Nutritional Status Indicators

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NUTRITIONAL STATUS INDICATORS:
THEIR USE IN APPLIED AGRICULTURAL DEVELOPMENT

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INTRODUCTION

Although applied agricultural development has as its goal an improvement in the human food supply, it is only in the last decade that attention has been paid to ways in which nutritional considerations can be incorporated into the design and evaluation of agricultural and rural development projects (1-5). At the small-farmer level of focus, it has become appreciated that unless the food consumption pattern and nutritional well-being of the families who are the major producers of food are protected, they may not benefit - and may even suffer - from agricultural development efforts even if these programs achieve their primary goals of increased agricultural production and income. At a policy level, the effects of agricultural and economic decisions on the health and nutritional status of the poor is beginning to receive attention not only for humanitarian motives but from an recognition of the real effect of inadequate food supply and poor health on sustained economic development (6, 7).

Even though consciousness has been raised, there remain significant methodologic and managerial challenges. Much research and dissemination of information is needed before we will be able to assume the routine incorporation of nutritional concerns into the planning of agricultural development efforts. Agricultural development efforts which focus on the individual farm family and utilize the knowledge and resources available to
the farmer are in a position to lead in this area, because by
definition they have a household as well as a production focus.

**APPROPRIATE NUTRITIONAL GOALS**

Incorporating nutritional goals into the design of
agricultural research and extension projects means the inclusion
in project objectives of direct improvements in human food
consumption or nutritional status, and the provision of
mechanisms for accomplishing that goal and/or mechanisms for
project evaluation on the basis of impact on food consumption or
nutritional status (8).

When nutritional goals are made explicit in the context of
agricultural projects, the outcome measure reflects the health
and well-being of the community. Nutritional status is a
sensitive measure of overall quality of life for populations at
risk of malnutrition. Food consumption patterns not only provide
insight into potential pathways for nutritional status impacts
but also, when interpreted in appropriate cultural context, give
us a measure of how well people feel they are doing. If
households state that they would not change their diets if they
had more money available, we have a good sense that they are
enjoying nutritional security in this fullest sense. If they
state that they would purchase more of their current diet, given
more money available, we have a clear idea that families are
vulnerable to insufficient food availability. If they would make only qualitative changes in their diets based on prestige or perceived nutritional adequacy, we can conclude that there are perceived needs even though total food is likely to be adequate. Especially when combined with an objective measure such as the amount of food available in storage, such a question will quickly identify those households which are most vulnerable to potentially worsening conditions.

From the standpoint of the goal of nutritional improvement, only improvements in the diets of households which currently include malnourished individuals or those at significant risk of malnutrition are of interest (1). This basic fact has major implications for project design. If malnourished or at-risk households are not included in agricultural development projects, or are selected out by the sampling design or criteria for participation, the impact of the program on their health is unlikely to be evaluated. While data on nutritional impact of agricultural development projects on farm families are scarce, even scarcer is information on the impact on other families in the community who may be nonparticipants in the development intervention. Baseline data collection and evaluation strategies need to focus on families which are malnourished or at risk of malnutrition, since they are the only ones who will benefit from nutritional improvements. Attention to this consideration can yield gratifying results. An example is the improvement in
anemia rates in school children from an entire community after a successful development project which focused on household-based poultry production (9).

We should not forget that an appropriate nutritional goal may be to prevent deterioration in food consumption or nutritional status, particularly when the agricultural change involves a shift to heavier reliance on fewer crops or on the cash economy for the household food supply. When this is the goal, the design of data collection and analysis also must be appropriate. That is, baseline data must identify the least nutritionally secure families, and followup should focus on their well-being.

Farming households and the communities which contain them are complex systems. Assessment of the state of the community should include not only agricultural problem diagnosis but also data which will enable the understanding of the health and nutritional condition of the population and its component groups. When agricultural innovations are designed specifically to alleviate nutritional problems they can be evaluated in terms of their impact on these problems. When the nutritional situation is relatively adequate, the appropriate goal is to prevent deterioration in nutritional status with agricultural change. Accordingly, risk factors for developing malnutrition in the community need to be identified and minimized, with the goal of keeping the community healthy and well-nourished.
WHY HAVE NUTRITIONAL STATUS INDICATORS NOT BEEN USED MORE OFTEN TO EVALUATE THE IMPACT OF AGRICULTURAL DEVELOPMENT?

