in all the data sets to facilitate cross-country comparisons.

## 4.1 Identifying Single Indicators

We are searching for indicators of food and nutrition security that correctly classify a high percentage of households or preschoolers as food or nutrition insecure across a range of cultures. As earlier mentioned (Chapter 3), we adopt a straightforward approach of estimating the percentage of households or preschoolers in a group, as determined by the value of an indicator, that are food or nutrition insecure. That is, instead of calculating the percentage of the food and nutrition insecure that have improved drinking water supplies, we ask, of all those who have improved drinking water, what percent are also food insecure?

### 4.1.1 Household Food Security[11]

Table 4.1 presents results for core variables across the seven data sets. The table indicates the percent of households in the upper and lower terciles of a particular variable, say, household size, that is

[11] Clearly, this section ignores the potentially important differences in food security within households that appear food secure at that level of aggregation. The reverse is also true, however, in that indicators of food and nutrition security at the preschool level are not necessarily the best indicators with which to identify households at risk of food and nutrition insecurity (Pelletier, Msukwa, and Ramakrishnan 1991).

Table 4.1--Household calorie adequacy overlaps with selected indicators for the seven data sets

| Variable | Brazil Rural | | Bukidnon Rural | | Ghana Urban | | Ghana Rural | | Luzon Urban | | Luzon Rural | | Mexico Urban | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percent | (t) | Percent | (t) | Percent | (t) | Percent | (t) | Percent | (t) | Percent | (t) | Percent | (t) |
| Household size | | | | | | | | | | | | | | |
| Upper tercile | 55 | 4.68 | 41 | 1.87 | 49 | 5.78 | 46 | 5.58 | 44 | 1.83 | 53 | 4.70 | 43 | 2.05 |
| Lower tercile | 11 | 7.84 | 22 | 3.17 | 21 | 6.62 | 24 | 5.74 | 16 | 3.08 | 17 | 4.89 | 26 | 1.85 |
| Dependency ratio | | | | | | | | | | | | | | |
| Upper tercile | 41 | 1.74 | 47 | 3.15 | 41 | 3.01 | 37 | 2.11 | 39 | 1.02 | 37 | 0.87 | 34 | 0.14 |
| Lower tercile | 23 | 2.99 | 24 | 2.59 | 22 | 4.96 | 31 | 1.50 | 42 | 1.20 | 29 | 1.31 | 32 | 0.34 |
| Number of unique foods | | | | | | | | | | | | | | |
| Upper tercile | 24 | 3.25 | 23 | 3.02 | 20 | 6.33 | 30 | 1.98 | 25 | 1.09 | 27 | 1.53 | | |
| Lower tercile | 47 | 3.38 | 43 | 2.43 | 43 | 4.00 | 35 | 1.08 | 35 | 0.53 | 36 | 0.86 | | |
| Land used per capita | | | | | | | | | | | | | | |
| Upper tercile | 26 | 1.94 | 27 | 1.65 | | | | | | | 28 | 1.19 | | |
| Lower tercile | 46 | 2.91 | 38 | 1.26 | | | | | | | 35 | 0.64 | | |
| Land owned per capita | | | | | | | | | | | | | | |
| Upper tercile | | | | | 34 | 0.42 | 27 | 3.80 | | | | | | |
| Lower tercile | | | | | 33 | 0.30 | 40 | 3.36 | | | | | | |
| Number of income sources | | | | | | | | | | | | | | |
| Upper tercile | 38 | 0.82 | 34 | 0.25 | 37 | 1.14 | 36 | 1.27 | 31 | 0.22 | 38 | 1.18 | | |
| Lower tercile | 33 | 0.05 | 38 | 1.28 | 31 | 1.36 | 33 | 0.30 | 34 | 0.24 | 28 | 1.40 | | |
| Total expenditure per capita | | | | | | | | | | | | | | |
| Upper tercile | 20 | 3.94 | 21 | 3.59 | 11 | 14.08 | 13 | 15.50 | 21 | 2.10 | 15 | 5.95 | | |
| Lower tercile | 57 | 5.42 | 45 | 2.87 | 61 | 11.01 | 64 | 16.17 | 51 | 2.67 | 64 | 7.04 | | |
| Food expenditure per capita | | | | | | | | | | | | | | |
| Upper tercile | | | 20 | 4.07 | | | | | 11 | 5.37 | 4 | 16.65 | | |
| Lower tercile | | | 49 | 3.83 | | | | | 55 | 3.22 | 66 | 7.72 | | |
| Household income per capita | | | | | | | | | | | | | | |
| Upper tercile | 23 | 2.65 | 29 | 1.08 | 21 | 5.92 | 14 | 13.85 | 24 | 1.57 | 24 | 2.37 | 32 | 0.32 |
| Lower tercile | 46 | 2.91 | 38 | 1.08 | 47 | 4.82 | 60 | 13.46 | 52 | 2.79 | 43 | 2.12 | 35 | 0.33 |

Note: Numbers in the table represent the percentage of all households in that tercile group which are also in the lowest calorie adequacy tercile. The further the number is from 33.3 percent, the stronger the indicator-calorie adequacy association.

An absolute t-value > 1.96 indicates a percent overlap which is significantly different from 33.3 percent.

also in the lowest household calorie adequacy tercile.[12] For example, for Brazil, 55 percent of households in the upper tercile for household size are also in the lowest tercile for household calorie adequacy. The results are surprising, in that variables that are relatively easy to collect—household dependency ratio, household size, and number of unique food groups—do nearly as well in locating the food insecure as do income or total expenditure.

- Household size is as good a predictor of household calorie adequacy as is total expenditure per capita or household income per capita. This result is strong in all countries tested here and in both rural and urban settings, and, perhaps surprisingly, in a labor-scarce region such as rural Ghana. This result also held for Kenya, but not for Malawi (Kennedy, Peters, and Bouis 1991).
- Higher household dependency ratios also show a positive association with membership of the lowest calorie adequacy tercile (although the association is negative for urban Luzon), but not as strong an association as household incomes or total expenditure.

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[12] It was decided not to use absolute cutoffs for the traditional indicators of food and nutrition security, and instead focus on relative food insecurity within each of the populations represented by the data sets. Any indicators performing well across this broad range of inter-data set food security levels would likely be more flexible in responding to various program and project needs, and in addition we avoid the question of what is the appropriate absolute cutoff. Instead we use terciles as our relative cutoff groups. The analysis here could be undertaken for absolute cutoffs, however, and, as Atkinson (1991) notes, the two methods do not necessarily lead to similar conclusions.

- Land used and land owned per capita also does fairly well in locating the food insecure, especially in rural areas, even in labor constrained areas such as rural Ghana.
- The number of unique foods at various levels of aggregation also seems a promising indicator in both urban and rural areas in all countries. Later tables will show that, in addition, the type of food consumed, for example, the use of oil in preparing children's food in Luzon, and the number of different cereal items, for example, in Bukidnon, are also indicators of food security.
- The number of income sources does not seem to be useful in identifying households that are at nutritional risk, at least in terms of the household calorie adequacy definition. For example, households in Brazil, Ghana, and rural Luzon, with a high number of income sources (upper tercile of their data set), have a marginally higher representation of household food insecure households than households with a low number of income sources; but, the reverse holds true for Bukidnon and urban Luzon.
- Of the more complex indicators, food expenditure per capita does better than total expenditure per capita, which in turn does better than household income.

Tables 4.2 and 4.3 present the best indicators within each data set in terms of their ability to predict which households are most likely to be in lowest calorie adequacy tercile and which are least likely. Note that indicators that are accurate in identifying households that are not

## Table 4.2--Some potential food security indicators from the data sets

| Data Set | Food Insecurity | Food Security |
|---|---|---|
| Brazil | • Most of household income is from off-farm (ag) labor income in a rural area<br>• Large household size, presence of preschoolers<br>• Sharecropper<br>• Low number of foods consumed<br>• Low land used per capita | • Low dependency ratio<br>• Low household size<br>• High percentage of income from off-farm nonagricultural sources<br>• High percentage of adults in household<br>• High number of unique foods consumed<br>• Female headedness |
| Bukidnon | • High percentage of children<br>• High dependency ratio<br>• Nonagricultural occupation<br>• Low number of foods groups: unique and nonunique<br>• Low percentage of income from own farm | • Sugar-mixed tenants<br>• High number of different cereal items consumed<br>• Land purchased recently<br>• Low household size, young parents<br>• Large number of unique food items |
| Urban Ghana | • Large number of wives<br>• Region (Mid-Forest)<br>• Large household size<br>• Low number of different food purchases<br>• Unimproved drinking water<br>• Low number of rooms per capita<br>• High percentage of older females | • Ownership of a vehicle<br>• Large number of food codes reported<br>• Small household<br>• Low dependency ratio<br>• Region (Accra, Upper Forest)<br>• Large number of rooms per capita<br>• Low percent of children |
| Rural Ghana | • Region (Mid-Forest)<br>• Large household size<br>• No land owned<br>• Some livestock owned<br>• Large number of wives<br>• Low value of assets | • Region (East Forest)<br>• Small household size<br>• Large area land owned<br>• High value of assets |
| Urban Luzon | • Large number of children<br>• Large households<br>• Low dependency ratio<br>• High number of unrecorded meals missed<br>• Food purchased mainly because it is readily available | • Small household size<br>• Small number of children<br>• Low number of unrecorded missed meals<br>• Joint or male decision-making on food and nonfood purchases<br>• Extra money would be spent on nonfoods |
| Rural Luzon | • Large number of children<br>• Large households<br>• Small number of rooms per capita<br>• Presence of older females<br>• Low food budget shares<br>• Food chosen because it does not have to be purchased | • Large number of rooms per capita<br>• Small household size<br>• Food purchased for storage quality<br>• Oil used in child food preparation<br>• Small number of children<br>• Mother participated in nutrition education program<br>• Some land owned |
| Mexico | • Large household size<br>• Low rooms per capita<br>• No improved sanitation<br>• No improved drinking water source<br>• Low education of father<br>• Low iron adequacy | • Small household size<br>• Improved floor<br>• Improved water source<br>• High rooms per capita<br>• High iron adequacy |

Table 4.3--Indicators of household calorie adequacy: Percent of households with the following characteristics which are also in the lowest and highest calorie adequacy terciles

| Overlap With Calorie Adequacy Tercile | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lowest | | | | Highest | | | |
| Country/ Variable | Percent Overlap | Number of Households in Group | t-test[a] | Variable | Percent Overlap | Number of Households in Group | t-test |
| ■ Brazil | | | | | | | |
| off-farm labor income | 57.1 | 49 | 3.37 | female headed hh | 24.2 | 33 | -1.22 |
| hh total exp pc - low | 57.0 | 128 | 5.42 | unique foods cons > 9 | 24.1 | 228 | -3.25 |
| hh size - high | 54.5 | 121 | 4.68 | hh total exp pc - med | 23.4 | 128 | -2.65 |
| sharecropper | 53.2 | 47 | 2.73 | hh income - high | 23.4 | 128 | -2.65 |
| % inc off-frm ag - high | 50.5 | 99 | 3.42 | hh is one m, one f | 23.4 | 77 | -2.05 |
| more fem than males | 47.2 | 89 | 2.63 | hh is two f, two m | 22.7 | 44 | -1.68 |
| unique foods cons < 9 | 46.8 | 156 | 3.38 | % of hh > 15 - high | 22.6 | 137 | -2.99 |
| land used pc - low | 46.1 | 128 | 2.91 | % of hh < 15 - low | 22.6 | 137 | -2.99 |
| hh income pc - low | 46.1 | 128 | 2.91 | dependency ratio - low | 22.6 | 137 | -2.99 |
| % hh fem <15 - upper | 45.3 | 64 | 1.93 | hh total exp pc - high | 19.5 | 128 | -3.94 |
| % hh male <15 - upper | 43.7 | 71 | 1.77 | % inc off-frm oth- uppr | 19.1 | 47 | -2.48 |
| preschooler in hh | 42.9 | 84 | 1.78 | hh size - low | 10.9 | 119 | -7.84 |
| ■ Bukidnon | | | | | | | |
| % fem 11-17 - med | 59 | 32 | 2.96 | % land to sugar - high | 23 | 105 | -2.51 |
| hh food exp pc - low | 49 | 149 | 3.83 | age of hoh - low | 23 | 149 | -2.99 |
| % mle > 15 - low | 46 | 147 | 3.09 | # of unq FCT codes- high | 22 | 152 | -3.36 |
| dependency ratio - high | 47 | 142 | 3.27 | mothers age - low | 23 | 149 | -2.99 |
| non-agric occp | 45 | 42 | 1.52 | % males >15 - high | 22 | 152 | -3.36 |
| hh total exp pc - low | 45 | 149 | 2.87 | hh size - low | 22 | 147 | -3.31 |
| # unq. brd food grp -low | 45 | 152 | 2.90 | land purchased recently | 22 | 27 | -1.42 |
| corn other tenants | 44 | 18 | 0.91 | no. of corn items - high | 22 | 141 | -3.24 |
| # unq food grps - low | 43 | 148 | 2.38 | no. oth cereal itm - hi | 21 | 117 | -3.27 |
| % males 11-17 - high | 42 | 150 | 2.16 | hh total exp pc - high | 21 | 150 | -3.70 |
| # recipes reported - low | 42 | 147 | 2.14 | hh food exp pc - high | 20 | 150 | -4.07 |
| % income own farm - low | 42 | 149 | 2.15 | sugar mixed tenants | 20 | 30 | -1.82 |
| ■ Ghana: Urban | | | | | | | |
| no. of wives hoh - high | 68.4 | 38 | 4.65 | Accra metropol hh | 25.7 | 303 | -3.03 |
| hh total exp pc - low | 61.1 | 370 | 10.97 | % hh male <15 - low | 24.7 | 507 | -4.49 |
| mid-Forest hh | 57.7 | 104 | 5.04 | food budget share: high | 24.3 | 367 | -4.02 |
| hh size - high | 48.6 | 352 | 5.74 | % hh fem <15 - low | 23.8 | 504 | -5.01 |
| % hh 0-6 - med | 46.3 | 205 | 3.73 | Upper Forest hh | 22.9 | 96 | -2.43 |
| % fem < 15 - med | 46.0 | 278 | 4.25 | rooms pc - high | 22.9 | 367 | -4.74 |
| food budget share - low | 45.7 | 370 | 4.79 | dependency ratio - low | 22.4 | 366 | -5.00 |
| hh income pc - low | 45.6 | 375 | 4.78 | hh income pc - high | 20.7 | 368 | -5.97 |
| # food codes rep - low | 43.3 | 386 | 3.97 | hh size - low | 20.7 | 460 | -6.67 |
| unimproved drink water | 43.0 | 135 | 2.28 | # food codes rep - high | 20.2 | 382 | -6.38 |
| rooms pc - low | 42.5 | 381 | 3.63 | owns vehicle | 17.9 | 28 | -2.13 |
| % fem > 60 - upper | 42.1 | 121 | 1.96 | hh total exp pc - high | 10.6 | 368 | -14.15 |

[a] An absolute t-value > 1.96 indicates that the percent overlap is significantly different from 33.3 percent.

(continued)

Table 4.3--Indicators of household calorie adequacy: Percent of households with the following characteristics which are also in the lowest and highest calorie adequacy terciles (continued)

| Overlap With Calorie Adequacy Tercile | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lowest | | | | Highest | | | |
| Country/ Variable | Percent Overlap | Number of Households in Group | t-test | Variable | Percent Overlap | Number of Households in Group | t-test |
| ▪ Ghana: Rural | | | | | | | |
| hh total exp pc - low | 64.4 | 620 | 1.92 | % fem < 15 - low | 27.4 | 744 | -3.61 |
| hh income pc - low | 60.5 | 585 | 2.02 | land own pc - high | 26.5 | 607 | -3.80 |
| Mid-Forest hh | 48.3 | 203 | 3.51 | East Forest hh | 26.0 | 196 | -2.33 |
| food budget share - low | 49.2 | 616 | 2.01 | val non-veh asstpc: high | 26.5 | 635 | -3.88 |
| hh size - high | 45.7 | 503 | 2.22 | > 10 acres land ownpc | 26.0 | 350 | -3.11 |
| no land owned | 42.5 | 424 | 2.40 | Upper Forest hh | 25.2 | 214 | -2.73 |
| val of livestock pc -upr | 40.3 | 139 | 4.16 | hh size - low | 23.8 | 661 | -5.74 |
| land own pc - low | 39.8 | 640 | 1.93 | hh total exp pc - med | 23.7 | 638 | -5.70 |
| no. of wives hoh - high | 39.4 | 170 | 3.75 | food budget share - high | 20.8 | 635 | -7.76 |
| % hh 0-6 yrs - med | 39.2 | 579 | 2.03 | West Coast hh | 20.1 | 234 | -5.04 |
| % fem < 15 - med | 39.0 | 498 | 2.19 | hh income pc - high | 13.8 | 600 | -13.85 |
| val non-vehc asstspc-low | 38.8 | 647 | 1.92 | hh total exp pc - high | 12.7 | 628 | -15.50 |
| ▪ Luzon: Urban | | | | | | | |
| hh food exp pc - low | 54.5 | 55 | 6.71 | hh income pc - med | 23.6 | 55 | -1.69 |
| hh income pc - low | 51.9 | 54 | 6.80 | wife not excl how much nf | 23.3 | 30 | -1.30 |
| hh total exp pc - low | 50.9 | 55 | 6.74 | % male 0-5 - low | 22.8 | 57 | -1.89 |
| % males 0-5 - med | 47.4 | 57 | 6.61 | wife not excl how meat buy | 22.2 | 27 | -1.39 |
| no. of children - high | 47.3 | 55 | 6.73 | % fem 0-5 - high | 21.6 | 51 | -2.03 |
| % males 5-15 - high | 47.2 | 53 | 6.86 | wife not excl how fish buy | 21.4 | 28 | -1.54 |
| food purch was avail mkt. | 45.5 | 44 | 7.51 | hh total exp pc - high | 21.4 | 56 | -2.17 |
| unrec missed meals - high | 44.7 | 85 | 5.39 | unrec missed meals - low | 20.7 | 82 | -2.82 |
| % fem 5-15 - med | 44.1 | 34 | 8.52 | no. of children -low | 20.7 | 58 | -2.37 |
| hh size - high | 43.7 | 71 | 5.89 | dependency ratio - med | 20.0 | 60 | -2.58 |
| dependency ratio - low | 41.9 | 43 | 7.52 | hh size - low | 15.9 | 44 | -3.16 |
| % fem 0-5 - low | 40.4 | 57 | 6.50 | hh food exp pc - high | 10.7 | 56 | -5.47 |
| ▪ Luzon: Rural | | | | | | | |
| hh food exp pc - low | 66.1 | 124 | 4.25 | % fem 5-15 - low | 24.7 | 150 | -2.44 |
| hh total exp pc - low | 63.7 | 124 | 4.32 | use oil in kids food | 24.5 | 94 | -1.98 |
| no. of children -high | 53.2 | 111 | 4.74 | food budget share - high | 24.2 | 124 | -2.37 |
| hh size - high | 53.2 | 139 | 4.23 | hh income pc - high | 24.2 | 124 | -2.37 |
| rooms pc - low | 50.8 | 124 | 4.49 | no. of children -low | 23.3 | 159 | -2.98 |
| % fem >60 -upper | 50.0 | 26 | 9.81 | % of males 5-15 -low | 23.2 | 151 | -2.94 |
| % food purchased - med | 46.8 | 124 | 4.48 | hh total exp pc - med | 21.8 | 124 | -3.10 |
| % male 0-5 - med | 45.0 | 109 | 4.77 | food purch for storage q | 18.5 | 27 | -1.98 |
| % inc small business -hi | 44.6 | 65 | 6.17 | hh size - low | 17.1 | 129 | -4.89 |
| food budget share - low | 44.4 | 124 | 4.46 | rooms pc - high | 16.5 | 133 | -5.22 |
| % male 5-15 - med | 44.3 | 115 | 4.63 | hh total exp pc - high | 14.5 | 124 | -5.95 |
| % feml 5-15 - med | 44.2 | 86 | 5.36 | hh food exp pc - high | 14.0 | 124 | -6.19 |

(continued)

Table 4.3--Indicators of household calorie adequacy: Percent of households with the following characteristics which are also in the lowest and highest calorie adequacy terciles (continued)

| Overlap With Calorie Adequacy Tercile | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lowest | | | | Highest | | | |
| Country/ Variable | Percent Overlap | Number of Households in Group | t-test | Variable | Percent Overlap | Number of Households in Group | t-test |
| ■ Mexico | | | | | | | |
| hh protein adeq - low | 70.8 | 113 | 8.77 | improved water source | 29.6 | 274 | -1.34 |
| hh iron adequacy - low | 67.3 | 113 | 7.70 | rooms pc - high | 29.2 | 106 | -0.93 |
| no improved water source | 50.0 | 64 | 2.67 | improved floor | 28.4 | 102 | -1.10 |
| hh retinol adeq - low | 49.6 | 113 | 3.47 | % hh < 6 - med | 28.0 | 118 | -1.28 |
| hh size - high | 42.9 | 112 | 2.05 | hh protein adeq - med | 27.4 | 113 | -1.41 |
| hh vit C adeq - low | 42.5 | 113 | 1.98 | yrs school dad - med | 26.4 | 121 | -1.72 |
| rooms pc - low | 41.1 | 107 | 1.64 | hh size - low | 26.3 | 99 | -1.58 |
| no improved sanitation | 40.0 | 50 | 0.97 | hh iron adeq - med | 25.7 | 113 | -1.85 |
| yrs school dad - low | 39.7 | 116 | 1.41 | hh vit C adeq - high | 21.4 | 112 | -3.07 |
| % hh < 6 - low | 37.0 | 108 | 0.80 | hh retinol adeq - high | 17.0 | 112 | -4.59 |
| yrs school mom - high | 36.9 | 65 | 0.60 | hh iron adeq - high | 7.1 | 112 | -10.80 |
| hh vit C adeq - med | 36.3 | 113 | 0.66 | hh protein adeq - high | 1.8 | 112 | -25.07 |

insecure may not necessarily be useful in telling us which households are insecure.

It was observed that variables that are relatively easy to collect—household size, number of foods consumed, occupational group, crop-tenancy status, and region—do nearly as well, and in some cases better, than per capita food expenditure, total expenditure, and income in identifying the food insecure households.

With respect to qualitative variables, the Luzon data set, which contained such variables, indicated that questions, such as the qualities sought in the consumption of food and whether the diet was considered adequate, did not rank in the upper group of indicators, although they did perform well in identifying the nutrition secure.

The results for Ghana, both urban and rural, demonstrate the importance of regional location as a first-stage stratifier in locating the food insecure. Households in the forest regions of Ghana seem particularly at risk of food insecurity.