Recent attention to the role of nutrition in agriculture has included major focus on the linkages between production and consumption and on economic indicators of food consumption on the community level (4). These foci are important and appropriate, since economic indicators are widely available and since the linkages between production and consumption provide the pathways through which agricultural changes can operate to bring about changes in consumption. However, there has been a general lack of attention to direct measures of nutritional status and dietary intake within agricultural projects, except when part of internal subprojects specifically targeted to nutritional interventions (such as supplementary feeding programs). Failure to measure food intake or nutritional status precludes accurate targeting or documentation of impact in terms of stated goals of nutritional improvement. Why have dietary intake and nutritional status measures been so conspicuously absent from the literature on agricultural development?

One possible reason is that nutrition may be perceived widely to be the proper concern of the health sector, and agricultural planners and project implementors may not believe they have the competence to deal with them; or they may be reluctant to tread on the bureaucratic territory of other sectors. A second possibility is that the measurement of nutritional status
and of dietary intake may be perceived to be too costly, complex, or difficult to interpret. This perspective may arise from casual exposure to classical methods of nutritional assessment rather than to the application of simple field methods. Both of these concerns can be addressed by careful selection of measures and information on their interpretation, and by development and dissemination of appropriate technology and methods.

A third possible reason is the unconscious or overt assumption that improvement in agricultural production will automatically improve the food supply of rural households, and thus nutritional status. It is clear that this relationship is not unidimensional or straightforward, and varies under differing social, ecological and agricultural conditions (5).

A fourth and final constraint to enthusiastic incorporation of nutritional status measures into agricultural planning is based on realistic assessment of the possible outcomes. Knowing that many factors other than food consumption affect nutritional status (such as infectious disease burden) and knowing that many factors other than agricultural production affect food consumption (such as intra-household distribution patterns), project planners sense the possibility that reliance on food intake or nutritional status measures will give falsely negative evaluations or impressions of the impact of agricultural changes. (The possibility of false positives is less alarming to project planners for obvious reasons). The challenge, then, is to develop guidelines and methods which clearly elucidate the nature
and causes of malnutrition in a community or an area, in order to set reasonable goals. We need to understand the sensitivity and specificity of indicators for various types of malnutrition in the community under different circumstances, in order to be able to predict the impact on community health of effective intervention.

USES OF NUTRITIONAL STATUS AND DIETARY INTAKE INDICATORS

There are three major uses of nutritional status and dietary indicators in the context of farming systems research: for targeting purposes, for guidance in the selection of interventions, and for project evaluation.

Targeting

Identification of malnourished households (households containing malnourished members or persons at risk of developing malnutrition) allows design of projects so as to ensure their inclusion. When program participation is not targeted, it is often the case that the farm households with the least resources and thus the least ability to risk a new strategy are the least likely to participate. Knowing who is malnourished also enables efficient design of subsequent data collection strategies, since there is little need to follow the food consumption patterns or nutritional status of these not at risk of malnutrition.

Selection of Interventions

Knowing who is malnourished can provide insight into the potential effects of alternative intervention strategies. Urban and non-producing rural households are most sensitive to prices.
Producers who also consume are less sensitive to prices, but more sensitive to the mix of crops produced and the changes in labor demands and time allocation which may follow on particular interventions. The nutritional status of children in rural households may deteriorate if changes bring about increased demands for time and labor for their mothers.

**Project Evaluation**

Knowing who is malnourished or at risk of malnutrition provides the basis for efficient, targeted evaluation of nutritional impact. There is no need to collect data on those for whom nutritional improvement cannot be measured, or on those whose resources buffer them for potential adverse effects of agricultural changes.