Rural-urban differences are also examined. In urban Ghana, quality of housing (rooms per capita, quality of drinking water) is a useful indicator of the food insecure, but this relationship is not found in the rural areas, where land ownership and value of non-vehicle assets seems to be more important. A different pattern shows up in the Luzon rural-urban comparison; rooms per capita is a more useful indicator in rural Luzon, and for obvious reasons, land is also a more useful indicator in rural Luzon. The motives for choice of food consumed differ for the food insecure in rural and urban Luzon: in urban areas,

one of the reasons mentioned is that food is readily available in the markets, whereas in the rural areas, one of the reasons associated with choice of food of the food insecure is that the food is homegrown.

### 4.1.2 Nutrition Security

In general, and similar to food security, many of the nonmonetary variables perform better than per capita household income and total expenditure in identifying the nutrition insecure. For instance, in Brazil, 51.4 percent of preschoolers in the upper tercile for dependency are in the lowest ZHA tercile compared to 50 percent of preschoolers in the lowest tercile for the per capita total expenditure of their households. Region continued to be an important factor in both urban and rural Ghana (the West Forest region, in particular, displaying high percentages of nutrition insecure preschoolers).

#### 4.1.2.1 Longer-Run Nutrition Security: Z-Score Height-for-Age

Apart from age (older preschoolers tend to be highly represented in the lower ZHA tercile), household variables tend to be better indicators of low ZHA, consistent with the interpretation of ZHA as a long-run indicator of nutrition security (see Tables 4.4 and 4.5). Dietary indicators, such as number of food groups consumed, and the reasons for food purchase also perform well in identifying the nutrition insecure. Source-of-income indicators perform well: high percent of income from off-farm nonagriculture, low percent income from livestock in Brazil, and nonlabor income in urban Luzon. Demographic indicators perform

## Table 4.4--Preschooler ZHA overlaps for the seven data sets

| Variable | Brazil Rural | Bukidnon Rural | Ghana Urban | Ghana Rural | Luzon Urban | Luzon Rural | Mexico Urban |
|---|---|---|---|---|---|---|---|
| Sex | | | | | | | |
| Male | 33 | 32 | 36 | 36 | 36 | 37 | 33 |
| Female | 33 | 35 | 30 | 31 | 34 | 37 | 32 |
| Age | | | | | | | |
| Upper tercile | 39 | 43 | 43 | 46 | 40 | 45 | 29 |
| Lower tercile | 30 | 19 | 17 | 14 | 27 | 26 | 36 |
| Age at weaning | | | | | | | |
| Upper tercile | | 44 | | | 37 | 47 | |
| Middle tercile | | 39 | | | 33 | 35 | |
| Lower tercile | | 29 | | | 37 | 26 | |
| Diarrhea | | | | | | | |
| Yes | | 29 | | | 46 | 38 | |
| No | | 34 | | | 34 | 32 | |
| Fever | | | | | | | |
| Yes | | 31 | | | 43 | 43 | |
| No | | 35 | | | 33 | 36 | |
| Days sick | | | | | | | |
| Upper tercile | | 34 | 37 | 33 | | | |
| Lower tercile | | 34 | 29 | 34 | | | |
| Birth order | | | | | | | |
| Upper tercile | | | 32 | 33 | 34 | 37 | |
| Lower tercile | | | 33 | 33 | 33 | 35 | |
| Child vaccinated | | | | | | | |
| Yes | | | 33 | 33 | | | |
| No | | | 31 | 34 | | | |
| Mothers' days sick | | | | | | | |
| Upper tercile | | 31 | 33 | 34 | | | |
| Lower tercile | | 35 | 31 | 33 | | | |

Note: Numbers in the table represent the percentage of all preschoolers in that indicator group which are also in the lowest ZHA tercile group. The further the number is from 33 percent, the stronger the indicator-ZHA association. For urban Luzon, this figure is 35 percent, and for rural Luzon, 37 percent.

In Bukidnon and urban Luzon, 36 percent of all children for whom we have a value for age at weaning are also in the lowest ZHA tercile. For rural Luzon, this figure is 33 percent.

Table 4.5--Indicators of ZHA: Percent of preschoolers with the following characteristics, which are also in the lowest ZHA tercile

| Variable | Value | Percent | t-test | Number of Households | Variable Explanation |
|---|---|---|---|---|---|
| ■ Brazil | | | | | |
| TDMGT15 | 1 | 54.3 | 2.52 | 35 | percent males > 15 -low |
| TDEPRATI | 3 | 51.4 | 2.23 | 37 | dependency ratio - high |
| TDFGT15 | 1 | 50.0 | 1.97 | 34 | percent females > 15 -low |
| TTOTEXPC | 1 | 50.0 | 2.29 | 46 | household total expenditure - low |
| TDMLT15 | 3 | 48.8 | 2.06 | 43 | percent males < 15 - high |
| THHSIZE | 2 | 48.5 | 1.77 | 33 | household size - medium |
| THHINCPC | 1 | 47.8 | 2.00 | 46 | household income per child - low |
| off-fm lab y | 4 | 47.6 | 1.33 | 21 | cluster classification: inc from off-farm labor |
| TLANDPC | 1 | 44.4 | 1.53 | 45 | land used per child - low |
| TPINCLIV | 1 | 44.4 | 1.53 | 45 | percent income from livestock - low |
| (all=33.1%) | | | | | |
| ■ Bukidnon | | | | | |
| TAGEWEAN | 3 | 44 | 1.67 | 140 | age at weaning - high (all=37%) |
| TTOTEXPP | 1 | 44 | 3.46 | 257 | household total expenditure per child - low |
| TPCALAEQ | 1 | 43 | 2.27 | 258 | preschooler calcium consumed - low (all=36%) |
| TACCAGE | 3 | 43 | 3.16 | 260 | age - high |
| TFOODEXP | 1 | 42 | 2.83 | 257 | household food expenditure per child - low |
| TNBFG7 | 1 | 42 | 2.65 | 226 | number of value-added foods - low |
| CRN OWN | 1 | 42 | 1.44 | 67 | from corn landowner household |
| TNUQFG | 1 | 41 | 2.54 | 264 | number of unique food groups - low |
| TNUQFCT | 1 | 41 | 2.45 | 245 | number of unique food items - low |
| (all=33.3%) | | | | | |
| ■ Urban Ghana | | | | | |
| W. Forest | 7 | 56.9 | 3.66 | 58 | household in West Forest region |
| DUMWATER | 0 | 49.3 | 2.77 | 73 | no improved water source |
| TMLCBF | 3 | 46.0 | 1.56 | 50 | months last child breast-fed - high (all=35%) |
| LANDOWNG | 3 | 44.3 | 2.00 | 79 | land owned per child 1-10 acres - small |
| DTOILET | 0 | 43.4 | 1.51 | 53 | no improved toilet facility |
| TAGE | 3 | 42.8 | 2.58 | 173 | age - high |
| Volta B. | 9 | 42.5 | 1.20 | 40 | household in Volta Basin |
| ELEC | 0 | 42.1 | 2.75 | 228 | no electricity in household |
| DSAVANNA | 1 | 41.5 | 1.09 | 41 | household in Savanna region |
| BALANCE | 1 | 41.3 | 1.32 | 63 | more males than females in household |
| (all=33.1%) | | | | | |

(continued)

Table 4.5--Indicators of ZHA: Percent of preschoolers with the following characteristics, which are also in the lowest ZHA tercile (continued)

| Variable | Value | Percent | t-test | Number of Households | Variable Explanation |
|---|---|---|---|---|---|
| ▪ Rural Ghana | | | | | |
| TAGE | 3 | 46.4 | 5.06 | 371 | age of child - high |
| TMLCBF | 3 | 42.0 | 1.33 | 119 | months last child breast-fed - high (all=36%) |
| TAGE | 2 | 41.7 | 3.26 | 367 | age of child - medium |
| Savanna | 10 | 40.9 | 1.98 | 164 | households in Savanna region |
| M. Forest | 6 | 40.6 | 1.49 | 101 | households in Mid-Forest region |
| TFOODSHR | 3 | 40.4 | 2.82 | 379 | food budget share - high |
| TNFOODGP | 1 | 39.1 | 1.99 | 281 | number of food groups purchased/grown - low |
| TROOMSPC | 1 | 39.0 | 2.00 | 292 | rooms per child - low |
| W. Forest | 7 | 38.9 | 1.38 | 144 | household in West Forest region |
| TPCTREM | 2 | 38.5 | 1.39 | 169 | percent income from remittances > 0 |
| (all=33.3%) | | | | | |
| ▪ Urban Luzon | | | | | |
| DCFUEL | 0 | 59 | 3.12 | 41 | no improved fuel used |
| TTEPC | 1 | 50 | 3.19 | 113 | household total expenditure per capita - low |
| TFEPC | 1 | 50 | 3.19 | 113 | household food expenditure per capita - low |
| ADEQNUTR | 0 | 49 | 2.80 | 100 | household reports not enough food adequate nutrition |
| TDEMM051 | 3 | 45 | 2.05 | 104 | percent males 5-15 years - high |
| TPCTNONL | 2 | 44 | 1.50 | 68 | percent income, non-labor > 0 |
| THHINCPC | 1 | 44 | 1.94 | 114 | household income per child - low |
| diarr | 1 | 46 | 1.31 | 35 | child had diarrhea past week |
| fever | 1 | 43 | 1.33 | 68 | child had fever past week |
| TROOMSPC | 2 | 43 | 1.77 | 120 | rooms per child - medium |
| (all=35%) | | | | | |
| ▪ Rural Luzon | | | | | |
| tHHINCPC | 1 | 46 | 2.86 | 250 | household income per capita - low |
| FOODCONV | 1 | 46 | 1.25 | 48 | food purchased because storable |
| tAGEMONT | 3 | 45 | 2.55 | 251 | age - high |
| tDRATIO | 3 | 45 | 2.50 | 241 | dependency ratio - high |
| tTEPC | 1 | 44 | 2.22 | 248 | total expenditure per capita - low |
| fever | 1 | 43 | 1.28 | 111 | child had fever in past week |
| tROOMSPC | 1 | 43 | 1.98 | 267 | rooms per capita - low |
| tXTRANFD | 3 | 43 | 1.33 | 174 | percent of extra 100 pesos to nonfood-high (all=38%) |
| GENDBAL | 2 | 42 | 1.19 | 139 | number of males = number of females |
| ADEQNUTR | 0 | 42 | 1.48 | 212 | household reports not enough food adequate nutrition |
| (all=37%) | | | | | |

reasonably well for three Z-score types, but not as strongly as they did for the food security analysis.

4.1.2.2 Shorter-Run Nutrition Security: Z-Scores for Weight-for-Age and Weight-for-Height

Here, preschooler, as opposed to household, characteristics (with the exception of sanitation indicators) prove to be the more useful indicators of medium- and short-run nutrition insecurity (see Tables 4.6, 4.7, 4.8, and 4.9). Recall morbidity was a useful indicator wherever it was available (Bukidnon, Luzon, and Ghana), with 'child not vaccinated' proving the top-rated indicator of low ZWA in urban Ghana.

The more qualitative indicators, such as reasons for food purchase, opinion of respondent as to diet quantity and quality, and who makes the purchasing decisions, again featured prominently where available in the Luzon data set. Where the wife is not the sole food marketer (that is, joint, or male, or other), nutrition security seemed high. Low number of rooms per capita was important in Mexico and rural Ghana, but in urban Luzon, a high number of rooms per capita was associated with low ZWH. High age at weaning performed quite well whenever available (in Luzon and Bukidnon) across all three Z-score types. Birth order did not perform well wherever available, and mothers' days sick (available in Ghana and Bukidnon) showed no association in Ghana, and performed in an perhaps unexpected way in Bukidnon: higher maternal illness was related to lower preschooler illness. This latter result can be plausible if it is the case that the quality of time inputs an ill mother can provide is

## Table 4.6--Preschooler ZWA overlaps for the seven data sets

| Variable | Brazil Rural | Bukidnon Rural | Ghana Urban | Ghana Rural | Luzon Urban | Luzon Rural | Mexico Urban |
|---|---|---|---|---|---|---|---|
| Sex | | | | | | | |
| Male | 34 | 44 | 38 | 36 | 60 | 61 | 35 |
| Female | 33 | 21 | 29 | 31 | 64 | 60 | 32 |
| Age | | | | | | | |
| Upper tercile | 38 | 29 | 31 | 46 | 73 | 67 | 34 |
| Lower tercile | 30 | 36 | 34 | 14 | 49 | 52 | 28 |
| Age at weaning | | | | | | | |
| Upper tercile | | 40 | | | 58 | 59 | |
| Middle tercile | | 36 | | | 62 | 57 | |
| Lower tercile | | 34 | | | 59 | 58 | |
| Diarrhea | | | | | | | |
| Yes | | 44 | | | 74 | 65 | |
| No | | 30 | | | 61 | 60 | |
| Fever | | | | | | | |
| Yes | | 37 | | | 69 | 71 | |
| No | | 30 | | | 60 | 58 | |
| Days sick | | | | | | | |
| Upper tercile | | 37 | 41 | 33 | | | |
| Lower tercile | | 30 | 32 | 34 | | | |
| Birth order | | | | | | | |
| Upper tercile | | | 41 | 34 | 62 | 56 | |
| Lower tercile | | | 31 | 32 | 62 | 66 | |
| Child vaccinated | | | | | | | |
| Yes | | | 31 | 33 | | | |
| No | | | 49 | 34 | | | |
| Mothers' days sick | | | | | | | |
| Upper tercile | | 30 | 33 | 35 | | | |
| Lower tercile | | 35 | 32 | 33 | | | |

Notes: Numbers in the table represent the percent of all preschoolers in that indicator group which are also in the lowest ZWA tercile. The further the number is from 33 percent, the stronger the indicator-ZWA association. For urban Luzon, this figure is 63 percent, and for rural Luzon, 60 percent.

In Bukidnon and Luzon, 36 percent of all children for whom we have a value for age at weaning are also in the lowest ZWA tercile.

Table 4.7--Preschooler ZWH overlaps for the seven data sets

| Variable | Brazil Rural | Bukidnon Rural | Ghana Urban | Ghana Rural | Luzon Urban | Luzon Rural | Mexico Urban |
|---|---|---|---|---|---|---|---|
| Sex | | | | | | | |
| Male | 34 | 37 | 33 | 32 | 17 | 16 | 36 |
| Female | 32 | 30 | 34 | 34 | 14 | 13 | 31 |
| Age | | | | | | | |
| Upper tercile | 34 | 28 | 24 | 18 | 11 | 10 | 34 |
| Lower tercile | 37 | 35 | 44 | 40 | 21 | 23 | 30 |
| Age at weaning | | | | | | | |
| Upper tercile | | 37 | | | 19 | 21 | |
| Middle tercile | | 35 | | | 14 | 13 | |
| Lower tercile | | 34 | | | 14 | 15 | |
| Diarrhea | | | | | | | |
| Yes | | 39 | | | 29 | 18 | |
| No | | 33 | | | 14 | 14 | |
| Fever | | | | | | | |
| Yes | | 39 | | | 22 | 22 | |
| No | | 29 | | | 14 | 13 | |
| Days sick | | | | | | | |
| Upper tercile | | 38 | 41 | 40 | | | |
| Lower tercile | | 28 | 32 | 30 | | | |
| Birth order | | | | | | | |
| Upper tercile | | | 36 | 34 | 17 | 15 | |
| Lower tercile | | | 35 | 31 | 13 | 17 | |
| Child vaccinated | | | | | | | |
| Yes | | | 32 | 33 | | | |
| No | | | 40 | 34 | | | |
| Mothers' days sick | | | | | | | |
| Upper tercile | | 27 | 32 | 32 | | | |
| Lower tercile | | 37 | 34 | 34 | | | |

Notes: Numbers in the table represent the percent of all preschoolers in that indicator group which are also in the lowest ZWH tercile. The further the number is from 33 percent, the stronger the indicator-ZWH association. For Luzon, this figure is 15 percent.

In Bukidnon, 35 percent of all children for whom we have a value for age at weaning are also in the lowest ZWH tercile. For urban Luzon, this figure is 17 percent, and for rural Luzon, it is 16 percent.

Table 4.8--Indicators of ZWA: Percent of preschoolers with the following characteristics, which are also in the lowest ZWA tercile

| Variable | Value | Percent | t-test | Number of Households | Variable Explanation |
|---|---|---|---|---|---|
| ■ Brazil | | | | | |
| TDGT15 | 1 | 60 | 3.34 | 37 | percent households > 15 - low |
| TDLT15 | 3 | 60 | 3.34 | 37 | percent households < 15 - high |
| TDEPRATI | 3 | 60 | 3.34 | 37 | dependency ratio - high |
| TDMGT15 | 1 | 57 | 2.86 | 35 | percent households male > 15 - low |
| TDMLT15 | 3 | 47 | 1.83 | 43 | percent households male < 15 - high |
| TPCTSHRC | 3 | 44 | 1.52 | 48 | percent of land sharecropped - high |
| DTENURE | 1 | 44 | 1.24 | 32 | sharecropper |
| TDFGT15 | 1 | 44 | 1.28 | 34 | percent households female > 15 - low |
| DEDMHOH | 2 | 44 | 1.58 | 52 | head male has education - medium |
| TPINCOFN | 3 | 44 | 1.32 | 36 | percent income off farm nonagriculture - high |
| GENDBAL | 1 | 42 | 1.40 | 60 | number of males > number of females |
| (all=33.1%) | | | | | |
| ■ Bukidnon | | | | | |
| TPCALAEQ | 1 | 48 | 3.86 | 258 | preschooler calorie intake - low (all=36%) |
| SEX | 1 | 44 | 4.36 | 410 | male child |
| DIAR | 1 | 44 | 2.13 | 98 | child had diarrhea |
| TAGEWEAN | 3 | 40 | 0.97 | 140 | age at weaning - high (all=36%) |
| TDEMF05 | 1 | 40 | 2.20 | 259 | percent of households female 0-5 - low |
| CRN LAB | 4 | 40 | 1.35 | 98 | from corn laborer households |
| TTOTEXPP | 1 | 40 | 2.19 | 257 | households total expenditure per child - low |
| TFOODEXP | 1 | 40 | 2.19 | 257 | households food expenditure per child - low |
| TYCORRPC | 1 | 39 | 1.88 | 258 | households income per child - low |
| TNBFG4 | 1 | 38 | 1.62 | 279 | number of meat items consumed by households - low |
| (all=33.3%) | | | | | |
| ■ Urban Ghana | | | | | |
| CHLVAC | 0 | 49 | 2.61 | 70 | child not vaccinated |
| W. Forest | 7 | 47 | 2.08 | 58 | households in W. Forest |
| DUMWATER | 0 | 44 | 1.82 | 73 | no improved drinking water |
| LANDOWNG | 3 | 43 | 1.72 | 79 | land owned per child - some |
| TDAYSIMO | 2 | 42 | 1.47 | 71 | number of days mom ill/28 - some but not high |
| DFEMED | 0 | 42 | 2.65 | 232 | not one female in households with some high school education |
| TNDURGDS | 1 | 42 | 2.32 | 178 | number of durable goods owned/17 - low |
| ELEC | 0 | 41 | 2.33 | 228 | no electricity in households |
| TDEMFLT1 | 1 | 41 | 2.20 | 202 | percent of households female <15 yrs - low |
| TORDCHL | 3 | 41 | 1.75 | 128 | birth order of child - high |
| (all=33.4%) | | | | | |

(continued)

Table 4.8--Indicators of ZWA: Percent of preschoolers with the following characteristics, which are also in the lowest ZWA tercile (continued)

| Variable | Value | Percent | t-test | Number of Households | Variable Explanation |
|---|---|---|---|---|---|
| ■ Rural Ghana | | | | | |
| TROOMSPC | 1 | 41 | 2.71 | 292 | rooms in house per capita - low |
| TPCTREM | 2 | 40 | 1.80 | 169 | percent of income as remittances - some but low |
| M. Coast | 2 | 40 | 1.55 | 125 | households in Mid Coast |
| SEX | 1 | 39 | 2.77 | 541 | male child |
| TDAYSIKI | 3 | 39 | 2.22 | 348 | preschooler days ill/28 - high |
| TDEMM155 | 1 | 38 | 2.10 | 449 | percent of households, males 15-59 - low |
| TAGE | 2 | 38 | 1.89 | 367 | age of preschooler - medium |
| M. Forest | 6 | 38 | 0.99 | 101 | households in Mid Forest |
| TDEPRATI | 3 | 37 | 1.19 | 230 | dependency ratio - high |
| TMLCBF | 3 | 36 | 1.36 | 119 | months last child breast-fed - high (all=30%) |
| (all=33.2%) | | | | | |
| ■ Urban Luzon | | | | | |
| DCFUEL | 0 | 81 | 2.94 | 41 | do not cook with improved fuel |
| THHINCPC | 1 | 75 | 2.96 | 114 | households income per child - low |
| DIARR | 1 | 74 | 1.48 | 35 | child had diarrhea past week |
| TPCTNONL | 2 | 74 | 2.07 | 68 | percent of income from non-lab y - high |
| FOODLIKE | 0 | 73 | 2.34 | 108 | food not purchased for taste |
| ADEQNUTR | 0 | 73 | 2.25 | 100 | do not think households diet adequate |
| TAGEMONT | 3 | 73 | 2.40 | 114 | age of preschooler - high |
| TDEMM051 | 3 | 72 | 2.04 | 104 | percent of households male 5-15 - high |
| TFEPC | 1 | 72 | 2.13 | 113 | household food expenditure per child - low |
| TTEPC | 1 | 71 | 1.87 | 113 | household total expenditure per child - low |
| (all=63%) | | | | | |
| ■ Rural Luzon | | | | | |
| FEVER | 1 | 71 | 2.55 | 111 | child had fever in last week |
| WHOFOOD | 0 | 69 | 2.35 | 146 | wife not exclusively decide on food purchases |
| ADEQNUTR | 0 | 68 | 2.50 | 212 | do not think households diet adequate |
| GENDBAL | 2 | 68 | 2.02 | 139 | number of males in households = number of females in households |
| tAGEMONT | 3 | 67 | 2.36 | 251 | age of preschooler - high |
| DNCORNGD | 1 | 67 | 0.89 | 36 | more than 7/11 corn items purchased |
| FOODCONV | 1 | 67 | 1.03 | 48 | food purchased for storability |
| tPFINC | 3 | 67 | 2.35 | 249 | percent of households income from females - high |
| tBIRTHOR | 1 | 66 | 1.99 | 248 | birth order low |
| tHHINCPC | 1 | 66 | 2.00 | 250 | households income per capita - low |
| (all=60%) | | | | | |

(continued)

Table 4.8--Indicators of ZWA: Percent of preschoolers with the following characteristics, which are also in the lowest ZWA tercile (continued)

| Variable | Value | Percent | t-test | Number of Households | Variable Explanation |
|---|---|---|---|---|---|
| ■ Mexico | | | | | |
| THHPRADQ | 1 | 52 | 3.78 | 103 | households protein adequacy - low |
| THHRETAD | 1 | 52 | 3.78 | 103 | households retinol adequacy - low |
| DSANITAT | 0 | 51 | 2.46 | 49 | no improved sanitation |
| TYRSCHDA | 1 | 49 | 3.17 | 103 | years of education of father - low |
| TROOMSPC | 1 | 48 | 2.91 | 99 | rooms per capita - low |
| TD0717 | 3 | 47 | 2.66 | 95 | percent of households 7-17 years - high |
| DWATER | 0 | 46 | 1.94 | 59 | no improved water source |
| THHCALAD | 1 | 46 | 2.57 | 103 | households calorie adequacy - low |
| THHFEADQ | 1 | 46 | 2.57 | 103 | households iron adequacy - low |
| TFAMSIZE | 3 | 46 | 2.54 | 101 | households size - high |
| (all=33.4%) | | | | | |