**SELECTION OF NUTRITIONAL STATUS AND DIETARY INDICATORS**

In this paper, we refer to nutritional status indicators as those measurements which reflect physical, biochemical, or functional characteristics of the individual and the population which are dependent on nutritional status; dietary indicators refer to pieces of information which reflect the quantitative or qualitative adequacy of diets of individuals. We exclude, for the purposes of this presentation, measures of household food consumption or use, although recognizing their importance in the assessment of nutritional linkages with food production.
The following presentation will be organized in three sections, reflecting the three major types of malnutrition which are most prevalent in the world today: protein-energy malnutrition, iron deficiency, and vitamin A deficiency. This organization does not imply that other types of malnutrition are not important. Iodine deficiency, rickets, pellagra, and other types of malnutrition exist in limited geographic and socioeconomic areas of some countries, and where they are prevalent they should be identified and followed with appropriate indicators. But the three types of malnutrition mentioned here account for by far the most prevalent forms of nutritional deprivation on a worldwide basis. Within each section, we will present examples of indicators appropriate for several types of assessment: initial reconnaissance to determine whether malnutrition is present in an area or community; rapid assessment to determine the basic extent, severity and epidemiological characteristics of malnutrition; and evaluation of the effects of changing conditions, including those of planned interventions.
Protein-Energy Malnutrition

Protein-energy malnutrition (PEM) is the commonest form of malnutrition and the only one which reflects directly the quantitative aspects of the diet in relation to requirements. Where there is high prevalence of PEM, there is increased risk of infant and child mortality (10) and of increased morbidity burden (11).

Where the staple grain or root crop is in short supply, PEM will manifest itself among those individuals and families most vulnerable to shortage. When PEM is seen in adult members of the population, total food availability is almost always problematic. The converse, however, is not true; when PEM is seen in children there are many potential causes including maladaptive infant feeding patterns and/or high burdens of infectious disease. PEM is most easily seen and measured in children; however, this should not lead us to ignore the potential effects on adults of chronic or seasonal shortages of food relative to requirements. Not only may the food supply be seasonally short (12) but when physical labor demands are seasonal a steady but marginal food supply may be seasonally inadequate for agricultural laborers even when there are no demonstrable production or market shortages (13).

Reconnaissance. Of all types of malnutrition, PEM is the type about which there is most likely to be existing data which may be enlightening. Infant mortality rates (the number of deaths up to age one year per 1000 live births) reflect both
malnutrition and infectious disease burdens; where they exceed about 35/1000 it is a clear indication that malnutrition may be a problem. Mortality rates in the age group from one to four years are also informative, but harder to come by. If available, data on cause-specific mortality can also be informative. Deaths due to diarrheal disease are commonly associated with malnutrition, and in areas where 50 percent or more of childhood and infant deaths are associated with diarrhea, it is a clear indication that malnutrition is endemic. When evaluating infant mortality rates, it is important to attend to the system of registering both births and deaths. If underreporting affects numerator and denominator equally, the net bias will be quite different than if deaths, but not births, are underreported. Data on weights and/or heights of children may exist in a variety of forms; clinic records, school records, and nutritional status surveys may be sources of information which can give a general notion of body size of children relative to international norms, which is the commonest measure of PEM prevalence and severity. It may be necessary to convert these data relative to current reference standards.

Indirect observations such as obvious malnutrition of farm and domestic animals, and lact of food in storage, give clues to nutritional marginality in communities and families. The presence of overt, visible malnutrition in a population is an obvious sign, but the absence of such observations should not be overinterpreted. Often, the sickest and most malnourished
children are secluded at home and are least likely to be seen by a casual or even a fairly systematic observer. And in most situations of chronic undernutrition, the commonest manifestation is in stunting (low height for age) of children; with weight-for-height relatively appropriate, children may look quite normal unless their ages are known. Clinically obvious malnutrition is an ominous sign on a community level; however, without further information it does not tell the observer whether the situation is deteriorating or improving. When the opportunity exists for interviews or examinations, the direct measurement of midarm circumference is relatively easy and cheap; if a large enough and representative sample can be had, arm circumference can give an indication of the severity and distribution of acute undernutrition. Questions about seasonal shortages of food and about weaning patterns can be incorporated into rapid reconnaissance surveys as well.