Table 4.9--Indicators of ZWH: Percent of preschoolers with the following characteristics which are also in the lowest ZWH tercile

| Variable | Value | Percent | t-test | Number of Households | Variable Explanation |
|---|---|---|---|---|---|
| ■ Brazil | | | | | |
| TDLT15 | 3 | 56.8 | 2.91 | 37 | percent household < 15 - high |
| TDEPRATI | 3 | 56.8 | 2.91 | 37 | dependency ratio - high |
| TPINCOFN | 3 | 44.4 | 1.36 | 36 | percent of income off-farm, nonagriculture - high |
| DEDMHOH | 2 | 44.2 | 1.61 | 52 | education of head male - medium |
| DSOURCES | 3 | 42.9 | 1.17 | 35 | number of income sources - high |
| TPTOTON | 2 | 42.6 | 1.32 | 47 | percent income, on farm - medium |
| DEDFHOH | 2 | 42.0 | 1.28 | 50 | education of head female - medium |
| TPCTSHRC | 3 | 41.7 | 1.21 | 48 | percent of area used as sharecropped - high |
| GENDBAL | 1 | 41.7 | 1.35 | 60 | more males than females in household |
| (all=33.1%) | | | | | |
| ■ Bukidnon | | | | | |
| TPCALAEQ | 1 | 43 | 2.27 | 258 | preschooler calorie intake - low (all=36%) |
| TMOMED | 2 | 41 | 2.44 | 243 | mothers education - medium |
| CRN TNT | 3 | 40 | 1.71 | 156 | corn share tenant |
| DIAR | 1 | 39 | 1.16 | 98 | child had diarrhea |
| FEVER | 1 | 39 | 2.23 | 365 | child had fever |
| TPARITY | 1 | 39 | 1.73 | 220 | parity of mother - low |
| TYSOURCE | 2 | 38 | 1.62 | 279 | number of income sources - medium |
| TNBFGS | 2 | 38 | 1.59 | 271 | number of vegetable items - medium |
| TAVNETWP | 2 | 38 | 1.55 | 255 | net worth of household assets - medium |
| TFATED | 2 | 38 | 1.59 | 268 | fathers education - medium |
| (all=33.3%) | | | | | |
| ■ Urban Ghana | | | | | |
| TAGE | 1 | 44.4 | 3.00 | 180 | age of preschooler - low |
| LANDOWNG | 3 | 44.3 | 1.97 | 79 | landowning group 1-10 acres per child |
| W. Coast | 3 | 41.7 | 1.18 | 48 | household in West Coast region |
| W. Forest | 7 | 41.4 | 1.25 | 58 | household in West Forest region |
| TDAYSIKI | 3 | 41.2 | 1.95 | 148 | child days ill/28 - high |
| E. Coast | 4 | 40.6 | 1.19 | 64 | households in East Coast region |
| DFFHOH | 1 | 40.2 | 1.59 | 127 | child from de facto female-headed household |
| CHLVAC | 0 | 40.0 | 1.14 | 70 | child not vaccinated |
| TMLCBF | 3 | 40.0 | 1.59 | 50 | months last child breast-fed - high (all=29%) |
| TNYSOURC | 1 | 39.7 | 2.01 | 237 | number of income sources - low |
| (all=33.3%) | | | | | |

(continued)

Table 4.9--Indicators of ZWH: Percent of preschoolers with the following characteristics which are also in the lowest ZWH tercile (continued)

| Variable | Value | Percent | t-test | Number of Households | Variable Explanation |
|---|---|---|---|---|---|
| ▪ Rural Ghana | | | | | |
| TAGE | 2 | 41.4 | 3.15 | 367 | age of preschooler - medium |
| TPCTREM | 2 | 41.1 | 2.05 | 168 | percent income from remittances > 0 |
| TAGE | 1 | 39.9 | 2.73 | 409 | age of preschooler - low |
| TDAYSIKI | 3 | 39.4 | 2.33 | 348 | days ill child/28 - high |
| Savanna | 10 | 38.7 | 1.42 | 163 | households in Savanna region |
| LANDOWNG | 2 | 38.7 | 1.82 | 269 | land owned per child - low |
| DFFHOH | 1 | 37.0 | 1.13 | 219 | child from de facto female-headed household |
| LANDOWNG | 4 | 36.4 | 0.77 | 143 | land owned per child - high |
| OCCGRP | 2 | 36.4 | 0.48 | 55 | occupation group - secondary (manufacturer) |
| TTNFOODC | 2 | 36.3 | 1.16 | 344 | number of foods purchased/produced - medium |
| (all=33.3%) | | | | | |
| ▪ Urban Luzon | | | | | |
| TXTRANFD | 1 | 25 | 1.78 | 73 | extra pesos on nonfood - low (all=16%) |
| TFEPC | 2 | 24 | 2.26 | 115 | food expenditure per capita - medium |
| TDEMM05I | 3 | 22 | 1.72 | 104 | percent males 5-15 age - high |
| THHTOT | 2 | 21 | 1.63 | 122 | household size - medium |
| TAGEMONT | 1 | 21 | 1.57 | 113 | age of preschooler - low |
| TROOMSPC | 3 | 21 | 1.56 | 112 | rooms per capita - high |
| TDEMF156 | 2 | 20 | 0.96 | 59 | percent female 15-60 - medium |
| TDEMF05 | 2 | 20 | 1.39 | 124 | percent female 0-5 medium |
| TPFINC | 2 | 20 | 0.88 | 50 | percent female income - medium |
| TYSOURCE | 3 | 20 | 0.93 | 55 | number of income sources - high |
| (all=15%) | | | | | |
| ▪ Rural Luzon | | | | | |
| FOODCONV | 1 | 27 | 1.87 | 48 | food purchased for ease of storage |
| WHOFOOD | 0 | 24 | 2.55 | 146 | wife does not decide how much on food purchased |
| tAGEMONT | 1 | 23 | 3.01 | 250 | age of preschooler - low |
| WHONFOOD | 0 | 20 | 2.06 | 272 | wife does not decide how much on nonfood purchased |
| GENDBAL | 2 | 19 | 1.20 | 139 | number of males = number of females |
| WHCHFOOD | 0 | 18 | 0.79 | 103 | wife does not decide on which foods to purchase |
| DWATER | 1 | 18 | 0.66 | 71 | improved water source |
| FOODHABT | 1 | 18 | 1.49 | 363 | food purchased because of familiarity |
| FISHBUY | 0 | 18 | 0.81 | 108 | wife does not usually buy the fish |
| tPCTFARM | 1 | 18 | 1.23 | 250 | percent income from farming - low |
| (all=15%) | | | | | |

(continued)

Table 4.9--Indicators of ZWH: Percent of preschoolers with the following characteristics which are also in the lowest ZWH tercile (continued)

| Variable | Value | Percent | t-test | Number of Households | Variable Explanation |
|---|---|---|---|---|---|
| ◙ Mexico | | | | | |
| THHRETAD | 1 | 52.4 | 3.86 | 103 | household retinol adequacy - low |
| THHPRADQ | 1 | 50.5 | 3.47 | 103 | household protein adequacy - low |
| DSANITAT | 0 | 46.9 | 1.89 | 49 | no improved sanitation |
| TYRSCHDA | 1 | 46.6 | 2.69 | 103 | fathers years schooling - low |
| TDLT6 | 1 | 45.6 | 2.32 | 90 | percent households < 6 yrs old - low |
| TROOMSPC | 1 | 45.5 | 2.42 | 99 | rooms per capita - low |
| TD0717 | 3 | 45.3 | 2.33 | 95 | percent households 7-17 age group - high |
| DWATER | 0 | 44.1 | 1.66 | 59 | no improved water source |
| THHFEADQ | 1 | 43.7 | 2.11 | 103 | household iron adequacy - low |
| THHASCAD | 1 | 43.7 | 2.11 | 103 | household vitamin C adequacy - low |
| TFAMSIZE | 3 | 43.6 | 2.07 | 101 | household size - high |
| THHCALAD | 1 | 42.7 | 1.91 | 103 | household calorie adequacy - low |
| TYRSCHMO | 1 | 42.3 | 1.84 | 104 | mothers years schooling - low |
| (all=33.4%) | | | | | |

better than that provided by a mother-substitute when the mother is working. In general, the young preschooler group was highly represented by lowest tercile ZWH preschoolers and, relative to females, male preschoolers showed a high association with poor anthropometric outcomes across all three Z-scores.

Gender of household head (available only for Ghana) did not come out strongly as a first-stage indicator of nutrition insecurity, but it may well be useful as a second-stage interaction stratifier when used with household income, as, for instance, in Kennedy and Haddad (1991).

A summary of nutrition insecurity indicator performance from the seven data sets is presented in Table 4.10.

## 4.2 Combining Indicators

We also attempted to improve the performance of single indicators by combining them.

### 4.2.1 Interacting Indicators

If we know that a household is large and consumes a small number of foods and uses a small land area, does this knowledge improve our ability to locate the food insecure?

Three limitations of this analysis should be mentioned here:

(1) Because the number of indicator combinations is endless, the specific combinations used will almost certainly be determined locally; our analysis is purely suggestive.

Table 4.10--Promising indicators of nutrition insecurity from the seven data sets

| Variable | Z-Score Height-for-Age | Z-Score Weight-for-Age | Z-Score Weight-for-Height |
|---|---|---|---|
| Brazil | • High dependency ratio<br>• Little land used per child<br>• High percentage income off-farm labor<br>• Low percentage income from livestock | • High dependency ratio<br>• Sharecropper<br>• High percentage income off-farm nonagriculture<br>• More males than females in household | • High dependency ratio<br>• High percentage income nonagriculture off-farm<br>• Large number of income sources<br>• Medium education father |
| Bukidnon | • High age at weaning<br>• Older preschoolers<br>• Low number of value-added foods<br>• Low number of unique food groups consumed | • Male preschooler<br>• Child had diarrhea<br>• Corn laborer household<br>• Low number of meat items in household consumed | • Medium maternal education<br>• Corn share tenant<br>• Child had fever<br>• Child had diarrhea |
| Urban Ghana | • Region (West Forest)<br>• No improved water source<br>• Months last child breast-, fed, high<br>• No improved toilet facility | • Child not vaccinated<br>• Region (West Forest)<br>• No improved water source<br>• Some land owned | • Young preschooler<br>• Some land owned<br>• Region (West Coast, West Forest)<br>• High number of days ill |
| Rural Ghana | • Older preschoolers<br>• Region (Savannah)<br>• Low number of food groups purchased/produced<br>• Small number of rooms per capita | • Low number of rooms per capita<br>• Some income from remittances<br>• Region (Mid-Coast)<br>• Male preschooler<br>• High number of days ill | • Young preschooler<br>• Some income from remittances<br>• High number of days ill<br>• Low amount of land owned<br>• From de facto female-headed household |
| Urban Luzon | • No improved fuel for cooking<br>• Household reports inadequate diet<br>• High percentage of males 5-15<br>• Some non-labor income | • No improved fuel for cooking<br>• Child had diarrhea<br>• High percentage income non-labor<br>• Food not purchased for taste | • Any extra income to nonfood, low<br>• Young preschooler<br>• High number of rooms per capita<br>• High number of income sources |
| Rural Luzon | • Food purchased for storability<br>• Older preschooler<br>• High dependency ratio<br>• Child had fever past week | • Child had fever<br>• Wife not sole food marketer<br>• Household reports inadequate diet<br>• Number of males in household = number of females<br>• Many corn items purchased | • Food purchased for storability<br>• Wife not sole food marketer<br>• Young preschooler<br>• Food purchased from familiarity |
| Mexico | Z-score not available. | • No improved sanitation<br>• Low father education<br>• Low rooms per capita<br>• High percentage older children<br>• No improved water source | • No improved sanitation<br>• Low father's schooling<br>• Low percentage preschoolers<br>• Low rooms per capita<br>• No improved water source |

(2) The best combination of indicators may not necessarily include indicators that performed well in the first-round overlaps.

(3) As we combine indicators, we run into sample size problems. In order to maintain the hypothesis that the mean of the indicators is normally distributed, one rule of thumb is that the category groups retain at least 30 households or preschoolers. If we want to look at the tercile interaction of three indicators, we face 27 combinations, and therefore, require a data set of at least 810 households (30x27). Such a sample size is only available for the Ghana data set.

(4) In attempting to make the indicators more specific (to reduce type II error), we run the risk of making them too specific to be of help in classifying large segments of the population (we may well increase type I error).

(5) Our exercise will assign equal weight to each of the indicators combined, but this may well be inappropriate. This is something to be determined locally.

#### 4.2.1.1 Food Security

Table 4.11 demonstrates both the gains and limitations of indicator interactions. Of all the Bukidnon households with high dependency ratios and a low number of foods consumed, 65.3 percent are food insecure. Operating singly, a high dependency ratio classified 47 percent of households as food insecure while a low number of foods consumed produced a corresponding figure of 42 percent. The tradeoff is

Table 4.11--Food insecurity and the interaction of dependency ratio and the number of unique food groups represented in the 24-hour recall: Bukidnon

| Composite Indicator | | Household Calorie Adequacy Tercile | | | Number of Households |
|---|---|---|---|---|---|
| Dependency Ratio Tercile | Number of Unique Food Groups Tercile | Low (t) | Medium | High | |
| high | low | 65.3 (4.71) | 20.4 | 14.3 | 49 |
| high | medium | 41.3 | 43.5 | 15.2 | 46 |
| medium | low | 37.0 | 42.6 | 20.4 | 54 |
| high | high | 31.9 | 31.9 | 36.2 | 47 |
| low | medium | 30.4 | 21.4 | 48.2 | 56 |
| medium | medium | 30.4 | 28.3 | 41.3 | 46 |
| low | low | 26.7 | 35.6 | 37.8 | 45 |
| medium | high | 22.8 | 40.4 | 36.8 | 57 |
| low | high | 14.6 (-3.67) | 35.4 | 50.0 | 48 |
| All households | | 33.3 | 33.3 | 33.5 | 100.0 |

Note: High, medium, and low correspond to upper, middle, and lower terciles.

that only 49 out of 448 households (11 percent) exhibit both these characteristics of a high dependency ratio and a low number of food consumed.

Table 4.12 carries this exercise further for rural Ghana by interacting three indicators. While the ability to locate the food insecure is enhanced (up to 54.7 percent from 45.7 percent using one indicator only, household size), the sample size is reduced significantly (to 53 out of 1,906 households or 3 percent). The interaction for Ghana demonstrates that the Households most likely to be food secure are small, own a lot of land, and have available a lot of different types of food to choose from. Note, however, that the ability of the composite indicator to locate the food insecure still lags behind that of per capita household total expenditure operating singly (64.4 percent).

Table 4.13 contains five indicator interactions for each of the seven data sets. The interactions were chosen from a much larger group of such experiments based on the strength of percentage overlap with low household calorie adequacy. Note that the t-statistics indicate a significant association between the alternative indicator interaction. In general, the best interactions involve such indicators that performed well. For example, household size, dependency ratio, number of unique foods, number of rooms per capita repeatedly show up as components of the composite indicators.

Table 4.12--Interaction of three indicators: Food security in rural Ghana

| Indicator Interaction | | | Household Calorie Adequacy Tercile | | | Number of Households |
|---|---|---|---|---|---|---|
| Household Size Tercile | Land Owned Per Capita Tercile | Number of Unique Foods Consumed Tercile | Low (t) | Medium | High | |
| | | | | (percent) | | |
| high | medium | low | 54.7 (3.13) | 13.2 | 32.1 | 53 |
| high | medium | medium | 53.7 | 35.8 | 10.4 | 67 |
| high | low | high | 50.9 | 33.3 | 15.8 | 57 |
| high | low | low | 50.0 | 37.0 | 13.0 | 46 |
| medium | low | low | 50.0 | 32.9 | 17.1 | 76 |
| high | medium | high | 47.0 | 36.1 | 16.9 | 83 |
| medium | low | medium | 43.5 | 35.2 | 21.3 | 108 |
| high | low | medium | 42.9 | 41.1 | 16.1 | 56 |
| high | high | high | 42.3 | 28.8 | 28.8 | 52 |
| low | low | low | 40.4 | 30.7 | 28.9 | 114 |
| high | high | medium | 37.5 | 45.8 | 16.7 | 48 |
| medium | high | med | 37.5 | 32.8 | 29.7 | 64 |
| medium | low | high | 35.8 | 42.0 | 22.2 | 81 |
| medium | high | low | 32.3 | 32.3 | 35.5 | 62 |
| medium | medium | low | 31.8 | 39.8 | 28.4 | 88 |
| medium | medium | medium | 29.2 | 39.6 | 31.1 | 106 |
| low | high | medium | 24.7 | 23.4 | 51.9 | 77 |
| low | medium | low | 24.6 | 29.2 | 46.2 | 65 |
| high | high | low | 24.4 | 39.0 | 36.6 | 41 |
| low | medium | med | 21.5 | 40.0 | 38.5 | 65 |
| low | medium | high | 20.5 | 29.5 | 50.0 | 44 |
| low | high | low | 20.5 | 23.9 | 55.6 | 117 |
| medium | high | high | 20.3 | 26.1 | 53.6 | 69 |
| low | low | medium | 20.0 | 30.9 | 49.1 | 55 |
| medium | medium | high | 19.3 | 39.8 | 40.9 | 88 |
| low | low | high | 17.0 | 29.8 | 53.2 | 47 |
| low | high | high | 13.0 (-5.30) | 32.5 | 54.5 | 77 |
| | All households | | 33.3 | 33.4 | 33.3 | 100 |

Note: High, medium, and low refer to upper, middle, and lower terciles.

Table 4.13--Indicator interactions and food security (percentage of household calorie adequacy): 7 data sets

| Country | Indicator Interaction | Percent Overlap with Lowest Household Calorie Adequacy Tercile | Number of Households | t-stat |
|---|---|---|---|---|
| Brazil | High household size and low land used per capita | 66.0 | 53 | 5.03 |
| | High household size and high area sharecropped | 61.9 | 42 | 3.82 |
| | High household size and high dependency ratio | 59.7 | 62 | 4.24 |
| | High area sharecropped and preschooler present | 57.9 | 38 | 3.07 |
| | High household size and preschooler present | 55.8 | 43 | 2.97 |
| | (All) | 33.3 | 384 | |
| Bukidnon | High dependency ratio and low number of recipes used | 65.7 | 35 | 4.04 |
| | High dependency ratio and low number unique broad food | 60.4 | 48 | 3.84 |
| | High household size and low number unique broad food | 58.5 | 41 | 3.27 |
| | Medium father's age and low number unique broad food | 57.9 | 57 | 3.76 |
| | Medium father's age and low number unique food groups | 56.1 | 41 | 2.94 |
| | (All) | 33.3 | 448 | |
| Mexico | Low rooms per capita and high dependency ratio | 54.7 | 53 | 3.13 |
| | High household size and low years of schooling for fathers | 50.9 | 57 | 2.66 |
| | Low years of schooling for father unimproved water | 65.5 | 29 | 3.65 |
| | Low years of schooling for mother unimproved water | 53.6 | 28 | 2.15 |
| | Low rooms per capita and unimproved water | 51.7 | 29 | 1.98 |
| | (All) | 33.3 | 338 | |
| Ghana: Urban | High household size and low number unique foods purchased | 69.3 | 75 | 6.76 |
| | High household size and high number of rooms per capita | 64.5 | 31 | 3.63 |
| | Low number unique foods purchased and low numbers of room per capita | 62.6 | 99 | 6.03 |
| | Low number unique foods purchased and high dependency ratio | 62.0 | 92 | 5.67 |
| | High household size and unimproved water | 60.0 | 45 | 3.66 |
| | (All) | 33.3 | 1,177 | |

(continued)

Table 4.13--Indicator interactions and food security (percentage of household calorie adequacy): 7 data sets (continued)

| Country | Indicator Interaction | Percent Overlap with Lowest Household Calorie Adequacy Tercile | Number of Households | t-stat |
|---|---|---|---|---|
| Ghana: Rural | Low land owned per capita high number of wives | 55.6 | 54 | 3.30 |
| | High household size and low number of wives | 54.4 | 90 | 4.02 |
| | High household size and no land owned | 53.8 | 93 | 3.97 |
| | High household size and low value of livestock per capita | 51.9 | 214 | 5.45 |
| | High value of livestock per capita and no land owned | 51.8 | 110 | 3.88 |
| | (All) | 33.3 | 1,959 | |
| Luzon: Urban | High dependency ratio and yes, household misses meals on average | 57.6 | 33 | 2.82 |
| | High household size and yes, household misses meal on average | 54.5 | 44 | 2.82 |
| | Low number income sources and yes, household misses meal on average | 51.6 | 31 | 2.04 |
| | Gender balance is m > f and spouse at least some HS on | 51.6 | 31 | 2.04 |
| | Low rooms per capita and yes, household misses meals on average | 51.5 | 33 | 2.09 |
| | (All) | 33.3 | 167 | |
| Luzon: Rural | Low rooms per capita and medium percent calories available | 69.2 | 39 | 4.86 |
| | Low rooms per capita and high number different crops | 64.5 | 31 | 3.63 |
| | Low rooms per capita and medium number income sources | 61.3 | 31 | 3.20 |
| | Low rooms per capita and gender balance is m < f | 58.5 | 53 | 3.72 |
| | Low rooms per capita and spouse not have at least some high school education | 51.8 | 110 | 3.88 |
| | (All) | 33.3 | 372 | |

Note: If absolute t value > 1.96, then the percent overlap is significantly different from the percent overlap were the indicator not associated with food insecurity.

4.2.2.2 Nutrition Security

Examples from rural Luzon and urban Ghana again demonstrate the tradeoffs involved from interaction of indicators. Fever was the best single indicator of low ZWA in rural Luzon. Interacting the fever indicator with another promising indicator—respondent thinks that household does not consume enough food for an adequate diet—improves indicator performance from 71 percent to 75.7 percent (all preschoolers = 60 percent), but at a cost of sample size reduction from 111 to 37 (Table 4.14).

Interacting three of the most promising ZWH single indicators (age of preschooler, days ill of preschooler, and whether or not the child was vaccinated) from the urban Ghana data set in Table 4.15 produced only 8 preschoolers in the group most likely to be at risk (young, high morbidity, and no vaccination). The most insecure group, 60.4 percent of whom are in the lowest ZWH tercile, are preschoolers who are young, have high morbidity, and have been vaccinated. Dropping the vaccination indicator, as in Table 4.16, drops the percentage representation in the lowest ZWH tercile to 58.9 percent and raises the sample size from 48 to 56. Both Ghana interactions improve the predictive power of the alternative indicators from a single-indicator high of 44 percent to approximately 60 percent.