**Rapid Assessment.** A relatively rapid and informative picture of the types and distribution of PEM in a community can be had with a cross-sectional survey of children. The minimal data to be collected are weight, height or length, and age. Considerable effort needs to go into sampling design, into the assessment of age, and into quality control for the weight and height measurements. Data must then be interpreted relative to standard reference populations, a task which has been made considerably easier in the last few years by the availability from the Centers for Disease Control (Atlanta, GA) of
microcomputer software for conversion of weight, height, and age
data into Z-scores, percentiles, and percent of median of the
reference population of children which has been adopted for
international use.

The combination of these measures can give a rather detailed
insight into the nutritional situation, and point to the most
likely causes and the linkages which should be explored. Table I
summarizes the major causes of childhood malnutrition by the
characteristics which can be derived from these few measures.
These characteristics are whether the predominant form of
malnutrition is acute or chronic; the age range most affected; and
whether it clusters in household or larger geographic units.

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<th>CHARACTERISTICS OF MALNUTRITION</th>
<th>MOST LIKELY CAUSES</th>
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<tr>
<td>Peak incidence in first six months of life</td>
<td>Maternal poor health and/or nutrition, resulting in high rates of low birthweight and/or inadequate lactation; babies not breastfed, or weaned early from the breast</td>
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<tr>
<td>Acute, peak incidence between 6 and 12 months of age</td>
<td>Sudden weaning from the breast with no adequate substitute</td>
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<tr>
<td>Acute and severe, any age during and after illness;</td>
<td>Extreme withholding of food; sudden separation from mother (e.g., maternal death);</td>
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Chronic, clustered in households (i.e., some households have every child malnourished, others relatively free of malnutrition)

Chronic, not clustered in households

Sudden food shortage (natural or other disaster) lasting more than a few weeks

Absolute resource limitations in poor households (income, food, water); infectious disease burden much greater in some households due to crowding, lack of water or sewage disposal; maternal factors (e.g., education)

Post-weaning diet of poor digestibility and/or nutrient density; high burden of infectious disease, particularly diarrhea, in whole community; withholding food from children during and after illnesses

The first distinction, acute vs chronic, can be made on the basis of weight and height for age. Chronic malnutrition is characterized by roughly equal deficits in both weight and height or length. In acute malnutrition, weight is relatively more affected than height or length.

Where acute malnutrition is endemic it often expresses itself early in life. In the first six months, malnutrition may result from low birthweight (and thus to poor nutritional status of women) or it may be consequence of lack of breastfeeding or early weaning with inadequate and unsanitary substitutes. When the peak incidence of malnutrition occurs somewhat later, it is more likely to be due to inadequate supplementation of breast milk, sudden weaning, and/or infectious disease. Chronic undernutrition in childhood expresses itself as progressive stunting, with the onset
of the growth deficit usually prior to six months and becoming progressively more severe until age 3-4 years.

The key information needed to hypothesize whether childhood malnutrition is related to food supply and agricultural production is distributional. When malnutrition is of the chronic type but not clustered in households, we must look for differential child care practices (by sex, birth order or other factors); high burdens of infectious disease, particularly diarrhea; post-weaning diets which are of poor quality; and maladaptive child feeding practices such as withholding food from sick children. If malnourished children are clustered in households, the most likely causes are inequity of resources resulting in absolute resource limitations (food, money) in poor households. When whole communities are malnourished, including adult members, food supply is almost always limiting and global intervention measures (short- and long-term) are called for. An example of a rapid cross-sectional survey of mothers and children in the context of an agricultural development is a recent study in Mauritania, in which local agricultural productivity was clearly tied to malnutrition (14).

**Evaluation and monitoring.** Repeated cross-sectional surveys are the simplest and most straightforward way to monitor change in nutritional status in the community in response to changing conditions, including planned interventions. Care must be taken to assure that sampling, seasonal factors, and other potentially biasing factors are accounted for or controlled.
Iron Deficiency

Although iron deficiency is common in women of childbearing age and in preschool children throughout the world, it is present in excess proportions in developing countries and its prevalence may respond dramatically to improvements in the quality of diet available, particularly to an increase in the amount of animal products in the diet. Unlike PEM, which usually reflects the quantity of the staple diet available and consumed, iron deficiency reflects a deficiency in dietary quality and/or the presence of factors which significantly elevate iron requirements.