Again we chose five indicator interactions for each data set, as present in Table 4.17. Here, some composite indicators that looked promising actually turned out to be insignificantly different from a non-indicator, due to small sample sizes (e.g., the fourth composite

Table 4.14--Nutrition insecurity (low ZWA) and the interaction of two indicators: Rural Luzon

| Indicator Interaction | | Z-Score Weight-for-Age Group | | Number of Preschoolers |
|---|---|---|---|---|
| Respondent Thinks Household Has Adequate Nutrition? | Child Had Fever? | Upper Group | Lower Group (t) | |
| | | (percent) | | |
| No | Yes | 24.3 | 75.7 (2.18) | 37 |
| Yes | Yes | 29.2 | 70.8 | 72 |
| No | No | 33.1 | 66.9 | 175 |
| Yes | No | 45.0 | 55.0 (-2.28) | 460 |
| All preschoolers | | 39.7 | 60.3 | 100 |

Table 4.15--Indicator interactions and nutrition insecurity (ZWH): Urban Ghana

| Indicator Combination | | | ZWH Tercile | | | Number of Preschoolers |
|---|---|---|---|---|---|---|
| Preschooler Age | Child Days Ill | Child Vaccinated? | Low (t) | Medium | High | |
| | | | (percent) | | | |
| low | high | yes | 60.4 (3.84) | 25.0 | 14.6 | 48 |
| low | medium | yes | 58.8 | 23.5 | 17.6 | 17 |
| low | high | no | 50.0 | 0.0 | 50.0 | 8 |
| medium | medium | no | 50.0 | 50.0 | 0.0 | 2 |
| high | high | no | 50.0 | 50.0 | 0.0 | 2 |
| medium | low | no | 44.4 | 33.3 | 22.2 | 9 |
| high | low | no | 44.4 | 33.3 | 22.2 | 18 |
| medium | high | no | 40.0 | 60.0 | 0.0 | 5 |
| low | low | yes | 35.8 | 35.8 | 28.4 | 81 |
| low | low | no | 34.8 | 30.4 | 34.8 | 23 |
| medium | high | yes | 34.1 | 31.8 | 34.1 | 44 |
| medium | low | yes | 29.6 | 34.6 | 35.8 | 81 |
| medium | medium | yes | 27.5 | 40.0 | 32.5 | 40 |
| high | low | yes | 24.7 | 44.4 | 30.9 | 81 |
| high | high | yes | 24.4 | 39.0 | 36.6 | 41 |
| high | medium | yes | 6.5 (-6.05) | 67.7 | 25.8 | 31 |
| low | medium | no | 0.0 | 100.0 | 0.0 | 3 |
| high | medium | no | 0.0 | 0.0 | 0.0 | 0 |
| All preschoolers | | | 33.3 | 37.5 | 29.2 | 100 |

Note: High, medium, and low refer to upper, middle, and lower terciles.

Table 4.16--Indicator interactions and nutrition insecurity (ZWH): Urban Ghana

| Indicator Combination | | ZWH Tercile | | | Number of Preschoolers |
|---|---|---|---|---|---|
| Preschooler Age | Child Days Ill | Low (t) | Medium | High | |
| | | (percent) | | | |
| low | high | 58.9 (3.86) | 21.4 | 19.6 | 56 |
| low | medium | 50.0 | 35.0 | 15.0 | 20 |
| low | low | 35.6 | 35.0 | 29.8 | 104 |
| medium | high | 34.7 | 34.7 | 30.6 | 49 |
| medium | low | 31.1 | 34.4 | 34.4 | 90 |
| medium | medium | 28.6 | 40.5 | 31.0 | 42 |
| high | low | 28.3 | 42.4 | 29.3 | 99 |
| high | high | 25.6 | 39.5 | 34.9 | 43 |
| high | medium | 6.5 (-6.05) | 67.7 | 25.8 | 31 |
| All preschoolers | | 33.3 | 37.5 | 29.2 | 100 |

Note: High, medium, and low refer to upper, middle, and lower tercile.

Table 4.17--Indicator interactions and nutrition security (preschooler ZWA): 7 data sets

| Country | Indicator Interaction | Percent Overlap with Lowest ZWA tercile | Number of Households | t-stat |
|---|---|---|---|---|
| Brazil | High dependency ratio and not sharecropping | 73.1 | 26 | 4.58 |
| | High dependency ratio and gender balance is m > f | 68.2 | 22 | 3.52 |
| | High percentage land sharecropped | 58.8 | 17 | 2.14 |
| | High household size and at least 3 years education of mho | 5.0 | 28 | 1.77 |
| | High land per capita and 1-3 years education of mhoh | 50.0 | 20 | 1.49 |
| | (All) | 33.3 | 139 | |
| Bukidnon | Low number meat groups and yes, diarrhea of child | 60.6 | 33 | 3.21 |
| | Low number unique food groups medium number days sick | 51.4 | 70 | 3.03 |
| | Low number meat groups and sex = male | 51.0 | 149 | 4.32 |
| | Medium age at weaning and sex = male | 50.7 | 142 | 4.15 |
| | Low number unique food groups sex = male | 50.0 | 136 | 3.90 |
| | (All) | 33.3 | 778 | |
| Mexico | Low years father's schooling, low number rooms per capita | 63.2 | 57 | 4.68 |
| | Low years mother's schooling, low number rooms per capita | 60.4 | 53 | 4.03 |
| | Low years father's schooling, high family size | 58.8 | 51 | 3.70 |
| | Low years father's schooling, low years mother's schooling | 57.4 | 61 | 3.81 |
| | Low years father's schooling, high dependency ratio | 56.0 | 50 | 3.23 |
| | (All) | 33.3 | 308 | |
| Ghana: Urban | Low number durable goods and child not vaccinated | 52.9 | 34 | 2.29 |
| | Medium number durable goods and high birth order | 52.4 | 42 | 2.48 |
| | Medium number durable goods and high land owning group | 50.0 | 34 | 1.95 |
| | Medium land owned per capita and child not vaccinated | 50.0 | 32 | 1.89 |
| | Medium land owned per capita and unimproved water | 49.1 | 55 | 2.34 |
| | (All) | 33.33 | 534 | |

(continued)

Table 4.17--Indicator interactions and nutrition security (preschooler ZWA): 7 data sets (continued)

| Country | Indicator Interaction | Percent Overlap with Lowest ZWA tercile | Number of Households | t-stat |
|---|---|---|---|---|
| Mexico | Low years father's schooling, low number rooms per capita | 63.2 | 57 | 4.68 |
| | Low years mother's schooling, low number rooms per capita | 60.4 | 53 | 4.03 |
| | Low years father's schooling, high family size | 58.8 | 51 | 3.70 |
| | Low years father's schooling, low years mother's schooling | 57.4 | 61 | 3.81 |
| | Low years father's schooling, high dependency ratio | 56.0 | 50 | 3.23 |
| | (All) | 33.3 | 308 | |
| Ghana: Urban | Low number durable goods and child not vaccinated | 52.9 | 34 | 2.29 |
| | Medium number durable goods and high birth order | 52.4 | 42 | 2.48 |
| | Medium number durable goods and high land owning group | 50.0 | 34 | 1.95 |
| | Medium land owned per capita and child not vaccinated | 50.0 | 32 | 1.89 |
| | Medium land owned per capita and unimproved water | 49.1 | 55 | 2.34 |
| | (All) | 33.3 | 534 | |
| Ghana: Rural | High preschooler age and male | 50.3 | 163 | 4.34 |
| | Low rooms per capita and male | 48.3 | 151 | 3.69 |
| | Low rooms per capita and high D | 46.7 | 105 | 2.75 |
| | High dependency ratio and male | 44.5 | 110 | 2.36 |
| | Low value non-vehicle capital per capita and sex = 1 | 43.0 | 200 | 2.77 |
| | (All) | 33.3 | 1,152 | |
| Luzon: Urban | High age in months and not buy food because it is tasty | 90.6 | 36 | 5.76 |
| | Medium age in months and not think household nutrition is adequate | 84.8 | 33 | 3.55 |
| | High age in months and high dependency ratio | 81.8 | 44 | 3.30 |
| | Medium number income sources and not think household nutrition is adequate | 80.6 | 36 | 2.73 |
| | Medium household size and not buy food because it is tasty | 79.5 | 44 | 2.78 |
| | (All) | 62.6 | 342 | |

(continued)

Table 4.17--Indicator interactions and nutrition security (preschooler ZWA): 7 data sets (continued)

| Country | Indicator Interaction | Percent Overlap with Lowest ZWA tercile | Number of Households | t-stat |
|---|---|---|---|---|
| Luzon: Rural | Low birth order and wife not decides food purchases | 78.3 | 46 | 2.96 |
| | High age in months and wife not decide food purchases | 76.9 | 52 | 2.84 |
| | Low dependency ratio and wife not decide food purchases | 76.8 | 69 | 3.25 |
| | Low birth order and high age in months | 76.0 | 96 | 3.60 |
| | High age in months and number of adult males of > number of adult females | 66.4 | 110 | 1.35 |
| | (All) | 60.3 | 751 | |

Note: If absolute t-value > 1.96, then the percent overlap is significantly different from the percent overlap were the indicator not associated with nutrition insecurity.

indicator for Brazil has a t-statistic of 1.77 but a percent overlap of 50).

### 4.2.2 Grouping Indicators

A second, cruder, attempt at combining indicators was made. Here, the number of indicators (selected from the 'best' single indicators) for which a household or preschooler registers an indication of insecurity is plotted against the average household calorie adequacy (or average ZWA for preschoolers). These plots are shown in Figures 4.1 to 4.7).

In general, as the number of indicators of food insecurity grows, household calorie adequacy and ZWA both decline. Regression lines were filled for the seven points on each graph, and then superimposed. Table 4.18 presents the slope coefficients.[13] The Ghana sample seems to be the most sensitive to the indicators developed, but this may be due to the use of calorie availability (from expenditure surveys) as opposed to calorie intake (24-hour recall) as in the other data sets. Both the urban data sets showed better indicator performance (Ghana, Luzon). Interestingly, note that the regions that show more indicator success in locating household food insecurity (Bukidnon) do not necessarily show more indicator success at the preschooler level.

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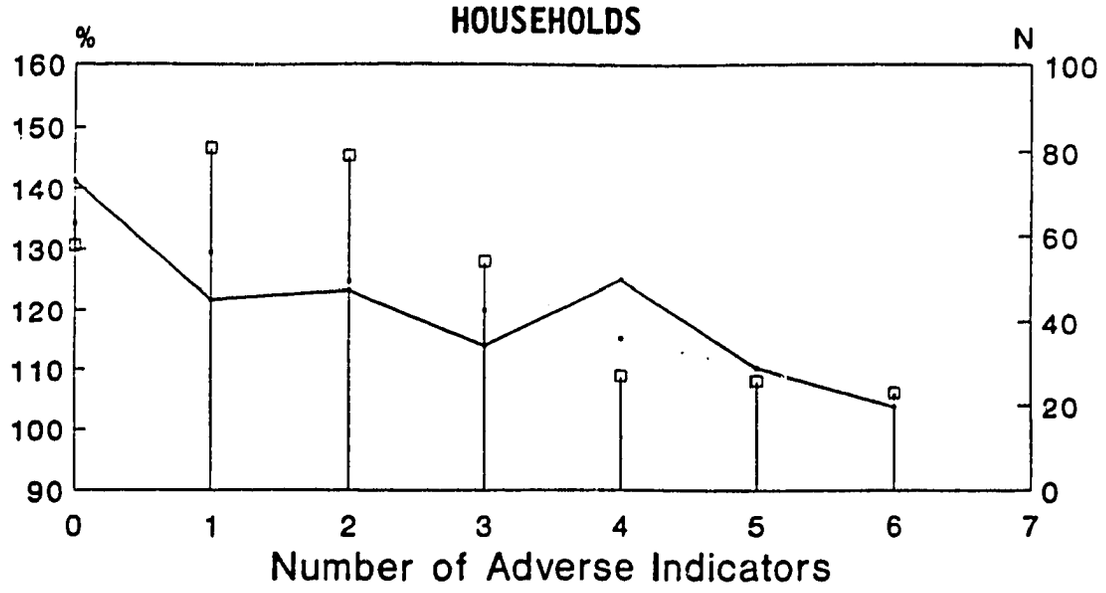
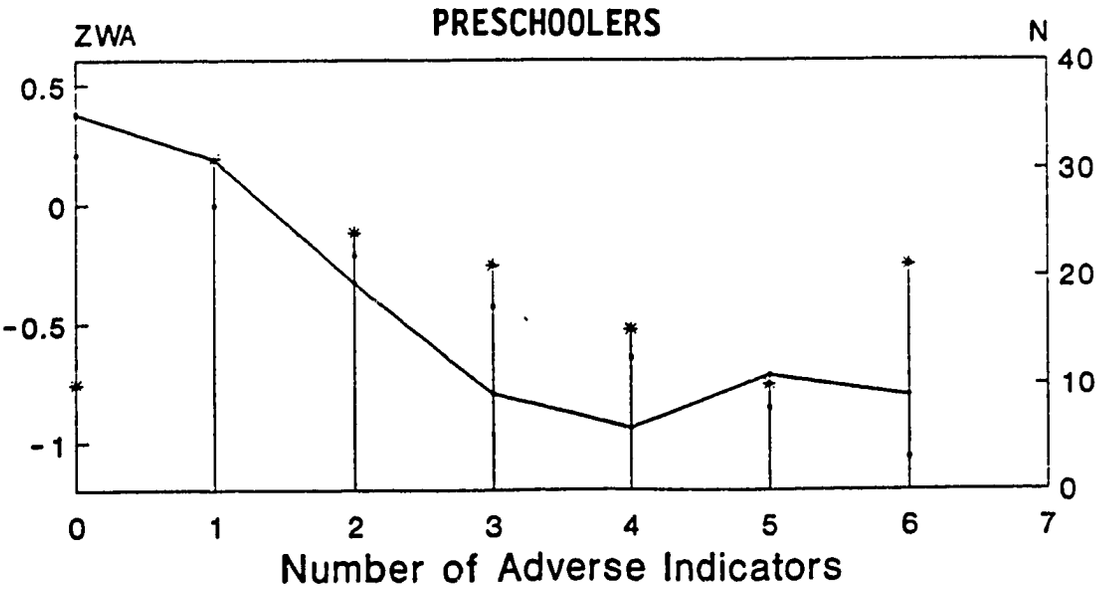
[13] While these slope coefficients are only suggestive and far from conclusive, they are included in attempt to foster cross-country comparisons for Figures 4.1 to 4.7.

Figure 4.1--Combining indicators of food and nutrition insecurity: Brazil

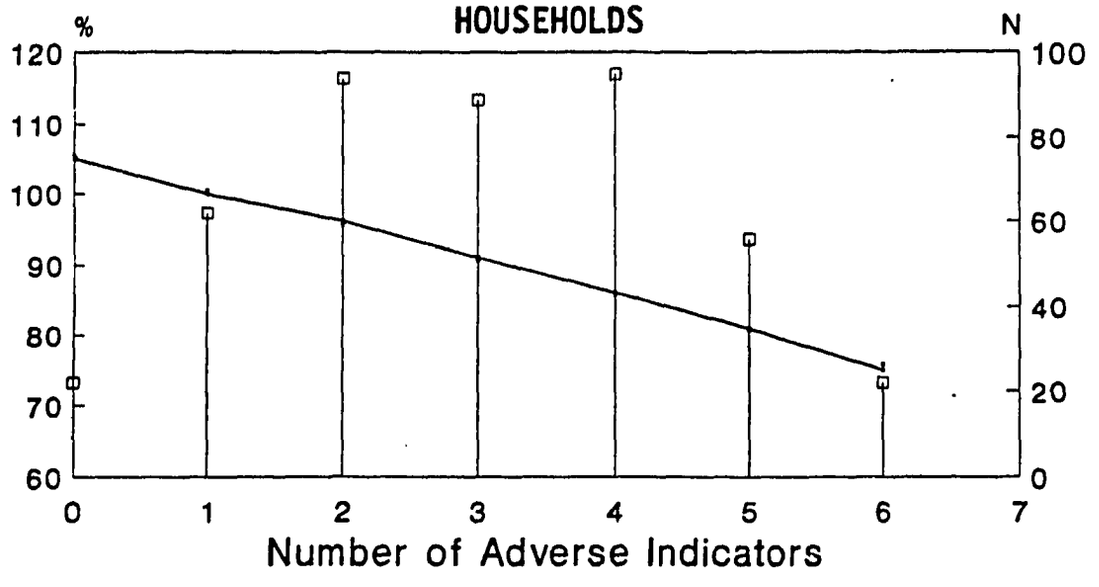



| | | |
|---|---|---|
| **Indicators for Brazil Households** | Household size = high | Number income sources = high |
| | Land used per capita = low | Tenure status = sharecropper |
| | Area sharecropped = high | Sex ratio = male < female |
| | Percent land used for sharecropping = high | Number of foods consumed = less than 9 |
| | Dependency ratio = high | Preschooler present in household = yes |

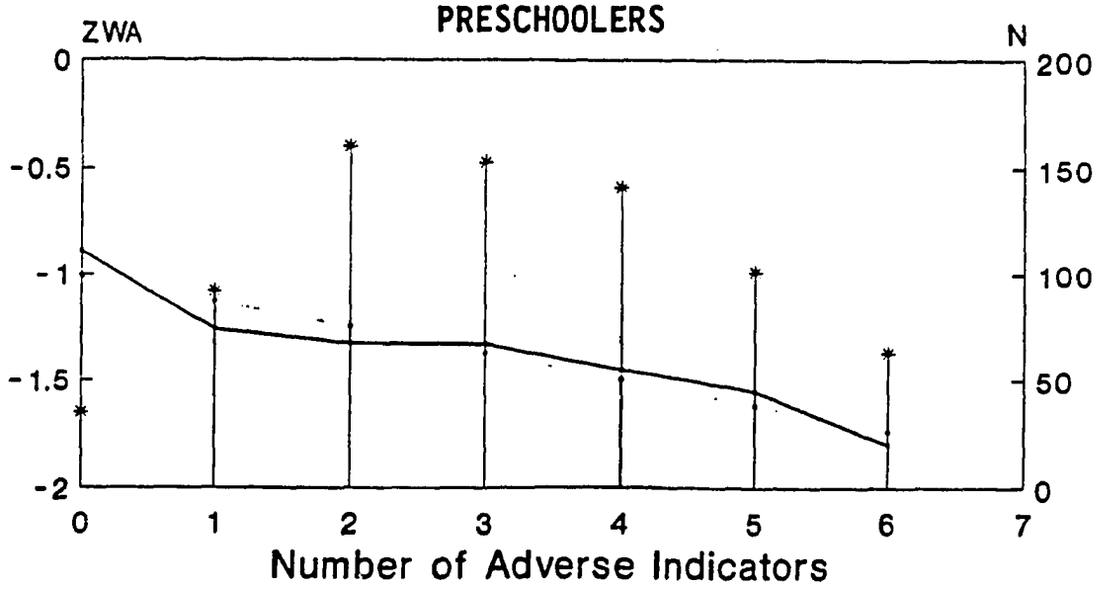



| | | |
|---|---|---|
| **Indicators for Brazil Preschoolers** | Dependency ratio = high | Sex ratio = male > female |
| | Tenure status = sharecropper | Area sharecropped = high |
| | Years education of male head of household = 1-3 | Land used per capita = low |
| | Years education of female head of household = 1-3 | Household size = medium |
| | Percent land used for sharecropping = high | |

Figure 4.2--Combining indicators of food and nutrition insecurity: Bukidnon, Philippines

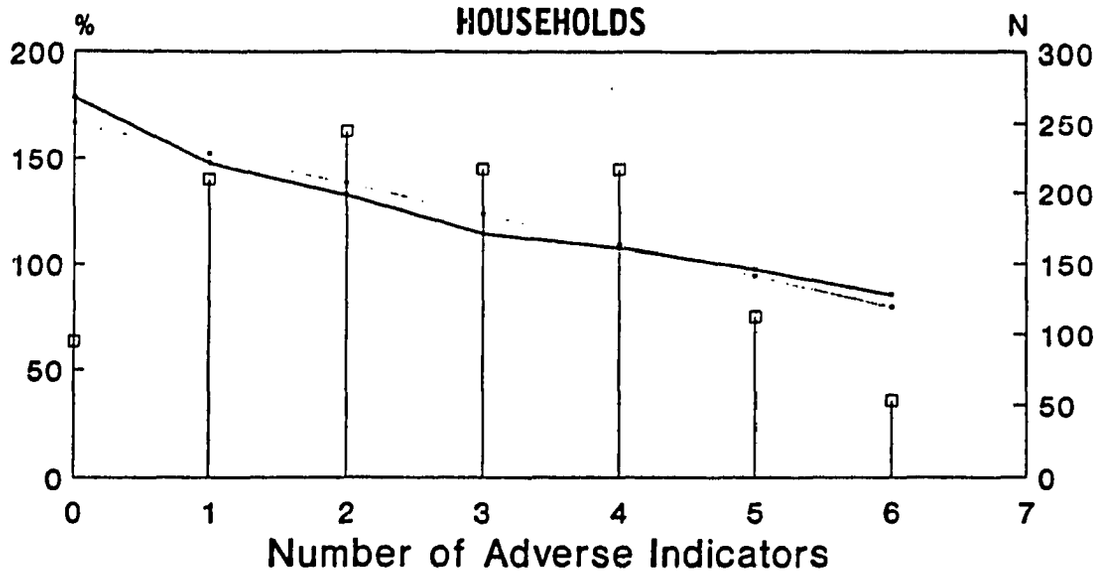



| | | |
|---|---|---|
| Indicators for Bukidnon, Philippines, Households | Dependency ratio = high | Number recipe lines = low |
| | Area cultivated per capita = low | Mother's age = high |
| | Number corn items consumed = low | Average net worth household assets per capita = low |
| | Household size = high | Number unique broad food groups = low |
| | Father's age = medium | Household = rural nonfarm |