For reconnaissance purposes, observations of the following give a clue to the probable existence of an iron deficiency problem: low portion of animal products in the diet; infant feeding practices which include early weaning (prior to 12-15 months) or very late introduction of supplements to breast milk (after 6-8 months); high fertility and/or short birth intervals (creating higher iron needs for women); the presence of parasitic diseases (chiefly hookworm) which directly compete for iron.

Rapid assessment and evaluation require direct measurement of iron status through biochemical methods. The simplest measures are hemoglobin and hematocrit, which are useful indicators except in areas where malaria is endemic (in the case of endemic malaria, most anemia would not be due to iron deficiency). The possibility of rapid field measurement of hemoglobin and hematocrit has improved dramatically with the development of the
method of Feraudi and Mejia (15), in which a drop of fingerprick blood is put on a pre-punched disk of filter paper, dried, and transported at the field team's convenience to the laboratory where hematocrit is determined gravimetrically and hemoglobin spectrophotometrically.

**Vitamin A Deficiency.**

Vitamin A deficiency is a major nutritional problem in many countries; xerophthalmia, the ultimate clinical manifestation of vitamin A deficiency, remains the most important cause of blindness in children in developing countries. In addition, subclinical levels of hypovitaminosis A are related to increased incidence of diarrheal and respiratory disease and to mortality risk in children. Vitamin A deficiency is in many places a seasonal problem, where the major dietary sources are fruits and vegetables with seasonal availability.

*Reconnaissance surveys* should include questions and observations designed to identify whether the community is at risk of vitamin A deficiency. If there are local terms for night-blindness or for the scaly, rough surface lesions of the cornea which typify early stages of the ocular manifestations of the disease (known scientifically as Bitot's spots, but in some cultures as "scaley eyes", "fish eyes" or similar terms), we can assume that the population is familiar with the manifestations of vitamin A deficiency. Since vitamin A is distributed primarily in animal foods and in green and orange fruits and vegetables,
food consumption and availability surveys can focus on sources of this nutrient. Particular attention should be paid to seasonal aspects, and to infrequent feasts which may include the consumption of organ meats, which are particularly concentrated sources of vitamin A.

There are no appropriate, field-adapted biochemical tests to monitor vitamin A status. Rapid assessment and monitoring of vitamin A deficiency has until recently depended on systematic identification of clinical cases of hypovitaminosis A and on dietary data collected to assess the consumption of sources of vitamin A and its precursor, beta-carotene. Food frequency approaches to dietary monitoring are particularly appropriate, since consumption of significant sources may not be regular. Recently a simple, field-appropriate physical test has been developed, conjunctival impression cytology, which is proving to be effective in detection of even mild vitamin A deficiency (16-18). The test consists of laying a small piece of filter paper on the surface of the conjunctiva for a few seconds; then lifting it off and staining it. The sample is stable to periods of at least several weeks, and the laboratory methods involved in staining and reading the samples are relatively simple and inexpensive. The sensitivity of the test appears to be excellent; specificity is limited on a cross-sectional basis because of variable and as-yet undefined time for the surface of the eye to recover after improvement of vitamin A status. Work is ongoing to establish the
specificity of the test under conditions in which eye infections such as conjunctivitis and trachoma are endemic.

CONCLUSIONS

Nutritional status offers a convenient summary measure of well-being which can aid in the planning and evaluation of applied agricultural programs. The type, distribution and prevalence of malnutrition give clues as to the degree to whether agricultural production and/or food supply are determinants of malnutrition. When they are important determinants, monitoring of changes in nutritional status in the population is a powerful evaluative tool.

There is a need for further development of simple, field-appropriate, inexpensive methodology for nutritional status assessment, for interpretation of nutritional status data, and for assessment of dietary intakes. Nevertheless, existing methods are adequate for the requisite information to be incorporated, with a minimum of technical assistance, into planning and evaluation for applied agricultural projects. The challenge to farming systems research at the present time is not only to figure out and implement what works for the farmer in terms of increasing agricultural productivity, but to understand what works for the farm household in terms of protecting and promoting health and well-being.
REFERENCES