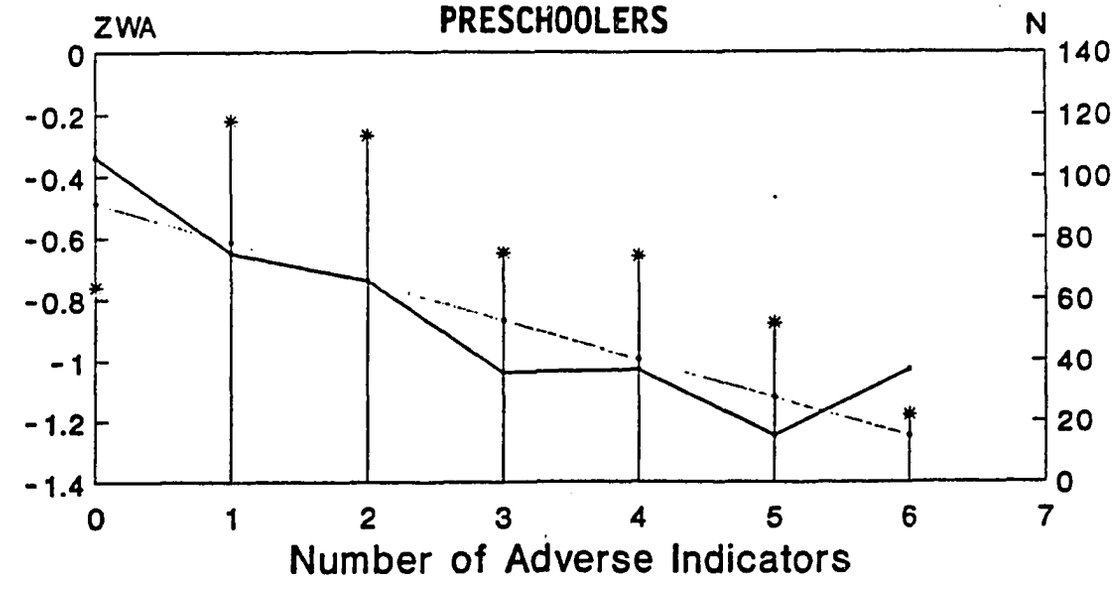



| | | |
|---|---|---|
| Indicators for Bukidnon, Philippines, Preschoolers | Sex = male | Number unique food groups = low |
| | Diarrhea in previous 4 rounds = yes | Number "other" items consumed = low |
| | Fever in previous 4 rounds = yes | Roof = unimproved |
| | Age when weaning foods first given = high | Number days sick = high |
| | Number meat items consumed = low | Dependency ratio = medium |

Figure 4.3--Combining indicators of food and nutrition insecurity: Urban Ghana

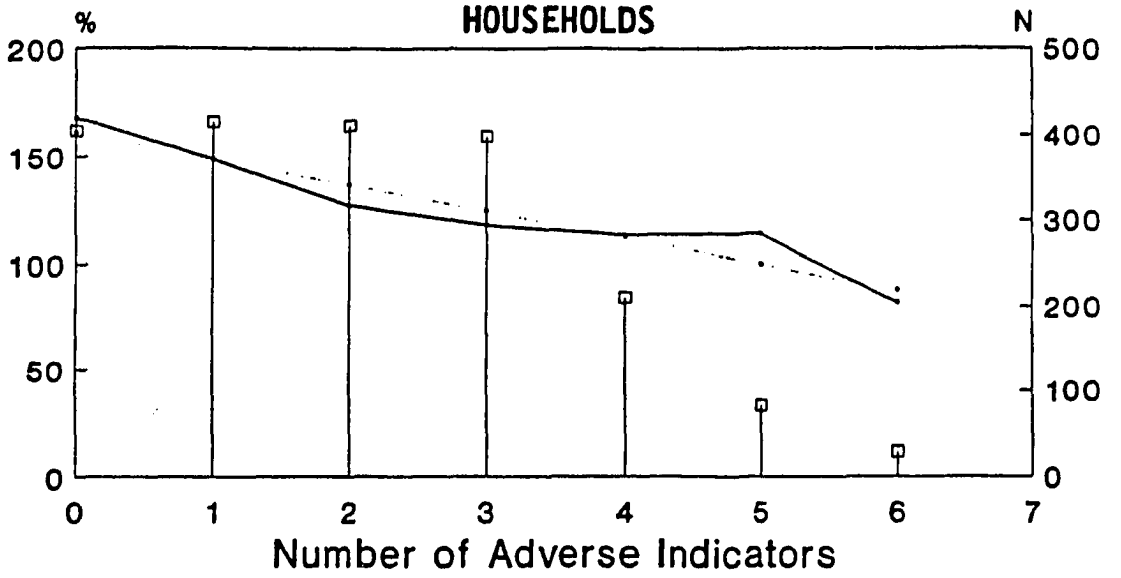



| | | |
|---|---|---|
| Indicators for Urban Ghana Households | Household size = high | Number unique foods purchased or produced = low |
| | Drinking water = unimproved | Value non-vehicle capital per capita = medium |
| | Rooms per capita = low | Occupation group = 1 |
| | Household head cannot do math | De jure female-headed household = 1 |
| | Dependency ratio = high | Number income sources = high |

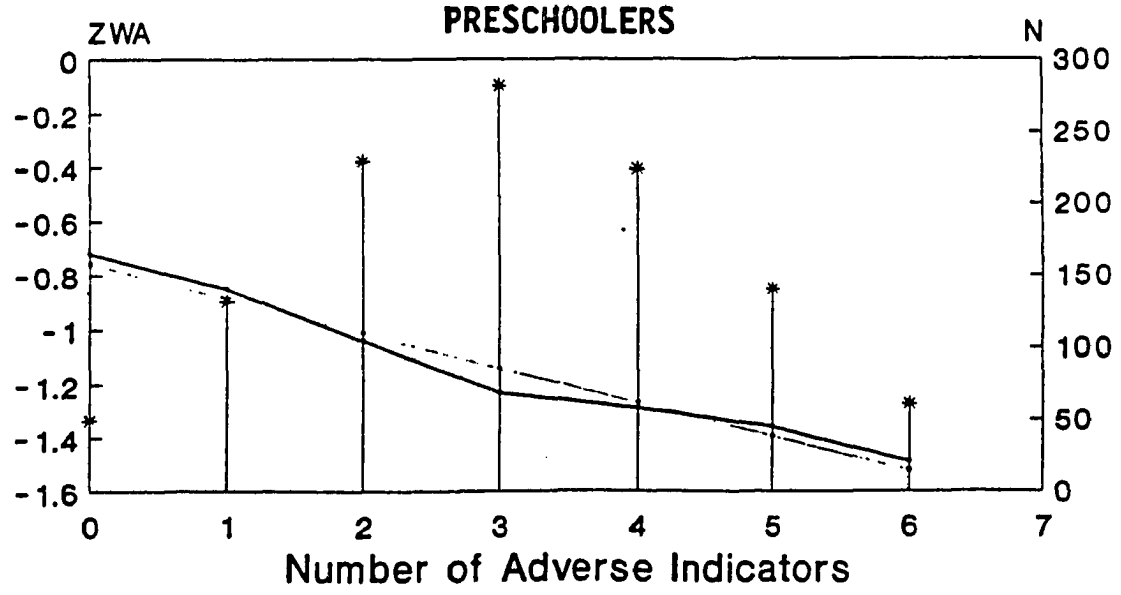



| | | |
|---|---|---|
| Indicators for Urban Ghana Preschoolers | Child not vaccinated | No female in household with at least primary education |
| | Water = unimproved | Number durable goods = low |
| | Landowning group = 3 (1-10) | Land owned per capita = medium |
| | Days mother sick = medium | Birth order = high |
| | Electricity = no | Number days child sick = high |

Figure 4.4--Combining indicators of food and nutrition insecurity: Rural Ghana

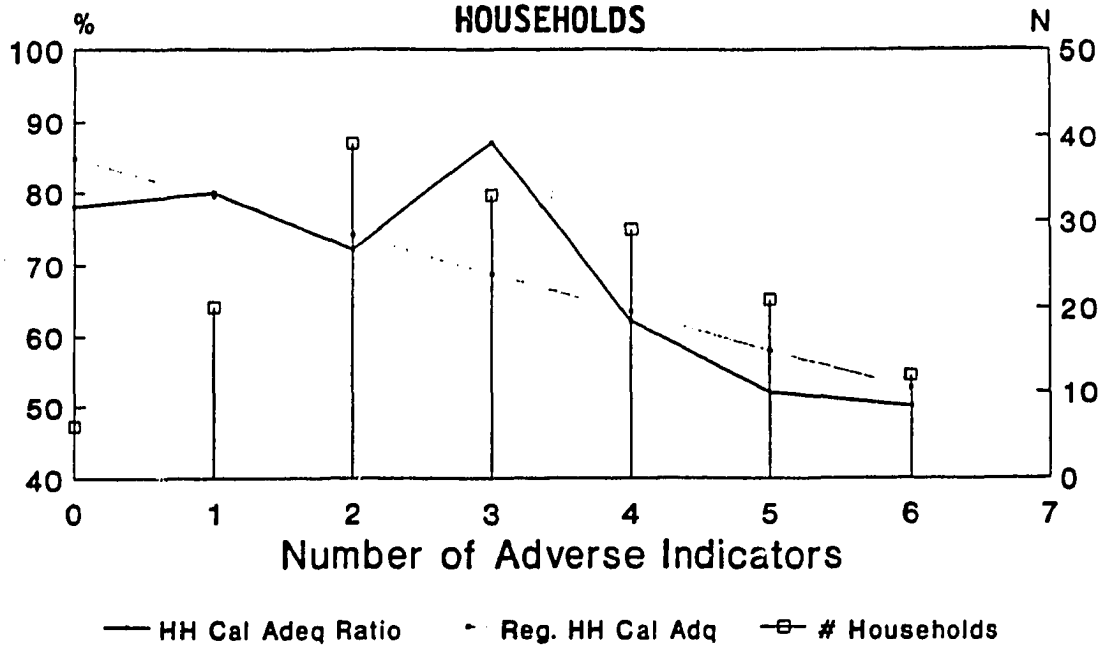



| | | |
|---|---|---|
| Indicators for Rural Ghana Households | Household size = high | Value non-vehicle capital per capita = low |
| | Landless = yes | Occupation group = 2 |
| | Value livestock per capita = medium | Electricity = yes |
| | Land owned per capita = low | Rooms per capita = low |
| | Number of wives = high | Drinking water = improved |

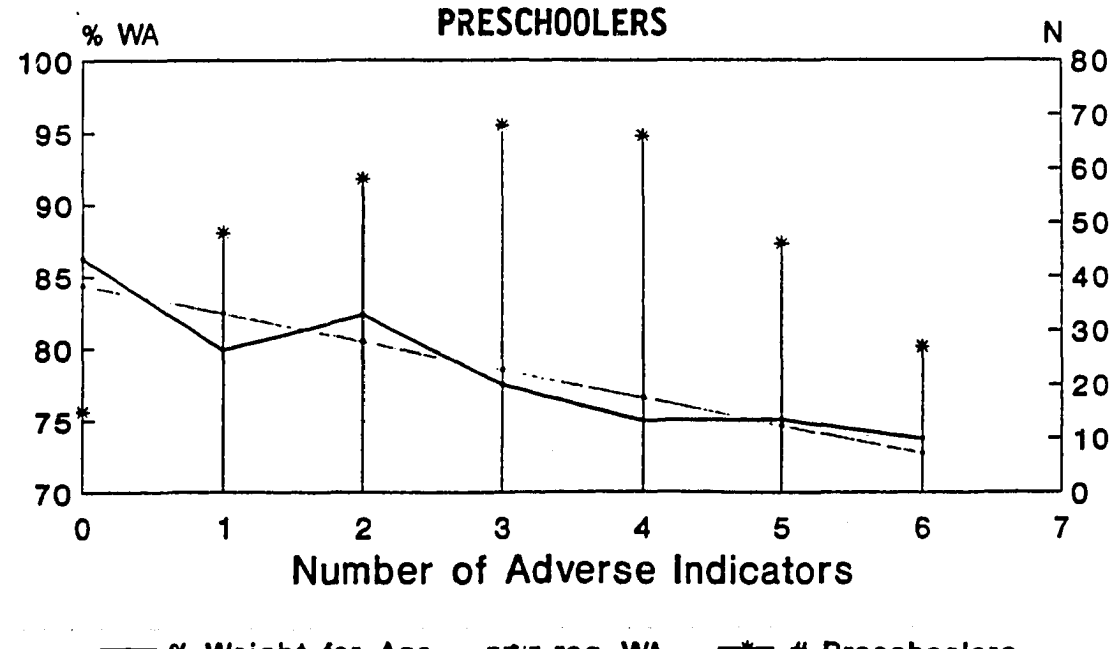



| | | |
|---|---|---|
| Indicators for Rural Ghana Preschoolers | Rooms per capita = low | Value non-vehicle capital per capita = low |
| | Sex = 1 | Number income sources = low |
| | Number days child sick = high | De facto female-headed household = 1 |
| | Age of preschooler = medium | Number months last child breast-fed = high |
| | Dependency ratio = high | No male in household with at least primary education |

Figure 4.5--Combining indicators of food and nutrition insecurity: Urban Luzon, Philippines

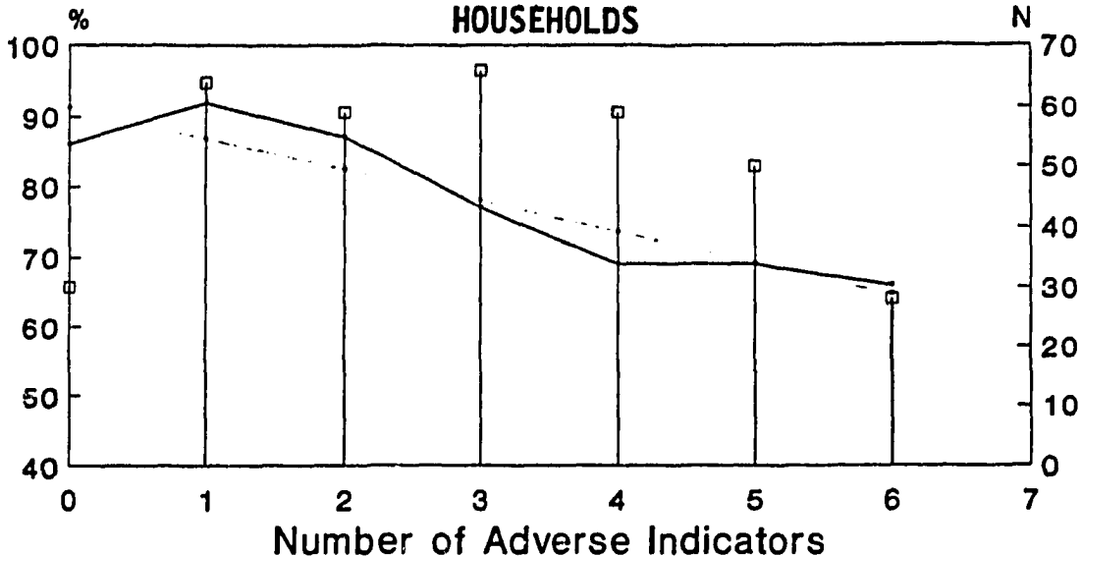



| | | |
|---|---|---|
| Indicators for Urban Luzon, Philippines, Households | Water = unimproved | Number children used in birth order calculation = high |
| | Household size = high | Mentioned food purchase as available |
| | Dependency ratio = low | dcfuel = 0 (cooks with wood, not imported fuel) |
| | Gender balance = 1 (m > f) | Household members miss non-restaurant meals on average = yes |
| | Number rooms per capita = low | foodnutr = 0 (did not mention nutrition for purchasing food) |

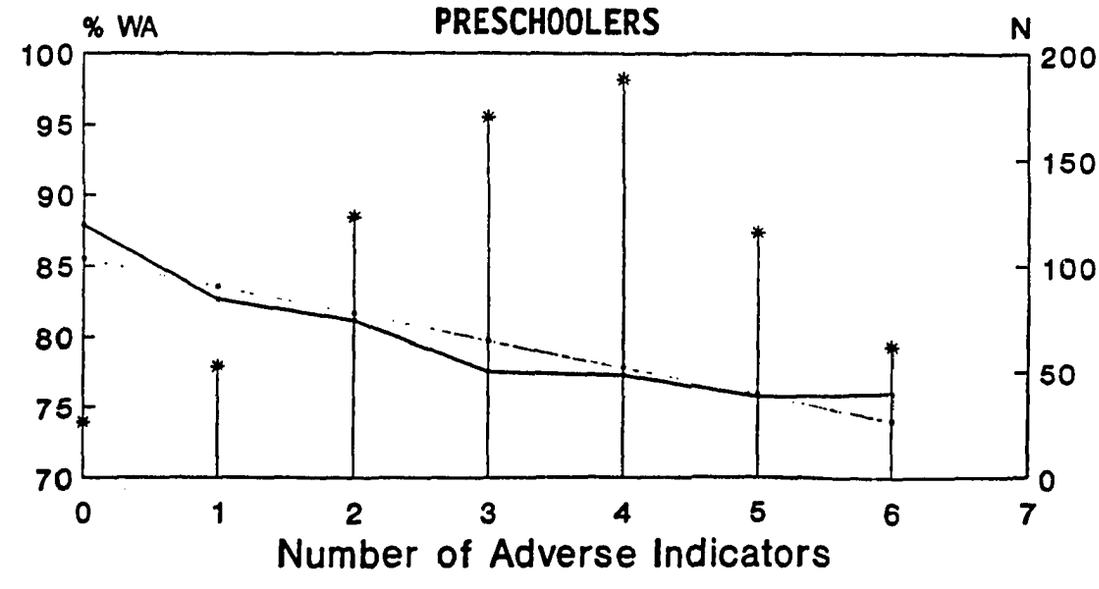



| | | |
|---|---|---|
| Indicators for Urban Luzon, Philippines, Preschoolers | dcfuel = 0 (cooks with wood) | foodlike=0 (did not mention taste for purchasing food) |
| | Age in months = high | adeqnutr=0 (not think hh food is adequate nutritionally |
| | Number income sources = medium | Spouse not have at least some high school education |
| | Dependency ratio = high | Household head not have at least some high school educ. |
| | Household size = medium | Purchased greater than 11 foods |

Figure 4.6--Combining indicators of food and nutrition insecurity: Rural Luzon, Philippines

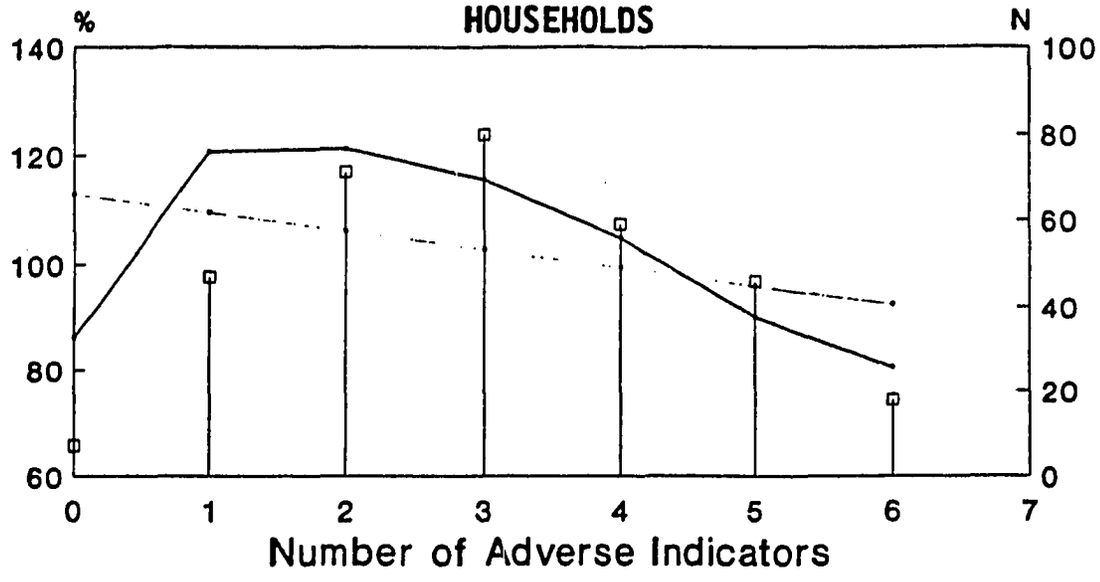



| | | |
|---|---|---|
| Indicators for Rural Luzon, Philippines, Households | Household size = high | Number children used in birth order calculation = high |
| | Number rooms per capita = low | Mentioned food purchase as accessible |
| | Number crops cultivated = high | Percent calories available, not purchased = medium |
| | Number income sources = high | Not use cooking oil in children's food |
| | Dependency ratio = high | HH members miss non-restaurant meals on average = yes |

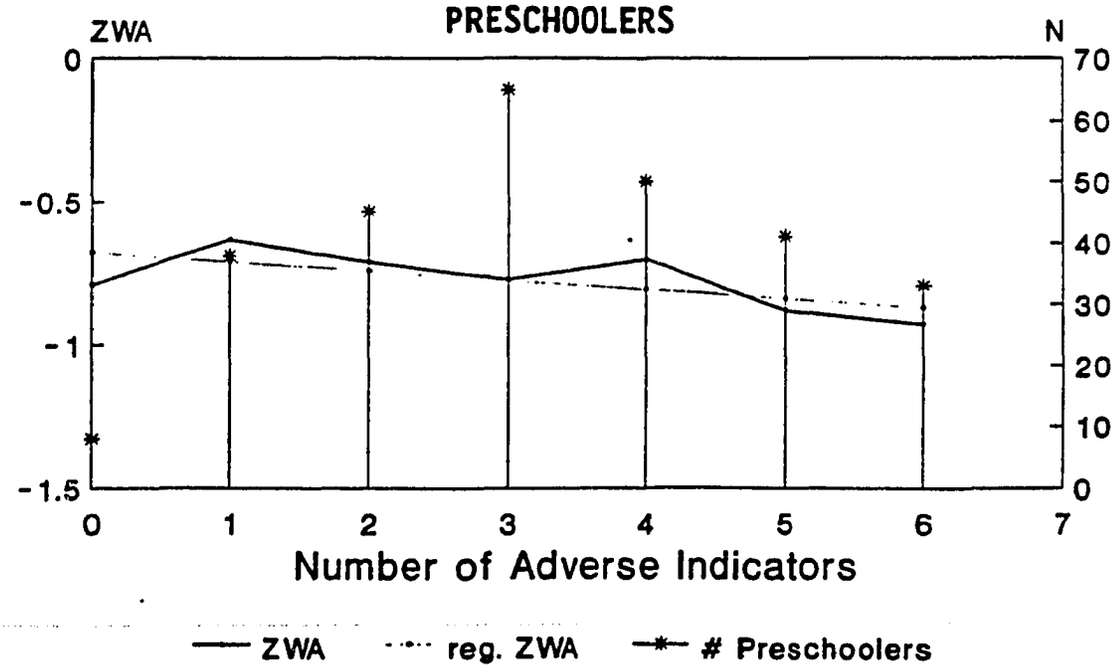



| | | |
|---|---|---|
| Indicators for Rural Luzon, Philippines, Preschoolers | Gender balance = 2 (m = f) | whofood = 0 (wife not decide food spending) |
| | Age in months of preschooler = high | adeqnutr=0 (not think hh food adequate nutritionally) |
| | Birth order = low | extranfd=2 (medium extra 100 pesos on nonfood) |
| | Dependency ratio = high | Number different crops cultivated = low |
| | Land cultivated per capita = low | Percent calories available, not purchased = medium |

Figure 4.7--Combining indicators of food and nutrition insecurity: Mexico City, Mexico




| | | |
|---|---|---|
| Indicators for Mexico City, Mexico, Households | Water = unimproved<br>Sanitation = unimproved<br>Floor = unimproved<br>Family size = high<br>Number rooms per capita = low | Number years schooling father = low<br>Years schooling mother = medium<br>Dependency ratio = medium<br>Number of rooms = less than 3 |




| | | |
|---|---|---|
| Indicators for Mexico City, Mexico, Preschoolers | Sanitation = unimproved<br>Water = unimproved<br>Floor = unimproved<br>Number years schooling father = low<br>Number years schooling mother = low | Number rooms per capita = low<br>Family size = high<br>Dependency ratio = medium<br>Age of preschooler = medium<br>Number of rooms = less than 3 |

Table 4.18--List of fitted line slope regression coefficients for household caloric adequacy ratios and ZWAs from 7 data sets in Figures 4.1 to 4.7

| Country | Households | Preschoolers |
|---|---|---|
| | Slope | Slope |
| Mexico | -3.364 | -0.033 |
| Rural Luzon | -4.429 | -1.917[a] |
| Brazil | -4.769 | -0.212 |
| Bukidnon | -4.928 | -0.123 |
| Urban Luzon | -5.357 | -1.948[a] |
| Rural Ghana | -12.214 | -0.128 |
| Urban Ghana | -14.607 | -0.127 |

[a] Preschooler slope not comparable to the other five data sets because the slope refers to a decline in percent weight-for-age, not ZWA.

## 4.3 Indicator Evaluation: An Example of the Gains to Food Security From Targeting

Using the interacted indicators of dependency ratio and number of food groups as a targeting instrument for Bukidnon, we calculate the extra calories necessary for an untargeted transfer to achieve the improvement in food security achieved with the indicator targeting. With no transfer, the average calorie adequacy shortfall ($P_{\alpha=1}$) is 0.04125 (Table 4.19). An untargeted transfer of 100,000 calories reduces $P_{\alpha=1}$ to 0.04032. A targeted transfer of equal budget size (100,000 calories), delivered only to households with high dependency ratios and a low or medium number of unique food groups, results in $P_{\alpha=1}$ of 0.03999. An untargeted transfer of 104,880 calories is necessary to achieve a level of undernutrition reduction comparable to the targeted transfer of 100,000 calories.

This example of one evaluation process underscores the fact that a true ranking of indicators can only be achieved within the context of a clearly stated specific objective, such as minimization of household calorie adequacy shortfalls for all households in the population.

Table 4.19--The compensated gains from targeting: Using dependency ratios and unique food groups in Bukidnon

| Scenario | Undernutrition Index, $P_1$ |
|---|---|
| No transfer | 0.04125 |
| Untargeted transfer of 100,000 calories | 0.04032 |
| Targeted transfer of 100,000 calories | 0.03999 |
| Untargeted transfer of 132,530 calories | 0.03807 |
| Untargeted transfer of 122,771 calories | 0.03873 |
| Untargeted transfer of 116,265 calories | 0.03941 |
| Untargeted transfer of 109,759 calories | 0.03964 |
| Untargeted transfer of 106,506 calories | 0.03986 |
| Untargeted transfer of 104,880 calories | 0.03998 |

Notes:

1. Individuals from households with high (upper tercile) dependency ratios and low or medium number of unique food groups (lower and middle terciles) are eligible for the calorie transfer.
2. 95 out of 448 households are eligible for targeted transfer.
3. Calorie adequacy threshold = 0.81, which is the highest value in the lowest calorie adequacy tercile.
4. The higher the undernutrition index, the more food insecure the entire population.

## 5. CONCLUSIONS AND PRIMARY DATA COLLECTION PROTOCOL

The central message of the empirical analysis is that relatively simple indicators perform well in locating the food and nutrition insecure. Comparable to more complex indicators, such as household income level, indicators such as number of unique foods consumed, region, dependency ratio, household size, rooms per capita, incidence of illness, vaccination status, age at weaning, drinking water and sanitation facilities—all coded with only two or three different values—were able, either singly or in combination, to identify households and preschoolers at risk.

The Kennedy, Peters, and Bouis work (1991) identified income per capita as the indicator which best differentiates food secure from food insecure households. The testing of many more indicators here results in a much more encouraging conclusion: that there are several 'qualitative' or alternative indicators which perform just as well as household income in identifying the food insecure households. This result holds true for preschoolers as well.

While we list some indicators that located the food and nutrition insecure in several of the data sets, we emphasize that the most appropriate set of indicators—in terms of costs of collection and noncollection—can only be determined in a location-specific setting—often in a participatory manner.

**5.1 Indicators That Located Food Insecure Households in Several of the Data Sets were:**

- Household size;
- Dependency ratio;
- High percentage of preschoolers;
- Region;
- Rooms per capita in home;
- Quality of drinking water and sanitation facilities;
- Land area cultivated and owned (in rural areas);
- Occupation/tenancy status;
- Number of unique foods consumed or available;
- Subjective perceptions of participant as to quality of diet; and
- Number of missed meals.

**5.2 Indicators That Located the Nutrition Insecure Preschoolers in Several Data Sets were:**

- Age of preschooler (low for low ZWH, high for low ZHA);
- Incidence/duration of illness (self-reported);
- Vaccination records;
- Improved water and sanitation facilities;
- Use of improved fuel for cooking;
- Characteristics demanded in food;
- Households' opinion about quality of diet;
- ~~Number and type of unique foods consumed;~~
- Region;
- High age of weaning;

- Income from remittances;
- De facto female-headed households;
- Dependency ratio;
- Crop-tenancy status of household; and
- Number of income sources.

## 5.3 Suggested Data Collection Protocol

Clearly the potentially more "user friendly" indicators that have been listed in sections 5.1 and 5.2 need to be tested in as broad a set of conditions as possible. The issue is not simply whether some of these alternative indicators do better or equally well but what are the trade-offs in terms of costs and precision. The assumption throughout much of this report is that the traditional indicators are the benchmark against which the new indicators will be tested. However, as part of this exploratory exercise on indicators, we propose that some of the more classical indicators also be reexamined. For example, household income per capita has been used here and also in an earlier indicators report (Kennedy, Peters, and Bouis 1991) as one of the traditional and generally accepted indicators of household food insecurity. However, the utility of income information depends on the period over which it was collected. Income information collected on repeated rounds covering short periods seems to be more accurate than income information collected on one measurement only. Since many of the monitoring systems that exist tend to collect cross-sectional data only, some traditional measures may have less precision. Thus, a part of the field work for

testing traditional versus alternative indicators will involve validating each of the indicators, not simply the innovative ones.

The list of indicators described in 5.1 and 5.2 will be tested in field sites that will begin as part of the agriculture/nutrition linkages work. A protocol using the alternative indicators will be developed, tested, and contrasted with the traditional indicators that have been used in monitoring systems in the various areas. This issue is taken up in another way in the companion report on micronutrients (Kennedy and Payongayong 1991). Several indicators for monitoring micronutrient status are identified. These also will be incorporated into the protocols that will be tested.

Field survey work will begin in Kenya and Ghana in 1992. We are in the process of identifying two additional field sites in Asia and Latin America.

An additional effort is also underway. As a result of the inventory work reported in a separate part of this volume, several of the institutions responding indicated a need for a simpler cadre of indicators. IFPRI is attempting to identify situations under which some of these alternative indicators can be tested in the context of an ongoing monitoring and evaluation system. Here again, information on the cost of data collection and analysis needs to be documented.

The ultimate product from the testing of indicators will be a set of guidelines on the type of indicators that can be used for various purposes and the context under which each indicator works best. There is a particular need to document the utility of selected indicators in

both urban and rural settings. Much of the emphasis in past monitoring systems has been placed on rural environments. With the increasing urbanization in developing countries, indicators for monitoring food security and nutrition need to be suitable for the urban settings. These guidelines will serve a variety of purposes including, possibly, in the current prism exercise within A.I.D.

# APPENDIX 1

## A SYNTHESIS OF THE BROADER LITERATURE ON POTENTIAL INDICATORS OF FOOD AND NUTRITION SECURITY

### INTRODUCTION

Policy analysts concerned with reducing and monitoring food insecurity must regularly ask themselves: Who is food insecure? How many individuals are vulnerable to food insecurity? Why or how did they become vulnerable? Where do they reside? Research into these and other questions necessarily involves a range of disciplines and ideologies, but it is this very diversity which contributes to the current lack of consensus on accepted indicators and methods of measurement of the food and nutrition insecure. There is an urgent need to define and adopt indicators of food and nutrition insecurity that are easy to collect and use in order that households and individuals can be accurately, reliably, and timely identified (Downing 1991) in a sustained manner.

This literature review attempts to identify those indicators which show the most promise for targeting and monitoring the food and nutrition insecure. An effort was made to describe new or innovative indicators which have not traditionally been included in monitoring or early warning systems. Many of these alternative indicators have evolved out of innovative multidisciplinary research in rural areas of developing countries. The best indicators, of course, are based upon local concepts and priorities, defined by the targeted populations

themselves. But no matter how sensitive, specific, timely, or easy to use an indicator may be, it is risky to rely too heavily upon a few indicators to explain complex processes or predict adverse outcomes (Chambers 1989). "Ideal" indicators do not exist (Autier et al. 1989); no single or simple index can capture all aspects of vulnerability, either within a given population or across different areas (Oshaug and Wandel 1989). Indicators, like the monitoring systems which employ them, must be flexible enough to evolve with the changing priorities and needs of the target population in order to detect subtle changes in economic behavior over time.

**COPING STRATEGIES**

A recurrent theme in the alternative indicator literature is how poor people cope with contingencies. It is widely recognized that people who live in conditions which put their main source of income at recurrent risk have developed self-insurance coping strategies to minimize risks to their food security and livelihoods (Campbell and Trechter 1982). These coping strategies are not only complex, but diverse, and challenge the view that the poor are passive (Beck 1989; von Braun and Pandya-Lorch 1991). Rural households not only plan for contingencies, but respond actively to them (Shipton 1990). Intensified cropping patterns, diversified income sources, off-farm work, rationing of food consumption, deferred expenditures, mortgaging or selling assets, and increased exploitation of community and kinship ties and resources are all examples of coping strategies cited in the literature;

these are regarded as potential alternative indicators in this paper. The various coping strategies are not mutually exclusive, however, and offer vulnerable households a wide range of alternatives for responding to adversity (Campbell 1984). How these behaviors are manifested depends upon the severity and duration of the potentially disruptive conditions (Thomas et al. 1989). In general, coping strategies are primarily concerned with maintaining the future income-generating capacity of the household, rather than simply maintaining current levels of food consumption (Corbett 1988; de Waal 1988).

Although coping strategies vary by region, community, social class, ethnic group, household, gender, age, season, and time in history (Chambers 1989; Thomas et al. 1989), they are generally not adopted in a haphazard or random manner, but typically fall into distinct sequences which can be monitored (Corbett 1988; Jodha 1975, Campbell and Trechter 1982; de Waal 1988; Cutler 1986; Dirks 1980; Watts 1983; Torry 1984; Thomas et al. 1989; Shipton 1990). In fact, these sequences of strategies are most frequently divided in the literature into three distinct stages of responses: stage one strategies involve an increased reliance on established community- or household-level insurance mechanisms; stage two strategies witness the gradual disposal of key productive assets; and stage three strategies can be viewed as a terminal stage of destitution which usually involves distress migration (Corbett 1988). For purposes of early warning and food security monitoring, this review concentrates on those coping strategies observed within the first two response stages. Watts (1983) notes that each

successive stage requires increasing commitment of domestic resources which becomes increasingly irreversible (Shipton 1990). For example, selling off the means of production such as farm tools (a stage two coping strategy) has more serious consequences for future household food security and future income-earning potential than a reduction in meal frequency (a stage one coping strategy).

The three response stages have also been described as stages of exploration, retrenchment, and exhaustion (Thomas et al. 1989), stages of alarm, resistance, and exhaustion (Dirks 1980), stages of austerity, divestment, and migration (Rahmato 1987, cited in Corbett 1988), or simply de Waal's (1988) three stages of destitution. Within each stage, the sequences of coping strategies available to households or individuals are generally predictable, and can act as potential alternative indicators of food and nutrition insecurity.

Which stage a household finds itself in when crisis threatens, such as preharvest food deficit, extended drought, civil disturbance, or economic adjustment, depends upon a variety of factors, including a household's main source of livelihood and its asset status. But even within a group of similar households, there may be significant differences between the options open to and the strategies chosen by each household (Corbett 1988). Different groups come into distress at different starting points, in varied ways, and with different expectations (Thomas et al. 1989). Certain exogenous factors are also important to consider when interpreting the responses to and consequences of food insecurity (Thomas et al. 1989). For example,

local market conditions, level of agricultural commercialization, and control of critical resources, such as land and labor, all influence the economic behavior that underlies household coping strategies (Corbett 1988; Cutler 1986). All households are not equally vulnerable to a decline in their entitlement to food (Corbett 1988).

Thus the challenges faced by food and nutrition monitoring systems are many. First, an effort to identify the conditions causing, perpetuating, and exacerbating food insecurity will help understand why certain groups are more vulnerable to risk than others. Second, depending upon the purpose of the monitoring system, sequences of locally-specific coping strategies must be identified and translated into a continuum of indicators of increasing vulnerability; this can be facilitated through collaborative discussions with local informants. Third, distinction must be made between indicators of seasonal or transitional food insecurity and indicators of a more prolonged or pronounced food crisis. Fourth, pretesting of indicators is necessary to determine whether local factors may distort an indicator's validity and reliability. Fifth, multiple indicators should be used whenever possible to minimize inaccurate inferences made by reliance on single proxies which can lose their meaning over time and place (Honadle 1982). Finally, effective reconnaissance requires an interactive, participatory style of data collection and analysis (Chambers 1989; Honadle 1982). Understanding the indicators requires a deep, ongoing, and contemporary understanding of the society in question (de Waal 1988).

Borrowing from Downing's (1991) conceptual framework for analyzing

vulnerability to famine, this literature review will be organized around the three domains of food insecurity: regional food shortage, household food poverty, and individual food deprivation. Each domain is further subdivided into several dimensions, the choice of which is arbitrary, and depends upon specific situations and purposes. These dimensions attempt to capture the expected variations between vulnerable groups and regions. Alternative indicators are, therefore, specific measures within a given dimension.

The following section highlights selected alternative indicators gleaned from this literature review which seem easy to collect relative to more traditional indicators such as food recalls and anthropometry, and are, therefore, important to the sustainability of future food and nutrition monitoring systems. A discussion of methodological considerations will follow.

## THREE DOMAINS OF FOOD INSECURITY

### 1. Regional Food Shortage

#### 1.1 Geographic Components of Regional Food Shortages

##### 1.1.1 Ecological Indicators

Semi-arid agricultural zones are likely to be more vulnerable to food insecurity than humid zones (Downing 1991; Broca and Oram 1991). Similarly, regions which are historically prone to or currently experiencing drought or flooding may deserve targeted monitoring. When

combined with various government policies, agro-ecological differences contributed to substantial differences in the type and number of income sources in Burkina Faso (von Braun and Pandya-Lorch 1991).

### 1.1.2 Indicators Related to Agriculture Quality

The qualitative monitoring of crops, grazing patterns and wild food sources can provide rapid information on agricultural conditions and, by extrapolation, on regional food security. Farmers' answers to questions such as "Are the harvests expected in your area better than, equal to or worse than last year?" or "Does the rainfall seem sufficient, not quite sufficient or very insufficient for this year's crops?" are easily collected and more timely than postharvest calculations of crop or rainfall estimates. In Ethiopia, a large majority of famine refugees were able to locate the genesis of drought five-to-seven years before they were forced to migrate (Cutler 1986).

### 1.1.3 Macroeconomic Indicators

A variety of macroeconomic factors should be considered in determining constraints to regional and household food security, including national economic situations, regional and local labor markets (including women's access to labor markets), technological change, and level of infrastructure (Norris 1988). Countries or regions undergoing structural adjustment may be particularly vulnerable to short- and/or long-term reductions in welfare and food security (Cornia, Jolly, and Steward 1987). Welfare levels often vary distinctly by region (Haddad 1991).

### 1.1.4 Indicators Related to Social Disruption

Civil war, disproportionate military spending, and/or the active destruction of crops or infrastructure are obvious indicators of regional or national instability (Downing 1991). This also involves the interference with or sabotage of disaster-relief efforts and development-assistance projects.

## 1.2 Institutional Development Components of Regional Food Shortages

### 1.2.1 Indicators Related to Credit Availability

An increase in the demand for credit at the community level is a possible early warning indicator. Nearly half of rural South Indian households took loans during a recent drought, and most felt that these loans had been critical for maintaining minimum living conditions (Caldwell, Reddy, and Caldwell 1986). Securing loans or credit may be particularly important in urban areas where the poor typically lack access to nonmarket means that bridge the annual ups and downs of unstable income flows (von Braun 1987). A late-stage indicator would be the collapse of traditional lines of credit when collateral, especially livestock, disappears (Cutler 1986).

### 1.2.2 Indicators Related to Market Characteristics

The perception of present and future input and output market conditions by rural peoples has a major influence on their choice of coping strategies (Nabarro, Cassels, and Pant 1989). Rural farmers can

predict accurately if and when grain prices will go up based upon observations of rainfall patterns and crop quality (de Waal 1988). Sharp jumps in the retail prices of staple food grains have therefore been used as indicators of approaching crisis (Seaman and Holt 1980). However, rising grain prices are not always indicative of food insecurity since they do not always occur during the early stages of distress: in the Sudan, price rises occurred well after the regional government had predicted famine (de Waal 1988). A rise in petty commodity production and trading may be a more reliable early warning indicator (Cutler 1986; McCorkle 1987). Market proximity can also determine grain transaction behavior (D'Agostino 1988).

An increase in the volume of livestock offered for sale (especially at unseasonal times) and a corresponding fall in the price of livestock may indicate anticipated stress (Campbell and Trechter 1982; Cutler 1986; Corbett 1988): in Niger, meat prices began plummeting two months before a drought was officially recognized, in response to heavy livestock selling by pastoralists who realized that rangeland had not produced enough pasture to support their herds for another year (Swinton 1988). Livestock prices however, do not always fall during crisis, and may actually rise as animal deaths increase the value of surviving stock (Cutler 1984). Another potential indicator may be the number of animals <u>offered</u> for sale rather than the actual number <u>sold</u> (Cutler 1984). Sheep are more likely to be sold in Ethiopia than goats since the latter are hardier, being less reliant on pasture and, therefore, more likely to survive drought; there was an even greater reluctance to selling

camels, which were critical for trading (Cutler 1986). Therefore, assessment of the differential value of livestock in a particular region before monitoring market sales of livestock may improve the sensitivity of this potential indicator.

### 1.2.3 Indicators Related to Social Services

Health services which are accessible, effective, and cheap or free have a greater role in reducing vulnerability and limiting impoverishment than has been recognized in the literature (Chambers 1989). Reducing household-level malnutrition requires addressing community-level health and sanitation problems (von Braun and Pandya-Lorch 1991). Analysis of DHS data from northeastern Brazil showed evidence of significant interactions between levels of community infrastructure (garbage disposal, sewerage, and health facilities) and maternal education which impacted child height (Thomas et al. 1989). Another factor to consider in regional food insecurity is the presence or absence of school lunch programs or food works programs. De Waal (1988) concluded that the cause of excess mortality in the Sudan famine was not lack of food, but sickness related to unprotected water sources and inadequate primary health care. Improved access to health services which offer effective and rapid care to adults suffering from incapacitating illnesses will have a great impact on food security (Nabarro, Cassels, and Pant 1989). If possible, an index of a government's development philosophy regarding basic needs would also be a potential indicator (Downing 1991).

## 1.3 Communal Coping Strategies Related to Regional Food Shortages

### 1.3.1 Traditional Coping Strategies

The availability and use of common property resources (CPR) is an important buffer against seasonal shortages and contributes to rural equity and improved nutrition of the poor (Jodha 1975). Through the free collection of CPR, poor households provide a significant part of basic subsistence needs for housing, fuel, and food supplements, as well as income-generating activities such as dairying and crafts (Das Gupta 1987b; Zinyama, Matiza, and Campbell 1990). A decline in the diversity, quantity or quality of common property resources may be indicate regional food shortages, as could an increased use of or reliance on wild foods (Beck 1989; de Waal 1988).

Outside normal market transactions, gifts, and reciprocal exchanges often constitute a crucial part of household economic life, yet they are not expressed in monetary terms (Castro, Hakansson, and Brokensha 1981). Indicators which capture the level and intensity of nonmarket exchanges within the informal economy would be extremely valuable for monitoring systems (Beck 1989). For example, share-rearing of livestock (agistment), whereby animals are borrowed and exchanged between households to salvage unproductive stock, is widespread in Africa and Asia, and often results in an important source of income for rural poor (Jodha 1986; Swift 1989; Beck 1989). In Ethiopia, the most important coping strategy was found to be the borrowing and exchanging of oxen, during both non-drought and drought conditions (McCann 1987). In West

Bengal, more than half the study households were either currently share-rearing livestock or had done so within the previous five years (Beck 1989). Deviations from a region's "normal" level of share-rearing may indicate changing levels of vulnerability.

1.3.2 Untraditional Coping Strategies

There is a trend toward increased dependence upon resources outside the control of the local community, eg, relief efforts or employment schemes funded and operated by governmental or nongovernmental organizations (Thomas et al. 1989; Campbell 1987). A very early indicator of crisis with a long lead time would be unusually large influxes of people seeking work at established sites (Cutler 1984). Seeking food relief from external sources, however, was one of the last resorts of Ethiopian peasants who had managed to survive months, if not years, by strategic dissavings of assets (Rahmato 1987, cited in Corbett 1988). Among newly studied phenomena in urban Africa are quasi-families of room- or compound-mates who pool foods from their respective kin in different rural areas. Other urban coping strategies include urban agriculture, child fostering, and communal neighborhood restaurants or food centers (Shipton 1990). Urban agriculture is frequently overlooked as a source of nutrition (Obbo 1985, cited in Shipton 1990) or income (that frequently ends up in the hands of women) (von Braun 1987): 100 percent of vegetable consumption in Shanghai was from urban production (Gutman 1986, cited in von Braun 1987). Reliance on rural relatives or extended families and neighbors may prevail in urban areas, but appears

to be a weaker safety net than in rural communities (von Braun 1987; Obbo 1985, cited in Shipton 1990).

## 2. Household Food Poverty

### 2.1. Demographic Indicators of Household Food Poverty

#### 2.1.1 Indicators Related to Household Size/Composition

Adjustment of household size and composition is a common strategy for coping with recurrent food insecurity (Messer 1989a; Norris 1988; Nabarro, Cassels, and Pant 1989; Castro, Hakansson, and Brokensha 1981; von Braun and Pandya-Lorch 1991). Another strategy may involve changing the location or use of housing (Leeds 1974, cited in Norris 1988). Household size and composition is not static, but changes with a household's biological life cycle (Caldwell, Reddy, and Caldwell 1986). Households members come and go for various time periods and reasons, including sending children to live with relatives, migration of able-bodied adults seeking wages, or simply to reduce demand on limited household calories. Indicators which can distinguish stable households from those having to adjust their size/composition may be useful for targeting. The age composition of a household, especially when combined with dependency ratios, may be a strong indicator: the poorest households tend to have large, young families (Lipton 1983b), with limited income earning potential and greater child care demands (von Braun and Pandya-Lorch 1991). Large households with high status or

favorable dependency ratios, however, have been associated with higher incomes (Taal 1989), a greater diversification of income sources (Toulmin 1986; Nabarro, Cassels, and Pant 1989), and less vulnerable to illness or death of breadwinners (Toulmin 1986; Lipton 1983a; Caldwell, Reddy, and Caldwell 1986) than smaller households. Households with female heads are often, though not always, poorer and more vulnerable (Castro, Hakansson, and Brokensha 1981; von Braun and Pandya-Lorch 1991; Peters and Herrera 1989; Louat, Grosh, and van der Gaag 1991).

### 2.1.2 Indicators Related to Migration

The fact that migration occurs may be less important than understanding the timing of that migration in relation to the time of year with the greatest opportunity costs of an absent adult (Campbell and Trechter 1982; de Waal 1988). If harvest expectations are pessimistic, early departures of young men before the harvest are usually observed (Autier et al. 1989). Rural Ethiopians could anticipate six months in advance whether a household member would need to migrate (de Waal 1988). The type of migration is also important to determine: migration of household heads seeking wage employment for remittance back home is entirely different from migration in which the household head seeks relief to carry back home, and both of these are significantly different from distress migration which involves whole families (Cutler 1984). These types of migration overlap to some extent, depending upon the relative asset base of the household. Distress migration of whole families is a late stage indicator of stress

and clearly implies that other coping strategies have failed (Corbett 1988; Cutler 1984; Watts 1983). Finally, Nabarro, Cassels, and Pant (1989) suggest that households which "usually" are involved with migration should be distinguished from households which have only "recently" begun to do so.

### 2.1.3 Indicators Related to Region/Ethnicity

Welfare levels often vary distinctly by region (Haddad 1991). Focusing on rural areas is a simple way to reach many of the poor in Latin America (Pfeffermann and Griffin 1989). Certain ethnic groups may be historically or geographically more vulnerable to seasonal or chronic food insecurity (O'Brien-Place 1988).

## 2.2 Factor Market Indicators of Household Food Poverty

### 2.2.1 Indicators Related to Income

The actual amount of income earned by a family member may not be as important as whether or not that person has been able to find work (O'Brien-Place and Frankenberger 1988). Smallholders spread their risks through diversification of income sources, most notably off-farm employment (Downing 1988; Shipton 1990; Reutlinger 1987; Caldwell, Reddy, and Caldwell 1986; Merryman 1984). There are two distinct motives underlying income diversification: diversification in stagnating economies is a reflection of the poor's coping with income source-specific risks, while diversification in growing economies is a

reflection of dynamism and of capturing gains from specialization at the household level (von Braun and Pandya-Lorch 1991; Castro, Hakansson, and Brokensha 1981). As an alternative indicator, the number of income sources is easier to collect than estimates of total income, but its potential U-shape makes interpretation difficult. Perhaps recent changes in the number or type of income sources would be a more reliable indicator. Das Gupta (1987b) emphasizes the difference between levels of normal income and the security of normal income. Variability in seasonal agricultural wage labor rates is another important source of vulnerability (Swift 1989). A characteristic feature of poor households in India is the absence of a stable daily average of cash transactions; the tendency for lump-sum receipts (as well as disbursements) results in extremely large fluctuations of cash transactions (Bhattacharya et al. 1991). Income received seasonally in large sums will more likely be spent on lump-sum expenditures or consumer goods than on improved diets and other nutrition-related investments (Alderman 1986; Guyer 1980; Dewey 1979).

### 2.2.2 Indicators Related to Land

Diversification of landholdings may be a more sensitive alternative indicator than total acreage since households with fragmented landholdings, often outside the immediate village, can exploit differences in microclimates or ecological zones better than households with larger but often less diverse landholdings (Dei 1990; Colson 1979; Dewey 1981; Downs 1988 cited in Shipton 1990; Paterson 1980 cited in

Castro, Hakansson, and Brokensha 1981). Tenure status (communal, tenancy, squatting, freehold) also affects patterns of vulnerability (Downing 1990); if a household is a tenant, tenants' rents and the security of tenancy should be taken into consideration (Castro, Hakansson, and Brokensha 1981).

Intensification of land-use practices is one of the earliest responses in a sequence of farmers' adjustments to stress (Jodha 1975, 1978). Intercropping, multiple seed strains with different maturation periods and resistance to disease, and broad mixtures of available cultivars are important diversification strategies to minimize the risk of crop failure and enhance food security (Shipton 1990; Taal 1989; Smith 1986). Access to fallow land or land used to grow trees is an important buffering mechanism in resource-poor environments (Chambers and Leach 1989), as is access to seasonally flooded lowlands or wet-gardens (Moris 1989; Longhurst 1986). Access to good quality land and alternative employment sources may be more important in determining the nutritional status of rural households than choice of crop (DeWalt et al. 1990). In Tanzania, absolute land scarcity did not exist in the study area, but fertile land, especially riverland which was used for cash crops, was very scarce; distribution of riverland was found to be an important indicator of inequality (van Hekken and Thoden van Helzen 1972, cited in Castro, Hakansson, and Brokensha 1981).

### 2.2.3 Indicators Related to Livestock

When using livestock as an alternative indicator, it is important

to consider the different roles of each animal (traction, investment, manure, dowry/bridewealth payments, etc.), the existence of alternative investments in the region, and the differential productive aspects within a particular category of livestock (Castro, Hakansson, and Brokensha 1981; Collinson 1981). In Niger, ownership of goats indicates storage of wealth, since they are kept primarily for their meat and resale value, and only secondarily for their milk (Swinton 1988). The ability to market livestock for grain commonly determines who will survive a famine and who will not (Shipton 1990). Donkeys and mules are highly valued in famines because they help travel (Shipton 1990). Therefore, whether animals were sold or offered for sale may be less important than knowing what kind of animals were offered for sale. In addition, the sale of male animals before their optimum weight or of female animals before the end of their reproductive period can both be interpreted as indicators of stress (White 1986).

Diversified herds with different pasture needs are less vulnerable to drought or infection than more homogenous herds that may produce more meat or milk (Colson 1979; Cutler 1986). The distinction should not be between which households own small versus large herds, but between households which own no animals at all and those which have at least some (de Waal 1988). Access to milk is indicated by having a female animal (de Waal 1988). Although cattle and sheep are also important in Niger, goats are the only species owned in significant numbers by women (Swinton 1988). Lack of access to resources within Ethiopian households, primarily oxen, has made women particularly vulnerable to drought (McCann 1987).

2.2.4 Indicators Related to Liquid Assets

Many poor households possess a wide variety of assets which, however marginal, are crucial to their survival, and knowledge about them is critical for understanding household economic behavior (Heyer 1989). Farm households in semi-arid environments habitually undergo cycles of asset depletion and replenishment: assets accumulated under favorable agricultural conditions may be sold, traded or mortgaged in less favorable conditions, acting as a form of insurance (Swinton 1988). The conversion of surplus food into durable valuables which can be reconverted into food during emergencies is an important coping strategy (Colson 1979), and possibly shelters wealth from the daily demands of sharing food with one's relatives (Shipton 1990; Shipton 1989). In addition to asset sales, other household coping strategies include recalling loaned animals, emptying granaries or bank accounts, calling in labor debts, and activating community support mechanisms (Swift 1989). Low asset status, both number and diversity, would therefore make good indicators of vulnerability (Chambers 1989; Swift 1989), but household reluctance to divulge the number of liquid assets may make this indicator difficult to collect (O'Brien-Place and Frankenberger 1988). Therefore, estimates of existence/nonexistence of resources at a critical period such as just prior to harvest may be more useful than actual amounts of assets; a variation of this is to ask whether an animal or jewelry or other asset has been sold within the last month in order to obtain food or grain (O'Brien-Place 1988).

Successfully surviving a drought depends upon a household's ability

to retain intact all its productive assets solely by cutting back on ceremonial forms of consumption and by liquidating nonproductive assets (Jodha 1978). It is important to distinguish between disposal of assets which are primarily forms of insurance/saving from sales of key productive assets (Corbett 1988), since disposal of productive assets makes poor people poorer (Chambers 1989). It is also important to determine a household's primary economic activity before attempting an analysis of its asset behavior. Some landless peasants in Tanzania actually owned tractors (which they hired out) and sewing machines (to work as tailors) (Pipping 1976, cited in Castro, Hakansson, and Brokensha 1981).

For consumer durables, a potential indicator may be whether a household has or does not have enough cooking utensils to avoid borrowing plates or pots regularly from relatives or neighbors (Lewis 1951). "A man is poor [in Indonesia] if he has to borrow a bicycle when he wants to go somewhere" (Soetoro 1979, cited in Honadle 1982). Bhattacharya et al. (1991) suggest that certain aspects of living conditions are much more conspicuous indicators of poverty than malnutrition: 50 percent of adult women in their purposive sample owned only one saree. Moreover, 75 percent and 90 percent of women did not own a blouse or petticoat, respectively. The same study found that 90 percent of households did not have any kind of bedding materials, and none had any blankets or quilts to use in the winter. All of these items make potential alternative indicators.

## 2.3 Proximate Indicators of Household Food Poverty

### 2.3.1 Indicators Related to Health

The main asset of most poor people is their bodies (Chambers 1989). Work-disabling accidents or chronic morbidity of household breadwinners are often the pivotal events which impoverish households, making them useful potential indicators (Corbett 1989; Pryer 1989). The cheapest way to prevent child malnutrition may often be to prevent adult sickness, and the most sustainable way to overcome the malnutrition of a child may often be to overcome the disability of an adult (Pryer 1989). Another potential indicator may be whether a household has recently had to defer any medical treatments or expenditures.

### 2.3.2 Indicators Related to Investments

The quantity and quality of a household's labor supply is influenced by investments, some of which are not normally recognized as "productive," e.g., investments in housing, education, health, and marriage (Heyer 1989). In India, the most common reaction to the periodic nature of rural incomes was not improving farming or storage, but investing money and effort into securing the best marriages for daughters, preferably into nonfarming families (Caldwell, Reddy, and Caldwell 1986). The building of marriage networks to nonagricultural incomes increases the importance of children's education in South India (Caldwell, Reddy, and Caldwell 1986). How recently a household moved to the study area is a possible indicator: non-Maasai farmers had weak

intra-family ties, and few reported having given or received help from relatives (Campbell 1984). Newly established domestic groups without established herds are especially vulnerable to famine in Africa (Shipton 1990).

Few households with one educated member starve, precisely because such people can more effectively activate claims for assistance from their local government or institutions (Swift 1989). Women's schooling, even after adjusting for income, has a higher elasticity of nutrient demand than those for household size or income (Behrman and Wolfe 1984). Secondary school enrollment ratios for boys and girls have been suggested as an indicator of household welfare (Anderson 1990). Even in countries with no school fees, the poorest households are often not able to raise the money necessary for uniforms, books or building funds (Castro, Hakansson, and Brokensha 1981).

Housing is one of the most visible and important indicators of inter- and intra-community wealth differences (Bhattacharya et al. 1991; Chambers, Longhurst, and Pacey 1981; Lewis 1951); the type, quality, and location of housing within the community are all important factors to consider (Castro, Hakansson, and Brokensha 1981). Other potential housing indicators include the number of rooms, the presence or absence of specialized rooms for cooking, storage or entertaining, whether livestock sleep within the dwelling, and a subjective assessment of whether the house appears to be in need of obvious repair (especially a leaky roof).

### 2.3.3 Indicators Related to Dietary Practices

Fluctuation in the consumption of the main staple food or in meal patterns are indicative of household food insecurity (Bhattacharya et al. 1991; Beck 1989; Taal 1989; Campbell and Trechter 1982; Oshaug and Wandel 1989; Galvin 1988). Fluctuation in daily rice consumption was found to be a more critical indicator of poverty than overall level of rice consumption (Bhattacharya et al. 1991). Declining household food consumption is part of a deliberate and early strategic response to recurrent food insecurity (Corbett 1988; Cutler 1984; Shipton 1990). Voluntary rationing of food consumption is undertaken across all income groups, not just by the poorest households (Dreze 1988, cited in Corbett 1988). Missing meals completely for an entire day was an important indicator of household food insecurity in Cameroon (Campbell and Trechter 1982), but in Chad and Mali, the number of meals per day was not found to be a useful indicator (Autier et al. 1989), and in India, missed meals did not necessarily imply lack of food due to frequent meal consumption outside the home at community functions (funerals, weddings, births, harvest celebrations) or at work (Bhattacharya et al. 1991). A dramatic reduction in the consumption of pulses was observed in India during the 1987 drought (Rao 1989). It might also be useful to monitor changes in sharing between families or households, a practice which often intensifies as the poorest run out of food (Shipton 1990). However, sharing becomes more discriminant as hunger grows (Shipton 1990).

Establishing the preferences for certain foods in the region, and

monitoring shifts from preferred to lower status foods may be a useful indicator of food insecurity. These shifts are normal occurrences in areas facing seasonal food deficits, but may also be one of the first strategies adopted by households anticipating stress (Ogbu 1973; Colson 1979; Cutler 1986; Caldwell, Reddy, and Caldwell 1986; Corbett 1988; Shipton 1990). Such foods include poorer plant products (such as broken rice grains), bulkier items (starchy tubers, or grain ground with stalks, husks, or bran), and unconventional foods (wild foods, insects or game). The importance and intensity of wild food use depends upon the severity and length of the food shortage, the location of the household with respect to areas in which wild foods grow, and available household labor to collect them (DeWalt 1983; Zinyama, Matiza, and Campbell 1990).

### 2.3.4 Indicators Related to Food Storage Practices

Asking farming households for estimates of how many months grain stores will last is simpler and possibly more reliable than asking for volume estimates of how much food is in storage (O'Brien-Place and Frankenberger 1988). The ability to store food postharvest and the availability of stored food preharvest are important indicators to monitor (Chambers 1989; Thomas et al. 1989). Four food storage options have been identified in the literature: technological (receptacles, granaries); social (food reciprocity, redistribution); environmental (livestock, wild plants, and animals); and biological (human reserves). Alternative forms of storage have different adaptive advantages and

limitations, and vary with respect to type (endogenous versus extra-somatic), form (high versus low convertibility), and social level (household, community, regional government) (Thomas et al. 1989). The number and quality of storage facilities or practices may be a potential indicator of wealth; rich men in Nigeria continued to prosper through financial manipulation such as selling stored grain when the prices are high (Hill 1972, cited in Castro, Hakansson, and Brokensha 1981). The presence or absence of protection devices around granaries to minimize animal and insect damage to stored foods could also be an indicator of food security (Thomas et al. 1989).

## 3. Preschooler Nutrition Security

### 3.1 Demographic Indicators of Preschooler Nutrition Security

#### 3.1.1 Indicators Related to Household Size/Composition

Household size is generally assumed to be inversely associated with child nutrition status (Wolfe and Behrman 1982; Stinson 1980). However, larger households often have older children and/or other older relatives whose productive inputs can positively affect child growth in terms of income or child care (DaVanzo 1984; Stinson 1980). In this light, household composition may be a more appropriate alternative indicator than household size. Being a child of the household head was found to have a positive effect on child height in rural Gambia (von Braun, Puetz, and Webb 1989). A large household can be a disadvantage to child

health and nutrition status during the early growth of the household (Stinson 1980). Children's nutrition is often worse with nonmaternal (particularly sibling) caretakers (McGuire and Popkin 1990).

### 3.1.2 Indicators Related to Age and Gender

Prevalences of male and female child malnutrition, on a global level, are generally similar (Carlson and Wardlaw 1990), but within specific countries or regions, especially South Asia, there is quantitative evidence of a sex bias in patterns of child nutrition, health care utilization, and mortality (Kielmann, Taylor, and Parker 1978; D'Souza and Chen 1980; Chen, Huq, and D'Souza 1981; Sen and Sengupta 1983; Senauer, Garcia, and Jacinto 1988). Chen et al. (1981) found pronounced sex differentials in the food and health care received by Bangladeshi children. Differences in child mortality by gender in India were partially explained by variations in kinship systems and female autonomy between the north and south (Dyson and Moore 1983). In Egypt, while the incidence of diarrheal diseases is similar for boys and girls, the magnitude of weight loss associated with such episodes is significantly greater among females, explained in part by differences in treatment provided to male and female children during illness (Tecke 1990). While sex was not found to be an important predictor of anthropometric outcomes in Nepal, boys had significantly greater hemoglobin levels than girls (Martorell, Leslie, and Moock 1984). Das Gupta (1987a) suggests that sex differentials by birth order in India are far stronger than those by socioeconomic status. In Sub-Saharan

Africa, where female labor participation in the agricultural sector is comparatively high, and where polygamy, bride wealth, and early marriage of females are predominant customs, the nutrition and health status of females vis-a-vis males is favorable (Svedberg 1990).

The prevalence of malnutrition is consistently highest during the second year of life, corresponding with the end of the weaning process when children are fed an "adult" diet (Akin et al. 1985; Strauss 1990; Carlson and Wardlaw 1990). The highest prevalence of stunting tends to occur in children between 18-48 months (Haaga et al. 1986). The weaning period and its immediate aftermath are less life threatening in Egyptian homes with higher levels of maternal education and higher incomes (Tecke 1990).

### 3.1.3 Indicators Related to Ethnicity and Region

Ethnicity has been found to be significantly associated with child nutrition status in Papua New Guinea (Shack, Grivetti, and Dewey 1990). Lower caste children die more frequently in rural India (Kielmann, Taylor, and Parker 1978), but caste was not found to be related to children's nutritional status in Nepal (Martorell, Leslie, and Moock 1984; Brink et al. 1976). The regional distribution of child malnutrition differs depending on the particular anthropometric indicator used (Carlson and Wardlaw 1990). Prevalence ratios of stunting in Peru showed marked variation across regions (Leon et al. 1990).

## 3.2 Factor Market Indicators of Preschooler Nutrition Security

### 3.2.1 Indicators Related to Income

The flow, content, and ownership of farm income may be more important to nutritional status of children than level of income (Babcock and Zalla 1984). A steady, although low, source of income throughout the year may have a greater effect on nutritional status than intermittent lump sums from end-of-season wages or sale of cash crops (Dewey 1981). Increasing household income through commercialization of semi-subsistence agriculture does not appear to have dramatic positive or negative impacts on children's nutritional status (DeWalt et al. 1990; von Braun and Kennedy 1986; Strauss 1990; Sahn 1990; Shack, Grivetti, and Dewey 1990). The relationship between maternal work and child nutrition is also complex. A child's nutritional status may influence a mother's decision to work, as well as a mother's work affecting the child's nutritional status (Carloni 1984). Children of women working outside the home had significantly greater dietary diversity in Panama (Tucker 1989). Children whose mothers worked part-time in Zimbabwe had lower risks of malnutrition than those whose mothers either worked full-time or on a casual basis (Mazur and Sanders 1988). In San Salvador, poor women preferred two part-time jobs to one full-time job in order to return home at lunch to breast-feed (Nieves 1979). Child mortality rates in Bangladesh and India were substantially higher in households whose members were employed in lower status occupations and who were poorly educated (D'Souza and Bhuiya 1982; Kielmann, Taylor, and Parker 1978).

### 3.2.2 Indicators Related to Land

The amount of land available to rural households is an important predictor of child nutrition status (Rawson and Valverde 1976; Valverde et al. 1977; McDowell and Hoorweg 1977). In Nepal, landholdings were found to be positively and significantly associated with almost all measures of nutrition status (Martorell, Leslie, and Moock 1984). Landowners and/or those cultivating large areas in India have taller and heavier children who consume more calories than children of agricultural laborers (Chernikovsky and Kielman 1977, cited in Pebley 1984). While ownership of land appears to be an important factor for diet adequacy, the physical size of the farm itself does not seem to affect the prevalence of malnutrition as much (von Braun and Pandya-Lorch 1991). For example, size of landholding did not have an appreciable effect on preschooler calorie intake in the Philippines, but having access to a threshold of at least one hectare of cultivated land did (Bouis 1991).

### 3.2.3 Indicators Related to Housing

The best predictor of child mortality in Bangladesh was floor area of the home (Chen, Chowdhury, and Huffman 1980; D'Souza and Bhuiya 1982). Bangladeshi children living in households without latrines also had significantly higher risks of mortality (D'Souza and Bhuiya 1982). A greater degree of stunting and wasting was observed in children of parents who lodged rather than owned formal housing in peri-urban Zimbabwe (Mazur and Sanders 1988).

## 3.3 Proximate Indicators of Preschooler Nutrition Security

### 3.3.1 Indicators Related to Morbidity

Growth of children in poor communities is strongly influenced by infectious diseases (Mata 1978, 1979; Chen and Scrimshaw 1983, Martorell and Ho 1984; Kennedy and Cogill 1987; Bouis and Haddad 1990), especially diarrheal diseases and malaria (Black et al. 1982). In the Gambia, acute lower respiratory infections (ARLI) were found to have more of an impact on child growth per episode than diarrhea, however, given the greater prevalence of diarrhea in the region, diarrhea resulted in over half of growth deficits compared to 25 percent for ALRI (Rowland et al. 1988). Measles has been associated with weight loss, especially in severely malnourished children (Mata 1978), but the expected anthropometric improvements in children immunized against measles are not always demonstrated (Greenwood et al. 1987, cited in Huffman and Steel 1989; Kasongo Research Team 1981; Holt et al. 1989). Children in Cote d'Ivoire suffered less malnutrition if they lived in villages where dysentery and malaria were not serious health problems (Sahn 1990).

### 3.3.3 Indicators Related to Birth

The relationship between birth order and child nutrition status is complex, and may be nonlinear. Much of the literature suggests that high birth order children are disadvantaged relative to earlier siblings, the main explanation being strain on family resources (Horton 1988). In addition, a higher proportion of children in the household is

likely to increase exposure of an individual child to infection, adversely affecting nutrition status (Tecke and Shorter 1984; Horton 1988). However, some studies have argued that middle children are the most disadvantaged, since the last-born children eventually receive additional resources as older children either leave home or begin to earn income (Horton 1988; Behrman 1988; Senauer and Garcia 1991). In the Philippines, higher birth order had more adverse effects on long-run than on current nutritional status, suggesting that parents at a single point in time seem to allocate resources relatively equitably among children of different birth orders, but that higher birth order children are born when per capita resources are smaller (Horton 1988). Short birth intervals contribute to higher risk of mortality due both to biological disadvantages of maternal depletion (low birth weight) and to between-child competition for care and calories (DaVanzo 1984). Stunting in an older sibling was found to be an predictor of stunting in a target sibling (next youngest) (Leon et al. 1990).

The relationship between mother's age at birth and child nutrition status may be an inverted U-shape, with young age reflecting maternal immaturing and old age associated with increased likelihood of birth defects. For example, babies born to Malaysian mothers less than 19 and older than 40 were more likely to die in infancy than other infants. In the USA, competition for nutrients between still-growing adolescent mothers and their developing fetuses resulted in significantly decreased birth weights (Scholl, Hediger, and Ances 1990).

### 3.3.3 Indicators Related to Breast-feeding

Although often treated as a dichotomous variable, breast-feeding should ideally be thought of as a continuum. Full or exclusive breast-feeding needs to be distinguished from supplemental breast-feeding (the weaning period), and supplemental breast-feeding has its own continuum that gradually (or sometimes suddenly) results in complete cessation of breast milk (Huffman and Lamphere 1984). Moreover, the frequency, duration, intensity of suckling, and whether night feeds occur all influence breast-feeding performance, making this variable difficult to use as an indicator. Continued breast-feeding, once other foods have been introduced into the diet, has been shown to be a determinant of child nutritional status, especially weight-for-age (Greiner and Latham 1981; Almroth and Latham 1982; Lambert and Basford 1977). In Bangladesh, breast-feeding children 12-36 months old had larger arm circumferences than those who were not breast-fed (Briend et al. 1988). However, prolonged breast-feeding in Nepal was associated with reduced stature and low hemoglobin values but greater fat stores (Martorell, Leslie, and Moock 1984). Due to the interactive effects of breast-feeding with certain socioeconomic factors, breast-feeding as an indicator should probably be used in combination with other indicators. For example, the health benefits from exclusive breast-feeding differed by mother's education level in the Philippines, with children of less educated mothers deriving the most gains from exclusive breast-feeding (Barrera 1990). In Malaysia, the connection between reduced breast-feeding and increased infant mortality occurred primarily among families

without adequate household sanitation and water supplies (DaVanzo 1984).

### 3.3.4 Indicators Related to Parental Education

In the developing world, there is overwhelming evidence of a negative relationship between levels of maternal education and child mortality (Mosley 1985; Caldwell 1979; DaVanzo and Habicht 1986; Ware 1984; Cochrane, Leslie, and O'Hara 1982; D'Souza and Bhuiya 1982; Borton and Shoham 1989), although the amount and type of education required to produce a significant reduction in mortality varies from culture to culture (Ware 1984). Even quite low levels of maternal education have been shown to be associated with improved infant and child survivorship probabilities in Nigeria, without any increased in income or public health provision (Caldwell 1979). Palloni (1981) showed that the relative advantage of mother's education to child survival in Latin America is contingent on the social circumstances of the community in which she lives. The large and significant impact that maternal education had on child height in Northeastern Brazil was explained by indicators of access to information such as reading papers, watching television and listening to the radio (Thomas, Strauss, and Henriques 1989).

## METHODOLOGICAL CONSIDERATIONS

While some of the indicators discussed above, such as maternal education or migration, would not normally be considered "alternative", it is the way these variables have been used and interpreted in the

recent literature which makes them potential alternative indicators. To reiterate, whether an adult male has migrated may be less indicative of household food insecurity than whether that migration took place during the time of year of greatest opportunity costs of an absent able-bodied adult. Likewise, low levels of maternal education may not predict preschooler nutrition insecurity by themselves, but when combined with other carefully chosen variables such as exclusive breast-feeding, the effect on child survival in certain contexts may not be so negative.

Looking at "traditional" socioeconomic variables in new ways is what makes some of these indicators "alternative." Contributions from a variety of disciplines, including anthropology, early warning systems, medical geography, farming systems research, and rapid rural assessment (also referred to as participatory rural appraisal), have resulted in many innovative approaches to identifying the food and nutrition insecure. One of the underlying themes in each of these approaches is the emic perspective, or the insider point of view, in which the perceptions and knowledge systems of the study population are used to identify the most culturally relevant variables and to refine their definition for research purposes. The most sensitive and specific alternative indicators will be those that have been identified and ranked by food insecure people themselves, whose own culturally-established standards of living are likely to be very different from "western" ideals (Chambers 1989; Castro, Hakansson, and Brokensha 1981). The whole concept of sustainable food and nutrition monitoring programs may well rest on the choice of alternative indicators which are relevant to the target population.

A certain amount of time and energy must therefore be set aside at the beginning of research to attempt an emic understanding of the problems of food and nutrition insecurity so that the most appropriate alternative indicators can be chosen for monitoring. This will be greatly facilitated by the principles of rapid rural assessment (RRA) and a recent offshoot of RRA called participatory rural appraisal (PRA); in both, respect for and rapport with villagers is paramount (Chambers 1990). As a semi-structured process, PRA relies on a variety of innovative techniques to learn from, with, and by rural people about rural conditions. Two PRA techniques have proven particularly useful for identifying those households and individuals most vulnerable to food and nutrition insecurity. These include participatory mapping (in which villagers draw maps on the ground with sticks, colored powders, stones, and seeds to rapidly locate each household, often identified by different colors for different castes or relative wealth) and seasonal analysis (in which histograms are constructed using 12 stones for each month, under which smaller stones or seeds are placed to tally the number of days of rain, number of days of agricultural labor, or average food availability, etc., per month). Illiteracy appears to be irrelevant for either technique (Chambers 1990).

Another innovation which shows promise for alternative indicators is the use of ranking and scoring instead of direct measurement. This is especially important when collecting information on sensitive topics such as income or wealth. People are often keenly aware of local wealth differences, and they may be able to point out specific indicators of

these differences in their community (Castro, Hakansson, and Brokensha 1981). People may feel more comfortable discussing relative values of wealth than revealing estimates of absolute wealth for themselves or their neighbors (estimates which are often distorted anyway). Wealth ranking is thus an ingenious and simple method of eliciting relative wealth or wellbeing in a community (Chambers 1991). A related method is informant ranking, in which a small number of community members are asked to rank local households according to their socioeconomic standing (Castro, Hakansson, and Brokensha 1981), or to rank them according to their differential ability to withstand some crisis, such as a poor harvest or a seasonal food shortage (Hill 1972, 1977 cited in Castro, Hakansson, and Brokensha 1981). For example, a group of knowledgeable elders in Northern Nigeria was asked to rank subjectively the standard of living among different farming households, resulting the following four classifications: 1) actively assisting others with gifts and loans; 2) neither suffering nor helping; 3) suffering somewhat; and 4) suffering severely. These subjective rankings correlated well with socioeconomic data collected by the author (Hill 1972, cited in Castro, Hakansson, and Brokensha 1981).

Subjective assessments of other phenomena also can be used as alternative indicators. As mentioned above under Regional Food Shortages, farmers' answers to questions such as "Are the harvests expected in your area better than, equal to or worse than last year?" or "Does the rainfall seem sufficient, not quite sufficient or very insufficient for this year's crops?" are easily collected and, according

to some authors, are often quite accurate assessments of the qualitative state of agricultural and climatic conditions (Autier et al. 1989). As part of India's 38th round of the National Sample Survey, a single probing question was asked at the end of detailed expenditure survey regarding the adequacy/inadequacy of their habitual consumption. The estimates from the self-expressed opinions and from the more complicated expenditure data were very similar for rural areas, but differed significantly for urban areas (Minhas 1990). This type of qualitative assessment deserves more attention as a rapid monitoring tool.

# APPENDIX 2

## VARIABLE LABELS

### Variable Labels: Brazil

| | |
|---|---|
| AGECH | age of preschooler in months |
| AREASHAR | area sharecropped |
| CL84 | 1-coffee 2-corn 3-dairy 4-off-farm L Y 5 |
| DEPRATIO | DR 1e15/gt15, 24hr |
| DFGT15 | females gt 15, % of hh |
| DFLT15 | females lt 15, % of hh |
| DGT15 | alls gt 15, % of hh |
| DIST | dist (kms) from municipio |
| DLT15 | all lt 15, % of hh |
| DLT6 | all lt 6, % of hh |
| DMGT15 | males gt 15, % of hh |
| DMLT15 | males lt 15, % of hh |
| EDUCFHOH | Education of female hoh |
| EDUCMHOH | Education of male hoh |
| FOODS | Number of foods in 24hr |
| GENDHOH | Gender household head |
| HCALADEQ | Household caloric adequacy |
| HHDTYPE | 1(m=0,f>0)2(m>0,f=0)3(m=1,f=1)4(m=2,f=2) |
| HHID | farm hhid |
| HHINCPC | HH income/capita |
| HHSIZE | HH size at 24 hr recall |
| ID | child id |
| ILLIT | 1=either m or f hhh illit |
| LANDPC | Land used per capita |
| LDLESS | 1=farm area is all shrecrppd |
| NPRESCH | number of preschoolers in hh |
| PFINC | female income as % totinc |
| PINCAG | agric income as % of totinc |
| PINCLIVE | livestock income as % totinc |
| PINCOFA | Off-farm ag inc as % totinc |
| PINCOFNA | Off-farm non-ag as % totinc |
| POTHOFF | Other off-farm inc as % totinc |
| PTOTOFF | Off-farm as % totinc |
| PTOTON | On-farm inc as % totinc |
| SEXCH | sex of preschooler: 1-male, 2 female |
| SOURCES | Number of income sources |
| TOTEXPC | Total HH expenditures PC |
| ZHA | ZHA |
| ZHA2SD | 1 if ZHA < -2 |
| ZWA | ZWA |
| ZWA1SD | 1 if ZWA < -1 |
| ZWH | ZWH |
| ZWH1SD | 1 if ZWH < -1 |

## Variable Labels: Bukidnon

| | |
|---|---|
| ACCAGE | accurate age of individual in months |
| AGEWEAN | age when wean foods first given |
| AROWNDPC | hectares owned per cap |
| AVNETWPC | net worth of all hh assets per cap |
| BFEDDUM | 1-breastfed, 0 not |
| BIRTHORD | birthorder of child |
| CULTARPC | area cultivated per cap |
| DAREABGT | 1-land bought in previous 16 months |
| DAYSICK | daysick in past 14 days |
| DBACKYRD | 1 if >10% of income from bkyrd prodn |
| DDURASET | 1 if at least one durable asset owned |
| DELECT | 1 -electricity, 0 not |
| DEMF05 | pct FEM 0-5 in HH |
| DEMF1117 | pct FEM 11-17 in HH |
| DEMF511 | pct FEM 5-11 in HH |
| DEMFGT17 | pct FEM GT 17 in HH |
| DEMM05 | pct MALE 0-5 in HH |
| DEMM1117 | pct MALE 11-17 in HH |
| DEMM511 | pct MALE 5-11 in HH |
| DEMMGT17 | pct MALE GT 17 in HH |
| DFLOOR | 1 - improved floor, 0 not |
| DFRMASET | 1 if at least one farm asset owned |
| DIAR | 1 - diarrhea reported past 14 days |
| DNCROPS | 1-more than 2 crops grown |
| DRATIO | dependency ratio |
| DROOF | 1 - improved roof, 0 - not |
| DTOILET | 1-improved toilet facilities |
| DWALL | 1 - improved wall, 0 - not |
| DWATER | 1-improved primary water source |
| FATAGE | fathers age |
| FATED | years of fathers educ |
| FEMGTMLE | 1-more males than females in hh |
| FOODEXPC | food expend per cap |
| FOODSHRE | pct of total exp per cap on food |
| HHADEQ80 | 1-2-3 dummy cal adeq |
| HHADQRAT | hh calorie adequacy ratio |
| HHID | household id |
| HHTOT | hh size |
| HOMEFOOD | pct of value of food cons from home prod |
| ID | INDIVIDUALS ID NUMBER |
| MOMAGE | mothers age in years |
| MOMED | years of mothers educ |
| MOMNUTKN | mothers nutrtn knowldg |
| NBFG1 | # of food items cons-rice |
| NBFG2 | # of food items cons-corn |
| NBFG3 | # of food items cons-other cereals |
| NBFG4 | # of food items cons-meat |
| NBFG5 | # of food items cons-vegetables |
| NBFG6 | # of food items cons-fruit & dessert |
| NBFG7 | # of food items cons-other |
| NRECIPE | av number of recipe lines/hh |
| NUQBFG | av no of unique broad food groups |
| NUQFCT | av no of unique FCT codes presented |
| NUQFG | av no of unique food groups (PILOT) |
| OFFFSHRE | pct of income from off-farm sources |
| OWNFSHRE | pct of income from own-farm prodn |
| PARITY | number of pregnancies |
| PCALAEQ | preschooler calorie intake/adult eqv |

| | |
|---|---|
| PRCHFOOD | pct of value of food cons from purchases |
| RELTOHOH | 3 if son, 4 if daughter of hoh |
| SEX | sex; 1=male, 0=female |
| STOPBFED | age (mo) when breastfeeding stopped |
| TNINGRED | total number of fct lines |
| TNOKID1 | kids moved + died + miscarriages |
| TOTEXPPC | total expend per cap |
| YCORRPC | total income per cap |
| YSOURCES | number of income sources |
| ZHA | z-score, height for age |
| ZHA2SD | 1 < -2 zha, 0 not |
| ZWA | z-score, weight for age |
| ZWA2SD | 1 < -2 zwa, 0 not |
| ZWL | z-score, weight for height |
| ZWL2SD | 1 < -2 zwl, 0 not |

# Variable Labels: Ghana

| | |
|---|---|
| AGE | age in months |
| AGEHED | age of hoh |
| BALANCE | 1 m>f in hh, 2 m=f, 3 f>m: gender balance |
| CALQ_DPC | hh calorie intake/day/cap |
| CHLVAC | 1- CHILD VACCINATED 2-no |
| CLUST | hh cluster number |
| DAYSIKID | NO OF DAYS ILL: kid |
| DAYSIMOM | NO OF DAYS ILL: mom |
| DEM06 | pct of hh 0-6 yrs |
| DEMF1559 | pct hh fem 15-59 yrs |
| DEMFGT60 | pct hh fem > 60 yrs |
| DEMFLT15 | pct hh fem < 15 yrs |
| DEMM1559 | pct hh male 15-59 yrs |
| DEMMGT60 | pct hh male >60 yrs |
| DEMMLT15 | pct hh male < 15 yrs |
| DEPRATIO | dependency ratio: n lt 15/n ge 15 |
| DFEMED | at least one fem in hh with at least pri |
| DFFHOH | de facto fem head; husb > 6 mon from hom |
| DFOREST | 1 if forest aez, 0 not |
| DILLKID | kid ill/injured in last 4 weeks: 1-yes |
| DILLMOM | mom ill/injured in last 4 weeks: 1-yes |
| DJFHOH | de jure female headed; widowed, separate |
| DMALEED | at least one male in hh with at least pr |
| DOFFSHOH | 1-if child offsp of hoh, 0-not |
| DSAVANNA | 1 if savanna aez, o not |
| DTOILET | 1-toilet used, 0-no toilet |
| DUMWATER | 1- imprv drinking water source |
| DURBAN | 1 if urban, 0 o/w |
| ELEC | 1-electricity 0 o/w |
| FHOH | 1 female hoh |
| FOODSHRE | food exp per cap/total exp per cap |
| HCALADQG | hh cal adequacy group |
| HEDMATH | 1-hoh can do maths |
| HEDREAD | 1-hoh can read |
| HHCALADQ | hhcal adequacy ratio |
| HHSIZE | hh size |
| HID | HOUSEHOLD ID |
| HT | height in cm |
| LANDOWNG | 1-lanowpc=0, 2- 0.1-1 3- 1-10 4- >10 |
| LANDOWPC | acres of land owned pc |
| LCBF | BREAST FEED LAST CHILD? 1-y 0-n |
| MLCBF | months last child bfed:sysmis if curr bf |
| NCRPCULT | number of crops cult/12 mo |
| NDURGDS | no. of durable goods listed /17 |
| NFOODGP | no. of 6 broad food grps prch or prd by |
| NLVEBRTH | number of live births |
| NPREGBAD | TOTAL NUMBER OF interrp PREGNANCIES |
| NVEHCVPC | value of non-vehicle capital pc |
| NWVESHOH | number of wives |
| NYSOURCE | number of income sources |
| OCCGRP | main job clss,12mo,hoh:1-1ery 2-2ery 3-3 |
| ORDCHL | birth order of child |
| PARITY | number of live births+interr preg |
| PCOCOACR | pct of acreage to cocoa cultv |
| PCTREM | percent income from remittances |
| PID | PERSON ID |
| REGION | region: 10 administrative regions |
| ROOMSPC | number of rooms in hh per cap |

| | |
|---|---|
| RRPCTEXP | per capita total exp |
| SBFLC | STILL BREASTFEEDING LAST CHILD? 1-y 0-n |
| SEX | 1-male 0-female |
| TNFOODCD | no. of 62 unique foods purch or prodc |
| VEHICVPC | value of vehicles pc |
| VLIVESPC | value of livestock per cap |
| WID | ID NUMBER OF FERTILE WOMAN |
| WT | weight in kg |
| ZHA | zscore height for age |
| ZWA | zscore weight for age |
| ZWL | zscore weight for height |

## Variable Labels: Luzon

| | |
|---|---|
| ADEQNUTR | 1-think hh food for adeq nutr 0-ow |
| AGEMONTH | age in months |
| AGEWEAN | age (mo) when first non-milk foods intro |
| BIRTHORD | birth order |
| BUYFOOD | 1 -wife usually buys food, 0 -o/w |
| CHCREF | time spent in child care - female |
| CHCREM | time spent in child care - male |
| CULTAREA | sum of all land cult: intercrp poss negl |
| DAVMLNRC | 1 if on av, hh membs miss n-rstr meal,un |
| DBACKYD | 1-cultivates crops in home gdn |
| DCFUEL | 1 if cooking with imp fuel (not wood) |
| DEMF05 | % of hh females 0-5 age |
| DEMF0515 | % of hh females 5-15 age |
| DEMF1560 | % of hh females 15-60 age |
| DEMF60 | % of hh females >60 age |
| DEMM05 | % of hh males 0-5 age |
| DEMM0515 | % of hh males 5-15 age |
| DEMM1560 | % of hh males 15-60 age |
| DEMM60 | % of hh males >60 age |
| DEXPDUR | 1 if some exp on hh durable (radio etc.) |
| DHA | pct of ht for age < 90 |
| DIARRHEA | 1 if diarrhea 0 o/w |
| DLIVSTCK | 1 if some livestock cultivation |
| DLOWNER | 1-owns some farm land, 0 not |
| DNCORNGD | 1-n unique corn items purch >7 out of 11 |
| DNFDGRP | 1-n foodgrp purch >11 (out of 16:file3) |
| DNUTRED | 1 if mom has had some specific nutr ed |
| DOCCHOH | 1- hoh > 30 % of time in farming |
| DOMWKF | time spent in domestic work: females |
| DOMWKM | time spent in domestic work: males |
| DRATIO | depend ratio: 0-15/>15 |
| DTOILET | 1 if improved toilet |
| DUMEDHOH | 1 if hoh has at least some high schl ed |
| DUMEDSPS | 1 if spouse at least some high schl ed |
| DURBAN | 1-urban, 0 rural |
| DWA | pct of wt for age < 80 |
| DWATER | 1 if piped water source |
| DWH | pct wt for ht <80 |
| FEOPCT | pct food exp, other |
| FEPC | food exp per cap |
| FEPPCT | pct food exp, purchased |
| FEVER | 1 fever, 0 o/w |
| FISHBUY | 1- wife usually buys fish |
| FOODACCS | 1 mentd food purch as it is accessble |
| FOODAVAL | 1 mentd food purch as it is availble |
| FOODCONV | 1 mentd food purch as it is convenient |
| FOODHABT | 1 mentd food purch as it is familiar |
| FOODINEX | 1 mentd food purch as it is inexpen |
| FOODLIKE | 1 mentd food purch as it is tasty |
| FOODNUTR | 1 mentd food purch as it is nutritious |
| FOODSHRE | food budget share |
| GENDHOH | gender of household head: 1-male 2-femal |
| HA | pct height for age |
| HCALADQG | hhcal adq group |
| HEIGHT | height in centimetres |
| HHCALADQ | hhcal adequacy |
| HHCALPC | hh cal intake per cap |
| HHCALRDA | hhcal requirements |

| | |
|---|---|
| HHID | hhid |
| HHINC | hh income |
| HHTOT | hh size |
| MCALPUR | food exp cals purchased |
| MCALTOT | food exp cals total |
| MEATBUY | 1- wife usually buys meat |
| MKTPRDNF | time spent in market prdn, female |
| MKTPRDNM | time spent in market prdn, male |
| NUMKIDBO | number of kids used in birthorder calc |
| OTHBUY | 1- wife usually buys other items |
| PCTFARMY | pct of hh income from farming |
| PCTNFRMY | pct of hh income from small business |
| PCTNONLY | pct of hh income from non-labour income |
| PCTWAGEY | pct of hh income from wage/salary |
| PFINC | proportion of hh income from females |
| RICEBUY | 1- wife usually buys rice |
| ROOMS | number of rooms in hh |
| SEX | 1-male, 0-female |
| TEPC | total exp per cap |
| TERHCALP | tercile hhcal cons per cap |
| USEOIL | 1 if mother uses cook oil in child food |
| WA | pct weight for age |
| WEIGHT | weight in kg |
| WHCHFOOD | who decides which food to buy-1 wife |
| WHOFOOD | 1-wife decides how much spend on food |
| WHONFOOD | 1-wife decides how much spend on non foo |
| XTRAFOOD | how much of an xtra 100 pesos on food? |
| XTRANFD | how much of an xtra 100 pesos non food |
| YPC | hh income per cap |
| YSOURCES | number of hh income sources |
| ZHA | z score ha |
| ZWA | z score wa |
| ZWH | z score wh |

## Variable Labels: Mexico

| | |
|---|---|
| AGEPRSCH | age of preschooler |
| D0717 | pct of family between 6 and 17 years old |
| DBFED | 1-breastfed |
| DEPRATIO | dependency ratio |
| DFLOOR | 1-improved floor |
| DGT18 | pct of family greater than 17 years old |
| DLT6 | pct of family less than 6 years old |
| DROOMS | 1-more than 3 rooms |
| DSANITAT | 1-improved sanitat |
| DWATER | 1-improved water |
| FAMSIZE | family size |
| HHASCADQ | hh ascorbic acid adequacy |
| HHCALADQ | hh cal adequacy |
| HHFEADQ | hh iron adequacy |
| HHID | hh id |
| HHINCWPC | hh income per week/cap |
| HHPRADQ | hh protein adequacy |
| HHRETADQ | hh retinol adequacy |
| PSASCADQ | preschooler ascorbic acid adeq |
| PSCALADQ | preschooler calorie adeq |
| PSCALGRP | preschooler calorie group |
| PSFEADQ | preschooler iron adeq |
| PSFEGRP | preschooler iron group |
| PSPRADQ | preschooler protein adeq |
| PSRETADQ | preschooler vit a adq |
| PSRETGRP | preschooler vit a group |
| SEXPRSCH | sex of preschooler |
| YRSCHDAD | yrs of education father |
| YRSCHMOM | years of education mother |
| ZHA | z-score height for age |
| ZHA2SD | z-score height for age <-2 |
| ZWA | z-score weight for age |
| ZWA2SD | z-score weight for age <-2 |
| ZWH | z-score weight for height |
| ZWH2SD | z-score weight for height<-2 |

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